Wildlife Conservation Society

TECHNICAL PROPOSAL FOR THE CONTINGENCY PLAN ON ACTIVE SURVEILLANCE OF ZOONOSES:

Coordination, Risk Assessment And Emergency Preparedness.

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Executive summary

The Active Surveillance Plan for Zoonotic Diseases in Bolivia establishes a high-resolution monitoring framework to address the increasing risk of pathogen spillover at the human-wildlife interface. As wildlife trade, bushmeat consumption, and cultural practices continue to facilitate zoonotic disease transmission, the plan enhances Bolivia's early detection, response, and risk mitigation capabilities through a structured One Health approach. This strategy integrates epidemiological surveillance, molecular diagnostics, environmental assessments, and real-time data-sharing mechanisms to strengthen national preparedness and response frameworks.

A multi-sectoral governance structure, led by the National Zoonotic Surveillance Committee (NZSC), will oversee coordinated efforts among the Ministry of Health (MS), SENASAG, INLASA, MMAyA, and enforcement agencies. The plan prioritizes active surveillance interventions, including systematic wildlife pathogen screening, serological monitoring of at-risk human populations, and environmental contamination assessments. High-risk species such as primates (Alouatta spp., Ateles spp.), jaguars (Panthera onca), and armadillos (Dasypus novemcinctus) will be monitored in wildlife markets, hunting zones, and ecological corridors to detect zoonotic threats before they reach epidemic potential. The deployment of mobile diagnostic laboratories equipped with PCR, ELISA, and genomic sequencing technologies will enable on-site detection and risk evaluation, reducing response time to emerging zoonotic events.

Risk mitigation strategies will focus on wildlife trade enforcement, biosecurity enhancement, and behavioral interventions targeting bushmeat handling, illegal pet trade, and cultural practices involving wildlife use. The plan aims to achieve a 30% reduction in illegal wildlife trade cases within five years and a 50% increase in safe handling compliance in bushmeat markets. Additionally, an integrated Early Warning System (EWS) will aggregate real-time epidemiological, veterinary, and environmental data, enhancing predictive modeling and cross-border disease intelligence sharing with Brazil, Peru, Argentina, and Paraguay.
To ensure rapid containment and outbreak response, the plan establishes a Pandemic Preparedness Task Force responsible for executing quarantine measures, movement restrictions, and zoonotic risk assessments in the event of an outbreak. Indigenous Zoonotic Sentinels and Community-Based Surveillance Networks (CBSN) will be mobilized to integrate Traditional Ecological Knowledge (TEK) with formal disease surveillance, improving detection sensitivity in remote and high-risk areas. A structured Monitoring & Evaluation (M&E) framework will facilitate policy refinement, interagency coordination, and stakeholder engagement, ensuring iterative improvements in surveillance efficacy.

This technical proposal for the contingency plan on active surveillance for zoonotic diseases follows international best practices, including those from the World Organisation for Animal Health and WHO. It serves as a resource for policymakers, researchers, and stakeholders, offering strategies to reduce zoonotic disease risks, enhance One Health integration, and protect Bolivia's public and wildlife health.

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Acronym

ELISA	Enzyme-Linked Immunosorbent Assay
GIS	Geographic Information System
INLASA	National Institute of Health Laboratories
IZDRF	Interagency Zoonotic Disease Response Framework
MMAyA	Ministry of Environment and Water
MZRT	Municipal Zoonotic Response Teams
NEOC	National Emergency Operations Center
NZSC	National Zoonotic Surveillance Committee
OIE	World Organisation for Animal Health
ORAS-CONHU	Andean Health Organization
PAHO	Pan American Health Organization
PCR	Polymerase Chain Reaction
POFOMA	Forestry and Environmental Preservation Police
PPE	Personal Protective Equipment
RZSC	Regional Zoonotic Surveillance Center
SENASAG	The National Service for Agricultural Health and Food Safety
UAGRM	Universidad Autónoma Gabriel René Moreno
UMSA	Universidad Mayor de San Andrés
UTO	Universidad Técnica de Oruro
WHO	World Health Organization
ZDICS	Zoonotic Disease Incident Command System
ZDNTF	Zoonotic Disease National Task Force

Introduction

Wildlife trade in Bolivia, both legal and illegal, poses a significant risk for zoonotic disease transmission. The close interaction between humans and wildlife through pet ownership, bushmeat consumption, and traditional medicine increases the likelihood of pathogen spillover. The expansion of urbanization, deforestation, and climate change has further intensified human-wildlife interactions, increasing the frequency and impact of zoonotic disease outbreaks. Additionally, Bolivia's rich biodiversity, including high-risk species such as primates, jaguars, and armadillos, makes the country a potential hotspot for emerging infectious diseases.

The country's existing *Passive Surveillance Plan for Zoonotic Diseases*, which emphasizes structured monitoring and early detection, has laid the groundwork for addressing zoonotic threats. However, by implementing a comprehensive active surveillance strategy, authorities can detect zoonotic threats at their source, reducing the risk of large-scale outbreaks that could affect both public health and biodiversity conservation efforts. A successful active surveillance system integrate a multi-sectoral approach involving governmental agencies, Non-Governmental Organizations (NGOs), research institutions, and international partners. A One Health framework, that recognizes the interconnectedness of human, animal, and environmental health, will serve as the foundation for this initiative. By improving coordination, risk assessment, and early warning systems, Bolivia could build strong resilience against future zoonotic disease outbreaks while promoting sustainable wildlife trade practices.

This contingency plan outlines an active surveillance system for zoonotic spillovers from wildlife and bushmeat linked to trade, consumption and cultural practices. It details coordination mechanisms, emergency preparedness measures, joint risk assessments, risk reduction strategies, emergency communication frameworks, and the roles of various authorities in pandemic preparedness.

SECTION ONE

1. Coordination Mechanisms & Emergency response team.

A well-structured coordination mechanism is essential for the effective implementation of Bolivia's active surveillance system for zoonotic diseases. The establishment of an Interagency Zoonotic Disease Response Framework (IZDRF) will facilitate real-time collaboration, data-sharing, and rapid mobilization of resources among key stakeholders, ensuring swift detection, containment, and mitigation of zoonotic spillover events. The IZDRF is essential for coordinating Bolivia's response to zoonotic disease threats. This framework will unify government agencies, research institutions, law enforcement, and indigenous community networks.

Currently, Bolivia does not have a formal Zoonotic Disease Incident Command System (ZDICS) to streamline multi-sectoral coordination, outbreak management, and emergency response. Establishing such a system is critical to reducing redundancy, improving communication, and ensuring a swift, organized response to zoonotic disease outbreaks.

1.1. National Zoonotic Surveillance Committee (NZSC) and Interagency Task Force (ITF)

The National Zoonotic Surveillance Committee (NZSC) will be established as Bolivia's primary decision-making body for zoonotic disease monitoring and response. It will function under the One Health approach, integrating human, animal, and environmental health sectors to facilitate a coordinated, multi-sectoral response to emerging zoonotic threats. The NZSC will serve as the central authority responsible for oversight, policy development, and strategic planning, ensuring that Bolivia has a structured and proactive approach to mitigating zoonotic disease risks.

A key function of the NZSC will be to oversee national zoonotic disease surveillance efforts, ensuring that Bolivia maintains continuous pathogen monitoring and risk assessment across wildlife, livestock, and human populations. This will involve setting national guidelines for active and passive surveillance, defining high-risk species and geographic hotspots, and developing integrated monitoring systems that allow for early detection of emerging pathogens. The NZSC will coordinate with field surveillance teams, research institutions, and local health authorities to collect epidemiological data, analyze disease transmission trends, and identify areas where intervention measures are needed.

Another critical role of the NZSC is to develop data-driven risk assessment protocols that will guide Bolivia's outbreak prevention and response strategies. These protocols will be based on scientific research, epidemiological modeling, and real-time surveillance data, allowing the committee to evaluate zoonotic spillover risks at different points of human-wildlife interaction. The NZSC will use this data to establish risk classification systems, enabling authorities to implement targeted containment measures, such as wildlife trade restrictions, enhanced market sanitation protocols, and biosecurity controls in high-risk regions. This evidence-based decision-making will improve Bolivia's ability to anticipate, detect, and respond to zoonotic disease outbreaks before they escalate into national health emergencies.

To strengthen Bolivia's interagency collaboration and surveillance capacity, the NZSC will be supported by the Interagency Task Force (ITF), which will consist of representatives from governmental agencies, research institutions, law enforcement bodies, and international partners. The ITF will function as an operational unitresponsible for ensuring that surveillance strategies are implemented effectively on the ground. This task force will include health officials, veterinarians, ecologists, law enforcement officers, and local community representatives, allowing for a diverse and interdisciplinary approach to zoonotic disease surveillance. The ITF will be responsible for deploying rapid response teams (RRTs), managing field-based diagnostics, and ensuring that biosecurity measuresare enforced in wildlife trade markets, border regions, and rural communities with high human-wildlife interaction.

A major responsibility of the NZSC and ITF will be to facilitate cross-sectoral data-sharing agreements to enhance Bolivia's ability to detect and contain zoonotic threats. Currently, data fragmentation among different government agencies and research institutions creates gaps in disease monitoring and slows outbreak response efforts. To address this, the NZSC will develop a centralized zoonotic disease data platform, integrating surveillance reports from hospitals, veterinary clinics, environmental monitoring agencies, and wildlife conservation organizations. This system will allow for real-time exchange of information between relevant stakeholders, ensuring that Bolivia has an early warning system capable of detecting potential outbreaks at their source. The ITF will play a crucial role in coordinating these data-sharing efforts, ensuring that all agencies adhere to standardized reporting protocols and that epidemiological findings are communicated efficiently and transparently across sectors.

The establishment of the NZSC and ITF will eliminate redundancies, enhance coordination, and strengthen Bolivia's capacity to respond to zoonotic disease threats efficiently. By integrating policy-making, field operations, and data-sharing mechanisms into a single framework, this structure will ensure a faster, more coordinated, and scientifically informed approach to zoonotic disease surveillance and outbreak management.

1.1.1. The Interagency Task Force (ITF)

The Interagency Task Force (ITF) will function as an operational unit under NZSC, comprising specialized teams from Ministry of Health, SENASAG, MMAyA, INLASA, POFOMA, indigenous and Community-Based Surveillance Networks.

- **The Ministry of Health**

The Ministry of Health will oversee national zoonotic disease surveillance, ensuring rapid detection, reporting, and response to emerging threats. To address the current over-reliance on urban hospitals for zoonotic case reporting, the Ministry must expand surveillance beyond sentinel healthcare facilities by integrating community-based syndromic monitoring networks in rural and indigenous regions. Deploying trained local health workers, veterinarians, and community informants will facilitate early identification of unusual symptoms and unexplained illness clusterslinked to zoonotic pathogens. These frontline surveillance teams will utilize digital reporting tools to transmit real-time data to national health databases, enabling comprehensive trend analysis and predictive outbreak modeling.

Proactive field epidemiological investigations must be intensified in high-risk zones, including wildlife trade hubs (San Matías, Cobija, Riberalta, Trinidad) and remote rural communities with frequent human-animal interactions. The deployment of mobile diagnostic units equipped with serological and molecular screening technologies will enhance pathogen detection capabilities in underserved areas, reducing diagnostic delays. Additionally, routine syndromic surveillance programs must be implemented in community health centers, traditional healing practices, and indigenous settlements, ensuring that zoonotic disease signals are identified at their source.

To strengthen early warning mechanisms, the Ministry must integrate real-time data-sharing systems with veterinary, environmental, and epidemiological networks. Establishing community-led disease reporting protocols—leveraging mobile health technology and local knowledge networks—will improve surveillance sensitivity and enable targeted public health interventions. Swift implementation of vaccination campaigns, prophylactic treatments, and health education initiatives tailored to rural and indigenous populations will mitigate zoonotic spillover risks before they escalate into larger public health emergencies. This decentralized, One Health-aligned approach will ensure Bolivia's zoonotic disease surveillance system is responsive, inclusive, and equipped to detect and contain emerging threats at the community level.

- **SENASAG**

SENASAG will monitor animal health, particularly in high-risk wildlife species (primates, jaguars,armadillos, peccaries,capybaras and birds among others), livestock, and domestic animals that may serve as intermediate hosts. From an active surveillance perspective, SENASAG must implement systematic field monitoring programs that include serological testing, pathogen screening, and molecular diagnostics for key zoonotic agents such as *Brucella spp.*, *Leptospira spp.*, and *Rabies lyssavirus*. Targeted sampling efforts are to be conducted in known wildlife trade hotspots, livestock farms, and rural communities where human-animal interactions are frequent. Furthermore, SENASAG must establish mobile veterinary units equipped to conduct rapid diagnostic assessments and biosurveillance in areas with high disease transmission potential. These efforts will be complemented by routine collaboration with local veterinary practitioners and community-based surveillance networks to ensure early detection and reporting of unusual morbidity and mortality events in animals. Integration of SENASAG's surveillance data with national health databases will enable real-time epidemiological mapping, thereby strengthening Bolivia's capacity for zoonotic risk assessment and outbreak preparedness.

- **MMAyA**

The MMAyA have a critical role in assessing environmental risks associated with zoonotic disease transmission. From an active surveillance perspective, the MMAyA will focus on monitoring habitat destruction, water contamination, and climate change-driven alterations in disease patterns. Deforestation and habitat fragmentation will be mapped using remote sensing and GIS tools to identify high-risk areas where human-wildlife interactions are increasing. This information will be cross-referenced with zoonotic disease incidence data to pinpoint emerging hotspots. Additionally, MMAyA will conduct water quality surveillance in key ecosystems, especially in regions where wildlife and livestock interact with human populations. Sampling will be conducted in rivers, wetlands, and waterholes to detect

zoonotic pathogens such as *Leptospira spp.* and *Cryptosporidium spp.*. This surveillance will be complemented by vector monitoring, tracking insect populations that serve as disease vectors, such as mosquitoes responsible for transmitting arboviruses and *Plasmodium* species causing malaria.

Climate change projections will also be integrated into the active surveillance framework, allowing the prediction of shifts in vector distribution and zoonotic disease spillover risks. Rising temperatures and altered rainfall patterns can expand the range of disease-carrying wildlife and their associated pathogens. The MMAyA will collaborate with climatologists and ecologists to incorporate predictive modeling tools that estimate future zoonotic risks based on climate data. To ensure real-time environmental surveillance, the MMAyA will establish field monitoring stations in strategic locations, particularly within biodiversity-rich but high-risk areas such as the Amazon basin and the Gran Chaco region. These stations will collect real-time environmental and epidemiological data, which will be integrated into the national health data platforms to facilitate early warning and rapid response measures.

- **INLASA**

The National Institute of Health Laboratories (INLASA**)** plays a pivotal role in Bolivia's active surveillance system for zoonotic diseases. As the central reference laboratory, INLASA is responsible for conducting highly specialized diagnostic testing for suspected zoonotic pathogens, ensuring rapid and precise pathogen identification. Under the active surveillance framework, INLASA will integrate molecular and serological diagnostics with real-time data-sharing mechanisms to enable early detection of emerging zoonotic threats.

One of INLASA's core responsibilities is the deployment of mobile diagnostic laboratories to high-risk regions, such as wildlife markets (La Paz and Santa Cruz), border areas (such as Cobija or Pando, Puerto Suárez or Santa Cruz and Villamontes or Gran Chaco) and regions with documented zoonotic spillover events (such as Beni Department, Trinidad and Riberalta (Beni) and Yungas Region (La Paz). These units will conduct on-site PCR testing, ELISA serology, and genomic sequencing, allowing for the immediate confirmation of pathogens and timely epidemiological response. Additionally, INLASA will establish a biobank of zoonotic pathogens, preserving genetic material for research and comparative analysis, facilitating the tracking of pathogen evolution and transmission patterns.

To enhance national diagnostic capacity, INLASA will collaborate with regional laboratories **(**SENASAG Diagnostic Laboratories and Regional Veterinary Laboratories in Santa Cruz, Beni, and Pando)**,** universities (UMSA, UAGR and UTO) , and international research institutions (WHO, PAHO, OIE and ORAS- CONHU)**,** standardizing testing protocols and ensuring continuous training for laboratory personnel in biosafety, pathogen detection, and genetic sequencing. These efforts will minimize diagnostic delays, allowing public health authorities to implement rapid containment measures (such as Quarantine and Movement Restrictions, Immediate Diagnostic Testing and Surveillance, Public Health Interventions and Mass Vaccination and Risk Communication and Community Engagement among others) to prevent the escalation of zoonotic outbreaks.

Moreover, INLASA will be integrated into the National Early Warning System (EWS)**,** receiving and analyzing wildlife and human mortality reports in real time. Automated alerts will

trigger immediate sample collection and priority testing for suspicious cases. By aligning diagnostic efforts with active field surveillance, INLASA will enhance Bolivia's capacity to detect, verify, and respond to zoonotic disease threats at their earliest stages**.** By reinforcing its role within Bolivia's active surveillance system, INLASA will serve as the backbone for zoonotic disease diagnostics, ensuring early pathogen detection, rapid case confirmation, and real-time epidemiological reporting**.**

- **POFOMA**

The Forestry and Environmental Preservation Police (POFOMA) will be responsible for enforcing wildlife trade regulations, cracking down on illegal trafficking, and ensuring compliance with biosecurity measures in markets and trade hubs. POFOMA will work closely with customs and border control agencies to intercept illegally trafficked wildlife, dismantle poaching networks, and prosecute offenders under national laws (Law No. 1333 on the Environment (1992), Forestry Law No. 1700 (1996), Law No. 700 for the Defense of Animals Against Acts of Cruelty and Mistreatment (2015), Criminal Code of Bolivia (Article 223, 2009 and Law No. 300 (Framework Law of Mother Earth and Integral Development for Living Well, 2012)) as well as international laws (CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973), Convention on Biological Diversity (CBD, 1992) and nited Nations Convention Against Transnational Organized Crime (UNTOC, 2000)). Regular inspections of wildlife markets, breeding facilities, and transportation routes will be conducted to detect unlawful activities and ensure adherence to quarantine protocols. Additionally, POFOMA will collaborate with veterinary authorities to assess the health status of confiscated animals, implementing necessary containment measures to prevent the spread of zoonotic diseases. To strengthen enforcement capabilities, specialized training programs must be developed for officers on disease risk assessment, safe handling of wildlife, and forensic investigation techniques to track illegal trade routes. POFOMA will also coordinate with local communities to raise awareness about the legal implications of wildlife trafficking and encourage public participation in reporting suspicious activities. This will be achieved by engaging indigenous leaders and elders as trusted intermediaries, ensuring that community concerns and traditional knowledge are respected. Regular participatory meetings and assemblies will be conducted in local languages such as Quechua, Aymara, and Guaraní to raise awareness of the legal implications of wildlife trade and provide accessible reporting mechanisms. Local radio stations, storytelling workshops, and visual materials will be used to disseminate information in culturally relevant formats. To incentivize reporting, anonymous hotlines and mobile applications will be developed, allowing community members to report suspicious activities discreetly. Additionally, community-based wildlife monitoring programs will be established, training indigenous 'Wildlife Sentinels' to document and report illegal activities. POFOMA will also introduce financial and social incentives, such as rewards, and access to alternative income opportunities through ecotourism or sustainable farming. These integrated strategies will foster trust and encourage proactive community involvement.

- **Non Government Organizations (NGOs).**

The Wildlife Conservation Society (WCS) and other NGOs including universities will support field data collection by deploying trained personnel to conduct surveillance in wildlife trade hubs, natural habitats, and local markets. These organizations will contribute valuable insights into wildlife health trends by monitoring pathogen circulation in key species, collecting

biological samples for genetic and serological analysis, and identifying ecological factors that may facilitate zoonotic spillover. Additionally, NGOs will engage local communities and indigenous groups to enhance participatory surveillance, improve data accuracy, and strengthen disease early warning mechanisms.

- **Community-Based Surveillance & Indigenous Involvement**

Effective zoonotic disease surveillance in Bolivia necessitates the integration of Indigenous knowledge systems and community-based monitoring frameworks to enhance early detection capabilities. The establishment of Indigenous Zoonotic Sentinels will be prioritized, ensuring that local communities actively participate in pathogen surveillance through structured training programs focused on recognizing atypical wildlife morbidity and mortality events. Traditional ecological knowledge (TEK) will be systematically incorporated into risk assessments by leveraging Indigenous observations of animal behavior, environmental shifts, and climate-induced disease patterns. Furthermore, community-based syndromic surveillance networks (CBSN) will be established to facilitate early reporting of unexplained illnesses among both human and animal populations, supported by mobile health applications and digital data collection platforms. Anonymized wildlife morbidity reporting hotlines will be deployed to encourage community members to report suspected zoonotic events without fear of legal or economic repercussions. Participatory mapping techniques will be employed to identify high-risk zones, ensuring targeted interventions in areas with frequent human-wildlife interactions.

- **International Collaboration and Support**

International organizations, including the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the World Organisation for Animal Health (OIE), will provide technical support, capacity-building, and funding to enhance Bolivia's zoonotic disease surveillance infrastructure. These entities will facilitate cross-border collaboration, ensuring that surveillance efforts align with global health standards and international disease reporting obligations.

The WHO will play a key role in strengthening Bolivia's public health response capacity by providing guidance on disease control strategies, laboratory diagnostics, and outbreak investigation protocols. The FAO, through its Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES), will assist in implementing sustainable biosecurity measures in animal husbandry and wildlife management. The OIE will support veterinary capacity-building by improving disease reporting mechanisms, promoting international veterinary certification standards, and facilitating knowledge exchange through regional zoonotic disease surveillance networks.

Additionally, these organizations will facilitate real-time data exchange and technical cooperation between Bolivia and neighboring countries, particularly in the Amazon Basin region, to mitigate the transboundary spread of zoonotic pathogens. Joint simulation exercises will be conducted to assess Bolivia's pandemic preparedness and response effectiveness. These collaborations will also help Bolivia access emergency funding mechanisms such as the WHO Contingency Fund for Emergencies (CFE) and the FAO's Special Fund for Emergency and Rehabilitation Activities (SFERA)**,** ensuring rapid resource mobilization in the event of a large-scale zoonotic outbreak.

1.2. Emergency Response Units (ERUs) and Rapid Deployment Teams (RDTs)

To strengthen Bolivia's ability to detect, assess, and respond to zoonotic disease threats, Emergency Response Units (ERUs) will be established in key high-risk zones, including Santa Cruz, Beni, Pando, and border regions with Brazil and Peru. These areas are critical points of human-wildlife interaction, where factors such as bushmeat trade, deforestation, and illegal wildlife trafficking increase the likelihood of zoonotic spillover events. The ERUs will function as regional command centers, coordinating surveillance efforts, outbreak response, and data collection across different sectors. Their placement in these epidemiologically significant regions will ensure that Bolivia can respond swiftly and efficiently to potential zoonotic disease outbreaks before they escalate into widespread health crises.

Each ERU will be equipped with mobile diagnostic laboratories, allowing for rapid, on-site detection of zoonotic pathogens. These units will be outfitted with polymerase chain reaction (PCR) machines, enzyme-linked immunosorbent assay (ELISA) kits, and lateral flow rapid antigen testing technologies, ensuring that pathogens such as *Leptospira spp., Brucella spp., Rabies lyssavirus,* and emerging viral threats can be identified immediately at the source. This capability is crucial for preventing delays in diagnosis, which can significantly impact the timeliness of containment measures. Additionally, ERUs will maintain a stockpile of Personal Protective Equipment (PPE), including biosafety suits, gloves, masks, and decontamination supplies, to protect field personnel from direct exposure to high-risk biological materials. Each ERU will also be equipped with biosafety-level (BSL-3) containment units, enabling secure handling of hazardous pathogens during diagnostic testing and sample transport.

To enhance Bolivia's real-time disease tracking and outbreak prediction capabilities, ERUs will integrate Geographic Information System (GIS) surveillance platforms. These platforms will map zoonotic disease hotspots, track the spread of infections over time, and analyze environmental risk factors such as deforestation, water contamination, and wildlife migration patterns. The data collected will be synchronized with the National Zoonotic Disease Surveillance and Response Platform (NZDSRP), ensuring that epidemiologists, veterinary officials, and public health authorities have continuous access to up-to-date zoonotic disease intelligence. This integration will improve outbreak forecasting models, allowing authorities to implement preventive measures in regions identified as potential spillover sites.

To operationalize these surveillance efforts, Rapid Deployment Teams (RDTs) will be stationed within each ERU, ensuring that trained specialists can be deployed to suspected zoonotic spillover sites within 24 to 48 hours. These teams will include veterinarians, epidemiologists, environmental scientists, forensic specialists, and law enforcement officers, ensuring a multidisciplinary approach to outbreak response. The primary responsibilities of RDTs will be field-based pathogen sampling, community engagement, and biosecurity enforcement.

Field sampling efforts will involve the collection and analysis of biological specimens, including blood, saliva, fecal matter, urine, and environmental samples from wildlife, livestock, and human populations. Sampling sites will include wildlife trade markets, bushmeat processing sites, agricultural zones, and remote indigenous communities where zoonotic spillover risks are elevated. Advanced portable diagnostic equipment will allow on-

site analysis of samples, significantly reducing the time needed for laboratory confirmation. In cases where mobile diagnostics are not sufficient, samples will be securely transported to INLASA's central reference laboratory for further genomic sequencing and pathogen characterization.

In addition to field sampling, RDTs will engage with local communities, bushmeat vendors, hunters, and indigenous groups to promote early disease reporting and safe wildlife handling practices. Community engagement will include educational workshops, mobile information campaigns, and radio broadcasts in local languages, ensuring that rural populations are aware of zoonotic disease risks and prevention measures. Encouraging proactive reporting of wildlife die-offs, unexplained illnesses, and livestock mortalities will enhance Bolivia's early warning surveillance system, enabling faster detection of potential outbreaks.

A critical function of RDTs will be biosecurity enforcement at wildlife markets, livestock farms, and border crossings, where zoonotic transmission risks are highest. These teams will conduct routine inspections of wildlife trade facilities, ensuring that hygiene regulations, pathogen screening, and quarantine protocols are strictly followed. RDTs will also work alongside POFOMA (Forestry and Environmental Police) and customs officials to intercept illegal wildlife shipments, preventing the introduction of infected animals into human-dense environments. In high-risk outbreaks, RDTs will enforce temporary quarantine measures, movement restrictions, and decontamination protocols, limiting further spread of zoonotic pathogens.

1.3. Real-Time Surveillance Data Integration and National Zoonotic Data Integration Platform (NZDIP)

Effective zoonotic disease surveillance and response require real-time data integration across multiple sectors, enabling timely decision-making and rapid outbreak containment. In Bolivia, zoonotic disease monitoring is currently fragmented, with different institutions collecting data independently, leading to gaps in information flow, delayed outbreak detection, and uncoordinated response efforts. To address this, a National Zoonotic Data Integration Platform (NZDIP) will be developed as a centralized digital infrastructure, consolidating wildlife, human health, environmental, and trade surveillance data into a unified system. This platform will serve as a real-time repository of epidemiological intelligence, ensuring that all relevant stakeholders have access to up-to-date information on zoonotic disease risks, spillover events, and transmission patterns.

The NZDIP will function as a national database, integrating information from key surveillance networks, including wildlife disease monitoring databases (SENASAG, MMAyA), human disease surveillance records (Ministry of Health), and environmental pathogen tracking systems (MMAyA, WCS). This integration will allow health officials, veterinarians, environmental scientists, and law enforcement agencies to collaborate seamlessly, ensuring a cohesive approach to disease prevention and outbreak response. The platform will incorporate geospatial mapping, machine learning algorithms, and artificial intelligence-driven analytics, enabling authorities to predict disease emergence, track outbreak progression, and implement risk-based interventions. By using predictive modeling, the NZDIP will identify potential zoonotic hotspots, allowing proactive measures to be taken before an outbreak occurs.

A critical feature of NZDIP will be its automated outbreak alert system, which will continuously monitor incoming surveillance data for anomalies, unusual wildlife mortality patterns, or clusters of human illness. Once a potential zoonotic threat is detected, the system will trigger an immediate alert, notifying relevant agencies and activating contingency protocols. For example, if a sudden spike in respiratory illness is reported in a region known for wildlife-human interaction, the platform will automatically cross-reference this data with environmental surveillance reports, checking for recent wildlife die-offs or pathogen detections in the area. If a zoonotic link is suspected, the system will escalate the response level, prompting the deployment of Rapid Response Teams (RRTs), targeted biosecurity measures, and public health interventions.

To ensure effective data-sharing and interagency collaboration, the NZDIP will be integrated with Bolivia's existing health and environmental surveillance infrastructure, creating a national early warning network for zoonotic diseases. This integration will facilitate rapid information exchange between field surveillance teams, research laboratories, and decision-makers, minimizing response delays and improving crisis management efficiency. Data will be collected through mobile applications, digital reporting tools, and satellite-based remote sensing technologies, ensuring that even rural and indigenous communities can participate in early disease reporting.

The platform will also incorporate secure data encryption and access controls, ensuring that sensitive epidemiological information is protected while enabling authorized personnel to conduct real-time analysis and risk assessments. Additionally, the system will be designed for cross-border collaboration, allowing Bolivia to share zoonotic disease data with neighboring countries (Brazil, Peru, Argentina, and Paraguay) and international organizations (WHO, FAO, OIE, and PAHO). This capability will enhance regional preparedness and coordinated outbreak response, preventing the transboundary spread of zoonotic pathogens.

1.4. Cross-Border Coordination and International Collaboration for Zoonotic Disease Surveillance

Zoonotic diseases transcend national borders, making regional and international collaboration essential for effective surveillance, early detection, and outbreak containment. Given Bolivia's geographic location and ecological diversity, it shares significant transboundary zoonotic disease risks with neighboring countries, including Brazil, Peru, Argentina, and Paraguay. The movement of wildlife, livestock, and humans across borders creates potential pathways for disease spillover, re-emergence, and amplification, necessitating a coordinated, multi-country approach to zoonotic disease prevention. To address these challenges, Bolivia will establish a Regional Zoonotic Surveillance Alliance (RZSA), a structured partnership among national health agencies, environmental ministries, law enforcement bodies, and research institutions across the region.

The RZSA will facilitate joint epidemiological investigations to monitor, track, and contain zoonotic disease spillover events that occur in border regions, shared ecosystems, and key trade routes. Many zoonotic pathogens—such as L*eptospira spp., Brucella spp., Rabies lyssavirus*, and hemorrhagic fever viruses—circulate within wildlife and livestock populations that migrate across national boundaries. These movements, coupled with illegal wildlife

trafficking, cross-border bushmeat trade, and agricultural expansion, create an interconnected web of zoonotic risk that cannot be effectively managed by one country alone. Through collaborative research and synchronized surveillance efforts, Bolivia and its regional partners will establish standardized protocols for pathogen detection, data-sharing, and outbreak response. This will involve harmonized sample collection methodologies, coordinated laboratory testing strategies, and uniform reporting mechanisms to ensure that zoonotic disease threats are identified and addressed collectively.

A fundamental aspect of this regional partnership will be the harmonization of wildlife trade regulations to mitigate the risks associated with illegal wildlife trafficking and unsustainable bushmeat markets. Bolivia's proximity to major wildlife trafficking corridors, such as those connecting the Amazon Basin, the Pantanal wetlands, and the Gran Chaco biome, makes it a key player in the fight against transboundary zoonotic threats linked to the wildlife trade. Many species involved in this illicit trade—including primates, armadillos, and rodents—are known reservoirs of zoonotic pathogens. The RZSA will work to strengthen legal frameworks, enforcement mechanisms, and biosecurity measures at border crossings and wildlife markets, preventing the uncontrolled movement of potentially infected animals and animal products. This will include enhanced border inspections, mandatory health screenings for live animal trade, and the development of cross-border risk assessment protocols to ensure that wildlife commerce does not facilitate the spread of infectious diseases.

To improve regional outbreak preparedness, the RZSA will establish a shared early warning alert system for zoonotic disease detection. This system will function as a real-time digital platform, integrating epidemiological surveillance data, wildlife mortality reports, and environmental risk assessments from all participating countries. By utilizing satellite imagery, remote sensing technology, and AI-driven analytics, this system will provide early indicators of disease emergence, allowing for a proactive response before outbreaks escalate into widespread crises. When a zoonotic pathogen is detected in one country, the platform will automatically trigger alerts to notify health authorities, veterinary services, and environmental agencies in neighboring nations, ensuring that containment measures—such as quarantine enforcement, movement restrictions, and vector control operations—are implemented in a coordinated manner.

Additionally, Bolivia will engage in joint capacity-building programs, fostering technical exchanges, intergovernmental training sessions, and simulation exercises to enhance regional response capabilities. This will involve collaborative workshops on biosafety protocols, laboratory diagnostics, and zoonotic risk mitigation strategies, ensuring that public health professionals, veterinarians, and conservation officers across the region are equipped with the knowledge and tools to respond to emerging threats effectively. Strengthening cross-border collaboration will also enable Bolivia to access international funding mechanisms, technical expertise, and disease response resources from global health organizations, such as the World Health Organization (WHO), Food and Agriculture Organization (FAO), World Organisation for Animal Health (OIE), and Pan American Health Organization (PAHO).

2. Establishing an Interagency Zoonotic Disease Response Framework (IZDRF) in Bolivia

The IZDRF will be formed under the One Health framework, integrating health, veterinary, environmental, and law enforcement sectors to create a nationally coordinated zoonotic disease surveillance and response system. The key components of this framework include:

2.1. Multi-Sectoral Coordination & Stakeholder Involvement

The IZDRF will be led by a National Zoonotic Surveillance Committee (NZSC), which will oversee the policy, strategy, and implementation of active zoonotic surveillance. The core agencies involved will include:

- Ministry of Health : Leads human health surveillance, epidemiological investigations, and medical response strategies.
- SENASAG: Oversees zoonotic pathogen screening at the wildlife-livestock-human interface and enforces veterinary health regulations.
- MMAyA: Monitors ecological drivers of zoonotic spillover, including deforestation, habitat destruction, and waterborne disease risks.
- INLASA: Strengthens diagnostic capacity, coordinates pathogen sequencing, and standardizes laboratory testing for zoonotic pathogens.
- POFOMA: Enforces wildlife trade regulations, dismantles illegal wildlife trafficking networks, and ensures biosecurity compliance in wildlife markets.
- Customs and Border Control Agencies: Prevent the cross-border movement of infected wildlife, illegal animal products, and potential disease carriers.
- Indigenous & Community-Based Surveillance Networks: Report unusual wildlife morbidity, mortality, and zoonotic disease symptoms in remote areas.
- International Organizations (WHO, FAO, OIE, PAHO, USAID, CDC): provide technical expertise, funding, and access to international disease surveillance databases.
- Universities & Research Institutions (UMSA, UAGRM, UTO): Support pathogen research, genetic sequencing, and ecological risk assessments.
- NGOs (Wildlife Conservation Society, Fundación Amigos de la Naturaleza, etc.): Field-based surveillance and conservation-driven zoonotic disease monitoring.

2.2. Real-Time Collaboration and Data-Sharing

To facilitate real-time interagency collaboration, the IZDRF will implement the National Zoonotic Disease Surveillance and Response Platform (NZDSRP), a digital system integrating multiple data sources for comprehensive disease monitoring. Human health surveillance data, including hospital reports, syndromic surveillance records, and serological studies, will be incorporated into the platform. Veterinary health surveillance data will include disease testing results from wildlife and livestock, pathogen screening in domestic and wild animal populations, and mortality event tracking. Environmental surveillance data will assess contamination of water sources, deforestation rates, land-use changes, and climate change projections, all of which may contribute to zoonotic spillover risks. Law enforcement and trade surveillance reports will track wildlife confiscations, illegal pet trade seizures, and border interceptions of live animals to identify potential disease transmission pathways.

The NZDSRP will leverage Geographic Information System (GIS) mapping and artificial intelligence (AI)-based outbreak forecasting to provide real-time geospatial analysis,

identifying high-risk areas for zoonotic disease emergence and spread. Mobile data collection tools will enable rapid field data entry by surveillance teams and community-based networks, ensuring timely disease reporting. The platform will generate automated early warning alerts to notify government agencies, healthcare providers, and veterinary professionals about potential zoonotic outbreaks, enabling preemptive response measures.

2.3. Rapid Resource Mobilization Mechanism

A critical component of the IZDRF will be the establishment of a rapid resource mobilization mechanism to ensure timely and effective outbreak response. A dedicated Zoonotic Disease Contingency Fund will be allocated to facilitate immediate response actions, ensuring that financial constraints do not hinder critical interventions such as containment, treatment, and vector control efforts.

To enhance logistical preparedness, pre-positioned stockpiles of essential response supplies will be established in strategic locations, particularly in high-risk regions such as Santa Cruz, Beni, and Pando. These stockpiles will include personal protective equipment (PPE), diagnostic kits (including Polymerase Chain Reaction [PCR] tests, Enzyme-Linked Immunosorbent Assay [ELISA] kits, and rapid antigen tests), vaccines for priority zoonotic diseases, and a supply of antibiotics and antiviral medications.

Mobile diagnostic units will be deployed to outbreak sites to facilitate real-time pathogen detection and epidemiological assessments. These units will be equipped with advanced laboratory technologies, including PCR machines for rapid genetic identification of pathogens, ELISA testing for antibody detection and immune response analysis, and genomic sequencing tools to characterize emerging pathogens and identify potential variants of concern.

To ensure a coordinated and effective response to zoonotic outbreaks, emergency response protocols will be standardized, and Rapid Response Teams (RRTs) will be trained for immediate deployment. These teams will consist of epidemiologists, public health specialists, veterinary professionals, environmental scientists, and law enforcement officers. RRTs will be deployed within 24-48 hours of an outbreak alert and will follow structured response protocols, including immediate field investigation, contact tracing, epidemiological assessment, quarantine enforcement, targeted vaccination drives, and public awareness campaigns. Field teams will collect samples for laboratory analysis to confirm pathogen presence and characteristics, guiding targeted response measures.

3. Establishing Bolivia's Zoonotic Disease Incident Command System (ZDICS)

To enhance crisis response coordination, streamline decision-making, and prevent jurisdictional overlaps, Bolivia must establish a Zoonotic Disease Incident Command System (ZDICS) as the central framework for zoonotic disease outbreak management. The ZDICS will function as a structured, hierarchical system that defines stakeholder roles, delineates emergency response procedures, and facilitates real-time coordination between national, regional, and local authorities. This system will ensure that zoonotic disease outbreaks are managed efficiently through evidence-based decision-making, resource mobilization, and a rapid containment strategy.

3.1. National Level – Central Command & Decision-Making

At the national level, the Zoonotic Disease National Task Force (ZDNTF) will serve as the apex decision-making body responsible for formulating national policies, coordinating interagency collaboration, and approving large-scale response interventions. The ZDNTF will be led by the Ministry of Health, with active participation from the National Agricultural Health and Food Safety Service (SENASAG), the Ministry of Environment and Water (MMAyA), the National Institute of Health Laboratories (INLASA), the Forestry and Environmental Police (POFOMA), and international partners such as the World Health Organization (WHO), Food and Agriculture Organization (FAO), and Centers for Disease Control and Prevention (CDC). These agencies will collectively define national zoonotic disease surveillance priorities, approve funding allocations, and oversee high-level response strategies.

The National Emergency Operations Center (NEOC) will be activated when a zoonotic outbreak is declared. The NEOC will serve as the command hub for real-time surveillance, epidemiological data analysis, logistics coordination, and emergency public health communication. It will facilitate interagency cooperation by integrating human health, veterinary, environmental, and law enforcement data streams into a centralized response system. The NEOC will also oversee the deployment of Rapid Response Teams (RRTs), manage vaccine and medical stockpile distribution, and coordinate travel restrictions, quarantine enforcement, and biosecurity measures as required.

3.2. Regional Level – Emergency Response Units (ERUs)

To ensure a localized but coordinated response, Regional Zoonotic Surveillance Centers (RZSCs) will be established in high-risk departments, including Santa Cruz, Beni, Pando, La Paz, and Cochabamba. These centers will function as regional command posts, overseeing field surveillance, diagnostic testing, and emergency response measures. Each RZSC will host dedicated Rapid Response Teams (RRTs), which will be trained in epidemiological investigation, laboratory sample collection, outbreak containment protocols, and public health interventions. These teams will be deployed immediately upon confirmation of zoonotic disease outbreaks to conduct site assessments, initiate quarantine protocols, and administer targeted vaccinations.

In addition to RZSCs, Mobile Diagnostic Laboratories will be stationed at key wildlife trade hubs, livestock markets, and human-wildlife interface zones. These mobile units will be equipped with advanced molecular diagnostic tools such as Polymerase Chain Reaction (PCR) machines, Enzyme-Linked Immunosorbent Assay (ELISA) kits, and genomic sequencing platforms. By facilitating on-site pathogen identification, these mobile labs will enable early detection of zoonotic spillover events and guide evidence-based response interventions.

3.3. Local Level – Community-Based Surveillance & Field Investigations

At the local level, Community Zoonotic Surveillance Networks (CZSNs) will serve as the frontline monitoring system for detecting unusual patterns of wildlife mortality and zoonotic disease symptoms in humans and animals. These networks will be composed of trained local health workers, indigenous community leaders, subsistence hunters, and rural veterinarians who will actively report disease indicators through a real-time digital platform connected to regional and national response centers. Training programs will be established to equip local

surveillance members with field biosafety procedures, sample collection techniques, and early disease reporting mechanisms to enhance zoonotic disease intelligence.

Additionally, Municipal Zoonotic Response Teams (MZRTs) will be established at the municipal level to coordinate localized outbreak containment efforts. These teams will work in collaboration with local health departments, veterinary services, and law enforcement authorities to implement emergency protocols, including contact tracing, quarantine enforcement, decontamination procedures, and infection control measures. MZRTs will also play a critical role in community engagement and risk communication, ensuring that affected populations receive timely and accurate information on outbreak severity, personal protective measures, and available medical interventions.

3.4. ZDICS Emergency Response Protocols

The ZDICS will implement a structured and standardized emergency response protocol to effectively detect, assess, contain, and mitigate zoonotic disease outbreaks in Bolivia. Given the increasing risks associated with zoonotic spillovers, the response process must be systematic, data-driven, and scalable, ensuring that interventions align with outbreak severity. The response framework will consist of four key phases: detection and early warning activation, risk assessment and threat level classification, containment and response actions, and post-outbreak surveillance and recovery. Each phase will be governed by real-time surveillance data, interagency coordination, and rapid resource mobilization to minimize public health and economic consequences.

- **Detection & Early Warning Activation**

Early detection of zoonotic disease threats is critical to ensuring a timely response. The ZDICS will integrate community-based surveillance networks, sentinel health facilities, and digital reporting platforms to monitor unusual wildlife mortality, abnormal disease patterns in livestock, and emerging human infections linked to zoonotic pathogens. Community-based surveillance networks will include trained indigenous leaders, rural health workers, veterinarians, and hunters who will report suspicious wildlife deaths, unexplained livestock illnesses, and early symptoms of zoonotic disease in humans. These reports will be transmitted through mobile-based applications, field data collection tools, and designated hotline channels, ensuring that critical data reaches regional and national authorities without delay. In addition to community-level monitoring, sentinel health facilities will play a key role in detecting potential zoonotic outbreaks. These facilities, including primary healthcare centers, veterinary clinics, and national diagnostic laboratories, will conduct routine syndromic surveillance to identify clusters of fever, respiratory distress, hemorrhagic symptoms, or neurological abnormalities that may indicate a zoonotic disease outbreak. Veterinary surveillance teams will track livestock morbidity, wildlife infection rates, and unusual pathogen behaviors that could signal an impending spillover event. The National Zoonotic Disease Surveillance Platform (NZDSP) will act as the central repository for these real-time reports, using artificial intelligence (AI)-based predictive modeling and Geographic Information System (GIS) mapping to detect high-risk areas. If an anomaly is identified, automated early warning alerts will be sent to national and regional response agencies, triggering a structured risk assessment process.

- **Risk Assessment & Threat Level Classification**

Following early detection, the ZDICS will implement a structured risk assessment model to classify zoonotic threats based on severity, transmissibility, and public health impact. The risk classification system will have three levels: Low Risk, Medium Risk, and High Risk, with response measures escalating accordingly.

At the Low Risk level, if the detected case is an isolated zoonotic infection with minimal human-to-human transmission potential, the response will remain within routine surveillance operations. Field teams will intensify data collection in the affected region, monitoring any additional cases and analyzing pathogen genomic characteristics to determine mutation potential. Veterinary authorities will issue biosecurity advisories to farmers, livestock owners, and wildlife handlers, emphasizing preventive measures to reduce further pathogen transmission.

If an outbreak is classified as Medium Risk, indicating localized clusters of infections in humans or animals, Regional Rapid Response Teams (RRTs) will be activated. These specialized teams, composed of epidemiologists, virologists, public health experts, and veterinarians, will conduct field investigations, diagnostic sample collection, and epidemiological tracing. Immediate containment measures, such as localized quarantine enforcement, movement restrictions on livestock, and targeted culling programs, will be implemented to prevent the spread of infection. Health agencies will coordinate vaccination drives for at-risk populations and enforce temporary trade suspensions on wildlife or livestock products in affected regions.

A High Risk classification will trigger full-scale national intervention, requiring the deployment of the National Emergency Operations Center (NEOC) and the implementation of strict containment protocols. If the pathogen exhibits high transmissibility, severe clinical outcomes, or potential for cross-border spread, the Bolivian government will impose quarantine zones, halt wildlife and livestock trade, enforce border screenings, and restrict public mobility in outbreak areas. Emergency medical response teams will be deployed to hospitals and rural health centers to treat infected patients, provide prophylactic interventions, and manage critical care logistics. International assistance from the WHO, FAO, PAHO, and CDC will be requested if additional resources are needed for containment efforts.

- **Containment & Response Actions**

Once a zoonotic outbreak has been classified, ZDICS will activate immediate containment measures to control the spread of infection and reduce transmission risk. The first step in this phase will involve the deployment of mobile diagnostic laboratories equipped with Polymerase Chain Reaction (PCR) machines, Enzyme-Linked Immunosorbent Assay (ELISA) kits, and genomic sequencing tools. These units will facilitate on-site pathogen identification, genetic sequencing, and real-time confirmation of infection clusters, allowing authorities to rapidly implement targeted response actions.

To physically contain the outbreak, biosecurity zones will be established in high-risk areas, including wildlife markets, livestock farms, and international border crossings. These zones will be subject to disinfection protocols, controlled access measures, and mandatory health screenings to prevent the spread of disease. The decontamination of infected facilities, proper disposal of animal carcasses, and stringent enforcement of personal protective equipment

(PPE) usage among frontline response teams will be prioritized to minimize occupational exposure.

Effective risk communication will also be a fundamental part of containment efforts. The ZDICS will implement a multi-platform public health communication strategy, utilizing national television, radio broadcasts, indigenous community networks, and mobile alert systems to disseminate accurate information on outbreak status, recommended safety measures, and government response actions. Crisis communication specialists will ensure that messaging remains clear, scientifically accurate, and culturally appropriate, addressing misinformation and maintaining public trust in response efforts.

- **Post-Outbreak Surveillance & Recovery**

After the outbreak is contained, the ZDICS will shift focus toward long-term monitoring and recovery efforts to prevent recurrence. Longitudinal pathogen surveillance will be maintained in previously affected regions, with serological surveys, environmental sampling, and continuous wildlife monitoring conducted to detect any residual pathogen reservoirs. These activities will help identify secondary spillover risks and inform ongoing prevention strategies.

Cross-border collaboration will be essential to mitigating future zoonotic threats. The Bolivian government will strengthen regional coordination mechanisms with neighboring countries, ensuring joint outbreak investigations, synchronized quarantine policies, and the sharing of epidemiological data to minimize the risk of transboundary zoonotic disease transmission. International technical assistance and research collaborations will also be leveraged to improve Bolivia's national diagnostic capacity, biosurveillance infrastructure, and pandemic preparedness planning.

Finally, a comprehensive post-outbreak evaluation will be conducted, analyzing response effectiveness, containment efficiency, laboratory diagnostic accuracy, and interagency coordination. Lessons learned will be used to revise and strengthen emergency protocols, update national zoonotic disease policies, and improve frontline response training programs.

SECTION TWO

Emergency Preparedness.

Effective emergency preparedness is critical to mitigating the impact of zoonotic disease outbreaks in Bolivia. Given the increasing risk of pathogen spillover from wildlife to humans, a proactive and well-coordinated response system is essential to prevent large-scale health crises [1].Strengthening emergency preparedness involves developing outbreak response protocols, ensuring that essential medical and diagnostic supplies are readily available, and enhancing the capacity of rapid response teams to act swiftly in high-risk situations [2]. Furthermore, mobile diagnostic units must be deployed in key areas such as Santa Cruz and Beni, where zoonotic spillover risks are highest, enabling rapid on-site testing and containment [3]. Integrating Early Warning Systems (EWS) into national health data platforms will allow for real-time tracking of unusual mortality events in wildlife and human populations, ensuring that authorities can respond promptly before outbreaks escalate (World Health Organization [1].

1. Outbreak Response Protocols for High-Risk Zoonotic Diseases

Effective outbreak response protocols for high-risk zoonotic diseases, including bacterial, viral, and parasitic pathogens such as *Leptospira spp.*, *Rabies lyssavirus*, and *Plasmodium spp.*, among others, are critical for minimizing public health impacts and preventing widespread transmission [4]. The response framework must incorporate a multi-tiered approach involving early case detection, containment measures, medical and veterinary interventions, and cross-sectoral coordination [2].

1.1. Early Detection and Case Reporting

Effective early detection of zoonotic diseases requires a decentralized surveillance approach that extends beyond urban healthcare facilities to rural and indigenous communities, where pathogen spillover risks are highest. The current reliance on urban hospitals for case reporting creates significant delays in identifying outbreaks in remote regions, where limited access to healthcare and diagnostic services can result in underreporting and late interventions. To address this, Bolivia must establish community-based syndromic surveillance networks that integrate local health workers, traditional healers, and community informants into the national reporting system.

A tiered surveillance structure should be implemented, wherein trained community health monitors document and report unusual illnesses, unexplained animal die-offs, and suspected zoonotic symptoms in high-risk areas. These frontline reports must be linked to regional epidemiological units, which will conduct rapid field investigations and relay findings to national health databases. Leveraging mobile health applications, digital reporting tools, and radio communication systems will enhance real-time data flow from rural to national levels, ensuring early case detection even in resource-limited settings. To support early warning capabilities, rural health centers and veterinary posts must be equipped with portable diagnostic kits for syndromic screening, enabling the immediate detection of priority zoonotic pathogens such as *Leptospira spp., Rabies lyssavirus*, and *Brucella spp.* among other priority zoonotic diseases. Additionally, integrating indigenous knowledge systems into zoonotic risk

assessments—through collaboration with community elders and local wildlife trackers—will improve the detection of environmental and behavioral indicators associated with emerging disease threats.

By embedding community-based surveillance within the national reporting framework, Bolivia can bridge the gap between remote populations and centralized health systems, enabling real-time risk assessment across human, animal, and environmental health sectors. This holistic approach will ensure that suspected zoonotic cases are rapidly identified, verified, and responded to, mitigating the risk of large-scale outbreaks [4].

1.2. Containment and Biosecurity Measures

Once a zoonotic outbreak is identified, a comprehensive containment and biosecurity strategy must be enacted to prevent further transmission among wildlife, livestock, and human populations. This requires a multi-tiered response incorporating quarantine enforcement, movement restrictions, environmental decontamination, and targeted closures of high-risk areas to disrupt pathogen spread.

Quarantine measures are critical for both human and animal cases. For infected individuals, designated quarantine facilities must be established with controlled access, ensuring strict infection control measures, including the use of Personal Protective Equipment (PPE), biosafety barriers, and regulated medical waste disposal. Contact tracing and risk-based isolation of exposed individuals are essential for minimizing secondary transmission. For animal cases, infected or exposed livestock and wildlife must be quarantined in secure holding areas, where veterinary teams conduct serological and molecular diagnostics to confirm infection status before determining appropriate interventions, such as treatment, prolonged observation, or culling. Domestic animals in affected areas should undergo immediate pathogen screening and vaccination, where applicable, to prevent further disease spillover.

To further limit transmission, movement restrictions must be enforced in outbreak zones through human mobility controls, wildlife trade suspensions, and quarantine barriers. Travel bans and health screening checkpoints should be established at entry and exit points of affected regions, with biosecurity teams deployed at border crossings to inspect wildlife products, live animals, and travelers from outbreak zones. High-risk areas such as infected farms, wildlife habitats, and trade hubs must be placed under restricted access protocols, preventing disease vectors from spreading across regions. These restrictions should be accompanied by public awareness campaigns, ensuring community compliance and minimizing resistance to containment efforts.

In additon to this, effective environmental decontamination is essential to eliminate pathogen reservoirs in outbreak-affected locations. High-risk facilities, including wildlife markets, slaughterhouses, and quarantine stations, must undergo systematic decontamination using virucidal and bactericidal disinfectants. Safe disposal of infected carcasses, animal waste, and contaminated materials should be conducted through high-temperature incineration or deep burial, following biosafety level-3 (BSL-3) waste management protocols. Additionally, vector control interventions, such as targeted pesticide applications, must be deployed to reduce arthropod-borne transmission risks, particularly in cases involving vector-mediated zoonotic diseases. Soil and water decontamination in affected ecosystems is also necessary, particularly

for waterborne pathogens such as *Leptospira spp*. and *Cryptosporidium spp*., which can persist in environmental reservoirs and cause secondary outbreaks.

Given the role of wildlife markets as high-risk transmission points, temporary closure of affected markets and trade hubs is a necessary containment measure. Immediate suspension of live animal trade and restriction of wildlife product sales should be enacted in outbreak-affected regions, with market inspections and decontamination protocolsenforced before reopening. Additionally, mandatory health screenings for market vendors and traders must be implemented to assess potential zoonotic exposure, while legislative enforcement of wildlife trade restrictions should be strengthened to deter illegal trafficking and non-compliance with closure orders.

Post-outbreak surveillance must be maintained until epidemiological assessments confirm the absence of active transmission. Continuous health monitoring of recovered individuals, long-term pathogen surveillance in wildlife populations, and routine diagnostic testing of livestock are essential for detecting potential disease resurgence. Additionally, adaptive biosecurity policy evaluations must be conducted to refine containment strategies based on outbreak response effectiveness [3].

1.3. Diagnostic and Laboratory Confirmation

Rapid and accurate pathogen identification is critical for effective outbreak response, necessitating the immediate deployment of advanced molecular and serological diagnostics in affected regions. Polymerase Chain Reaction (PCR)-based assays provide high-sensitivity detection of zoonotic pathogens by amplifying specific genetic sequences, allowing for the rapid confirmation of infections even at low viral or bacterial loads. This technique is particularly essential for detecting high-risk zoonotic agents such as *Leptospira spp., Brucella spp.*, and *Rabies lyssavirus*, which may not present with distinct clinical symptoms in early stages. Quantitative PCR (qPCR) and Reverse Transcription PCR (RT-PCR) can further enhance detection by providing real-time viral or bacterial load quantification, which is crucial for monitoring disease progression and transmission potential.

Serological diagnostics, such as Enzyme-Linked Immunosorbent Assay (ELISA), play a complementary role in detecting host immune responses to zoonotic infections. ELISA assays enable the identification of IgM and IgG antibodies, differentiating between recent and past exposures, thus informing epidemiological assessments of pathogen circulation within human and animal populations. Rapid lateral flow immunoassays can further facilitate on-site serological screening, providing near-instant results that support early outbreak containment measures.

To ensure real-time diagnostic capacity in remote and high-risk areas, mobile laboratory units must be strategically deployed to outbreak zones, wildlife trade hubs, and rural health centers. These units should be equipped with field-adapted PCR thermocyclers, portable ELISA analyzers, biosafety containment equipment, and cold-chain storage for biological samples. Point-of-care molecular diagnostics, such as loop-mediated isothermal amplification (LAMP) and CRISPR-based detection systems, can further enhance field-level testing efficiency, allowing for rapid pathogen confirmation without the need for full-scale laboratory infrastructure. Additionally, genomic sequencing technologies should be integrated into

diagnostic workflows to identify novel pathogen variants, track transmission pathways, and support molecular epidemiology studies.

To optimize sample analysis and response coordination, diagnostic laboratories must establish a centralized digital data-sharing system that integrates test results with national epidemiological databases, ensuring real-time reporting to public health agencies and outbreak response teams. This connectivity will enable predictive modeling of outbreak dynamics, facilitate targeted interventions, and support international collaboration for zoonotic disease containment [2].

1.4. Medical and Veterinary Interventions

Effective management of zoonotic disease outbreaks requires pathogen-specific medical and veterinary interventions tailored to bacterial, viral, and parasitic infections. Bacterial zoonoses, such as leptospirosis and brucellosis, necessitate targeted antibiotic regimens—commonly doxycycline, azithromycin, or rifampin for brucellosis—administered alongside fluid resuscitation, renal support, and anti-inflammatory therapy to manage systemic complications. In severe cases of leptospirosis, particularly those leading to Weil's disease, hospitalization with intravenous antibiotics and hemodynamic stabilization is required to prevent multi-organ failure.

Viral outbreaks, including rabies and hemorrhagic fevers, demand rapid deployment of Post-Exposure Prophylaxis (PEP), including rabies immunoglobulin and a full vaccination regimen for exposed individuals. In hemorrhagic fevers such as Bolivian hemorrhagic fever (Machupo virus), supportive care is paramount, including fluid management, coagulation monitoring, and antiviral therapy such as ribavirin where applicable. Strict case isolation and biosafety protocols in healthcare settings, including negative-pressure isolation units and full PPE for medical staff, are critical to containing viral transmission.

Parasitic infections, such as malaria, require species-specific antimalarial regimens, with Artemisinin-based Combination Therapies (ACTs) for *Plasmodium falciparum* and chloroquine for *P. vivax* cases where resistance is absent. Vector control remains a cornerstone of malaria management, necessitating the distribution of Insecticide-Treated Bed Bets (ITNs), Indoor Residual Spraying (IRS), and larval source reduction to disrupt mosquito breeding cycles. Additionally, environmental modifications, such as drainage of stagnant water and habitat modification, must be implemented in endemic zones to reduce vector populations and disease transmission risk.

Veterinary interventions play a crucial role in preventing zoonotic spillover from animal reservoirs to humans. This requires mass vaccination campaigns for rabies in domestic dogs and livestock, systematic screening of wildlife and livestock for bacterial zoonoses, and the quarantine and culling of infected animals in outbreak scenarios. Deploying mobile veterinary response units equipped with rapid diagnostic tools will enhance field-based pathogen detection and allow immediate intervention in high-risk areas [4].

1.5. Public Health Communication and Risk Awareness

A structured public health communication strategy is essential to ensure timely dissemination of evidence-based information to high-risk populations, including indigenous communities,

wildlife traders, hunters, and rural populations engaged in subsistence activities. Risk communication must be linguistically and culturally adapted, leveraging local languages, indigenous communication channels, and trusted community leaders to ensure message comprehension and adherence.

Public health advisories will emphasize personal protective measures, such as safe handling of wildlife, proper hygiene practices, and the importance of thoroughly cooking bushmeat to mitigate infection risks. Clear symptom recognition guidelines for zoonotic diseases will be distributed through community radio broadcasts, mobile messaging systems, pictograms, and public meetings. These materials will stress the need for early healthcare-seeking behavior in suspected zoonotic infections, reducing diagnostic delays and enhancing outbreak response efficiency.Crisis communication teams will be trained to rapidly counter misinformation and prevent public panic through real-time media engagement and transparent government briefings. A dedicated public health emergency hotline will provide immediate guidance on zoonotic risk management, allowing individuals to report suspected infections, seek medical advice, and receive information on outbreak containment measures.

Additionally, behavioral change campaigns will be integrated into risk awareness efforts to promote alternative livelihoods for wildlife-dependent communities and reinforce the dangers of illegal wildlife trade and bushmeat consumption. These campaigns will be data-driven, leveraging sociocultural research and behavioral analytics to refine messaging strategies and ensure long-term risk awareness and compliance [5].

1.6. Interagency and International Coordination

Given the transboundary nature of zoonotic pathogens, effective containment requires coordinated response efforts between national agencies, regional health authorities, and international organizations such as the World Health Organization (WHO), Food and Agriculture Organization (FAO), and the World Organisation for Animal Health (WOAH). Establishing formalized international data-sharing agreements will enable real-time exchange of epidemiological information on zoonotic threats, improving early detection and joint outbreak management.

Bolivia must integrate its national zoonotic surveillance framework into regional platforms, such as the Latin American Network for Emerging Infectious Diseases (LANEID), to facilitate cross-border case tracking, genomic sequencing of emerging pathogens, and coordinated control measures with neighboring countries (Peru, Brazil, Argentina, and Paraguay). A regional task force for zoonotic emergencies should be developed to standardize outbreak investigation protocols, biosecurity measures at border crossings, and quarantine enforcement during cross-border pathogen transmission events.

To enhance veterinary collaboration, Bolivia must align its livestock and wildlife disease surveillance programs with the FAO's Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES). Joint livestock vaccination campaigns, particularly for rabies, brucellosis, and bovine tuberculosis, will mitigate zoonotic spillover risks at the human-animal interface. Strengthening Bolivia's One Health governance model—ensuring the integration of human, animal, and environmental health monitoring—will further enhance outbreak preparedness and prevention strategies [1].

1.7. Post-Outbreak Surveillance and Review

Sustained post-outbreak surveillance is crucial for detecting residual transmission, preventing secondary outbreaks, and assessing the long-term epidemiological impact of zoonotic spillover events. Bolivia must maintain continuous monitoring of affected regions for a minimum of six months following an outbreak, integrating human health, veterinary, and environmental surveillance data to track disease resurgence patterns.

A structured longitudinal monitoring framework should be implemented, incorporating repeat serological testing, molecular diagnostics, and community-based syndromic surveillance in previously affected populations. This requires enhanced field epidemiology training for regional health teams, ensuring rapid identification and investigation of new or re-emerging cases. Data from wildlife population health assessments must also be integrated, particularly for reservoir species such as primates, rodents, and bats, which can harbor persistent zoonotic pathogens.

A post-outbreak review committee should be established to conduct a comprehensive epidemiological assessment, evaluating response effectiveness, containment challenges, and areas for improvement. This review should incorporate genomic sequencing of recovered pathogens to assess mutation rates, potential antigenic shifts, and implications for future vaccine development. Lessons learned must be systematically documented in national outbreak preparedness guidelines, informing policy adjustments and resource allocation for future responses.

Additionally, public debriefings and stakeholder consultations should be conducted to assess community engagement effectiveness, compliance with containment measures, and residual public health concerns. A structured after-action report methodology must be applied to refine Bolivia's national pandemic preparedness framework, ensuring that identified gaps in diagnostic capacity, healthcare infrastructure, and risk communication are addressed before future outbreaks occur [3].

2. Stockpiling essential supplies

The ability to respond swiftly and effectively to zoonotic disease outbreaks hinges on the preparedness of a country's medical and logistical infrastructure. For Bolivia, a strategic stockpiling system for essential supplies is critical to ensure the availability and timely distribution of crucial resources, including diagnostic kits, PPE, and antiviral and antibiotic medications. The strategy involves not only the acquisition and storage of supplies but also their efficient management and distribution, particularly in high-risk zones where zoonotic diseases are more likely to emerge [4].

2.1. Diagnostic Kits

The timely and accurate detection of zoonotic pathogens is fundamental to controlling outbreaks. To achieve this, diagnostic kits with high sensitivity and specificity are essential. Real-time PCR kits, ELISA kits, and lateral flow assays are some of the key diagnostic tools needed for early pathogen identification. These tests are designed to identify priority zoonotic diseases such as *Leptospira* spp., *Rabies lyssavirus*, and *Plasmodium* spp., which pose significant health risks to both humans and animals. By strategically placing decentralized

storage hubs in major epidemiologically sensitive areas such as Santa Cruz, Beni, and Pando, Bolivia can ensure that diagnostic tools are readily available in regions most susceptible to zoonotic disease outbreaks. Additionally, establishing partnerships with international diagnostic manufacturers will ensure a continuous supply of cutting-edge diagnostic technologies and facilitate the rapid replenishment of testing kits as they become depleted or outdated [3].

2.2. Personal Protective Equipment (PPE)

Personal protective equipment (PPE) is essential for protecting healthcare workers, veterinarians, and field surveillance teams from zoonotic diseases. The stockpiling of appropriate PPE is a critical part of any zoonotic disease preparedness plan. Key items include N95 respirators, powered air-purifying respirators (PAPRs), biosafety level-3 (BSL-3) suits, nitrile gloves, face shields, and disposable coveralls. These items help to minimize the risk of infection, especially in environments where direct contact with infected wildlife or contaminated materials is possible. Furthermore, decontamination solutions are necessary to ensure that PPE can be safely used in high-risk zones. Establishing a national distribution network for PPE ensures that healthcare providers in urban hospitals and remote rural areas have timely access to the equipment they need. Regular fit-testing, training programs, and educational campaigns will be necessary to ensure that the PPE is used correctly, minimizing contamination risks and optimizing the protection of frontline workers [2].

2.3. Antivirals and Antibiotics

The swift treatment of zoonotic infections often requires access to antiviral and antibiotic medications, particularly for Post-Exposure Prophylaxis (PEP). For viral diseases like hemorrhagic fevers, medications such as ribavirin and favipiravir are necessary to reduce mortality and morbidity. For influenza outbreaks, oseltamivir (Tamiflu) should be included in the stockpile, while Artemisinin-based Combination Therapies (ACTs) are crucial for treating malaria, a major zoonotic disease. In addition to antiviral medications, antibiotics such as doxycycline and azithromycin are critical for treating bacterial zoonoses, including leptospirosis and brucellosis. The stockpiling strategy should incorporate cold-chain storage systems to maintain the efficacy of temperature-sensitive medications. It is also important to have a national stockpile rotation policy in place, which will ensure that drugs are regularly replaced before expiration, preventing wastage and ensuring that supplies remain effective when needed. (World Health [1].

2.4. Supply Chain and Logistics Coordination

Efficient logistics and supply chain management are essential for ensuring that stockpiled resources are distributed to areas affected by zoonotic outbreaks. Establishing a National Emergency Medical Stockpile Center (NEMSC) will centralize the procurement, storage, and distribution of essential medical supplies. The NEMSC should employ predictive analytics and Geographic Information Systems (GIS) to forecast the demand for medical supplies based on current epidemiological trends and potential outbreak scenarios. This will enable the rapid mobilization of resources in response to disease outbreaks. Collaboration with pharmaceutical companies and logistics providers through public-private partnerships can further optimize the distribution process. By leveraging existing logistics infrastructure and technological tools, stockpiled resources can be delivered to outbreak hotspots within 24 to 48 hours of detection, ensuring that healthcare teams are equipped to respond swiftly and effectively [2].

To further strengthen emergency preparedness, a National Zoonotic Response Logistics Framework will be implemented, ensuring fair distribution of diagnostic kits, personal protective equipment (PPE), and therapeutics. This framework will integrate an automated stockpile inventory system linked to real-time epidemiological data, allowing dynamic resource allocation based on threat levels. Additionally, regional storage hubs in high-risk areas such as Santa Cruz, Beni, and Pando will be established to pre-position essential medical supplies for rapid accessibility.

2.5. Regulatory Frameworks

To ensure an effective and enforceable response to zoonotic outbreaks, Bolivia must strengthen its legal and policy frameworks. This includes establishing a National Zoonotic Disease Act, which mandates outbreak response protocols, quarantine measures, and wildlife trade regulations. Legal compliance measures must be defined to ensure that community-based surveillance and containment protocols are followed, particularly in rural and indigenous areas, where enforcement challenges may arise. Coordination among the Ministry of Health, Ministry of Environment, and local municipalities will be crucial to ensure streamlined enforcement of these policies.

Additionally, regular stockpile audits and emergency preparedness drills should be mandated to assess inventory levels and logistical efficiency. Biannual national zoonotic outbreak drills will be required, involving health, veterinary, environmental, and law enforcement sectors. These exercises will include field-based outbreak containment scenarios, rapid diagnostic response evaluations, and interagency coordination tests. Following each drill, post-simulation assessments will identify operational gaps, ensuring iterative improvements to outbreak response protocols and overall preparedness.

2.6. Securing Funding and Sustainability

Sustained financial investment is essential for the long-term viability of zoonotic disease surveillance. To maintain long-term financial sustainability, Bolivia will establish a dedicated Zoonotic Disease Response Fund (ZDRF), supported by government allocations, private sector investments, and international health agencies. This financial framework will ensure a stable funding base to support continuous monitoring and rapid response capabilities.

Collaborative partnerships with international organizations, including WHO, FAO, OIE, and PAHO, will enhance both technical and financial resources, aligning Bolivia with global best practices. Additionally, Public-Private Partnerships (PPPs) with pharmaceutical and biotech firms will facilitate the ongoing production of diagnostic kits, PPE, and mobile diagnostic units. These partnerships will promote technological innovation, capacity building, and the sustainable development of zoonotic surveillance infrastructure.

Furthermore, a structured grant acquisition strategy will be implemented to secure additional funding from regional and international health initiatives. The establishment of a public-private partnership model will also support the development and maintenance of diagnostic laboratories, ensuring that infrastructure remains operational and effective.

3. Training Rapid Response Teams

Bolivia must strengthen its emergency preparedness capacity by establishing a comprehensive training program for rapid response teams composed of epidemiologists, veterinarians, and wildlife experts. These teams will be responsible for identifying, containing, and mitigating zoonotic disease outbreaks in high-risk areas. To achieve this, the following key measures will be implemented:

3.1. Capacity Building and Specialized Training

The capacity building of rapid response teams is fundamental to their effectiveness during an outbreak. This specialized training will involve highly focused, scenario-based exercises that replicate real-world outbreaks, such as those of zoonotic diseases like avian influenza. These programs will cover a broad range of critical skills, including field epidemiology techniques for disease surveillance, understanding and implementing biosecurity protocols to prevent the spread of pathogens, and the proper collection and handling of specimens for diagnosis.

To strengthen emergency response capabilities, mandatory biannual training for rapid response teams will be implemented, integrating these scenario-based outbreak simulations. In addition to technical competencies, the teams will receive training in rapid diagnostic techniques, ensuring that they can identify zoonotic agents promptly. Training exercises will also emphasize decision-making under pressure, coordination between sectors (e.g., veterinary, public health, wildlife conservation), and the effective use of communication tools in crisis situations. Addressing the unique challenges of zoonotic diseases, the workshops will specifically target bacterial, viral, and parasitic pathogens, equipping teams with the knowledge to manage different types of zoonotic threats that might emerge due to wildlife consumption and trade as well as cultural practices that involve wild animals.

To further incentivize participation, stipends and career development pathways will be introduced for local healthcare workers engaged in zoonotic disease surveillance. University partnerships will also be established to provide specialized training in veterinary epidemiology and One Health approaches, ensuring that Bolivia's workforce remains well-equipped to respond to emerging disease threats [1,2].

3.2. Establishment of Regional Response Units

To bolster response times and effectiveness, regional response units will be strategically placed in Bolivia's high-risk zones. These regions are often characterized by significant wildlife trade, diverse ecosystems, and cultural practices involving wildmeat consumption, all of which contribute to the increased risk of zoonotic disease transmission. By decentralizing response efforts, these units can conduct swift on-site assessments and deploy containment measures more effectively. Regional units will be equipped with diagnostic tools, mobile laboratories, and protective gear to enable immediate investigations and early intervention when zoonotic diseases are suspected. The establishment of such units will not only improve local capacity but also enable more tailored and context-specific responses that account for the varying risks across Bolivia's diverse landscapes [3].

3.3. Cross-Sectoral and International Collaboration

The transboundary nature of zoonotic diseases necessitates a coordinated approach that transcends national borders. Bolivia's rapid response teams will be integrated into a broader

network of international organizations, including the WHO, FAO, and OIE, to standardize protocols, exchange epidemiological data, and enhance technical support during outbreaks. These collaborations will ensure that Bolivia benefits from global best practices and innovations in outbreak management. Additionally, Bolivia will foster bilateral agreements with neighboring countries to ensure coordinated responses to zoonotic threats that may cross national borders due to wildlife migration or illegal trade practices. Cross-border collaboration is crucial for sharing information, providing resources, and coordinating surveillance and containment activities across regions [1, 6].

3.4. Strengthening Laboratory Diagnostic Capacity

The rapid identification of zoonotic diseases relies heavily on advanced diagnostic capabilities. By equipping rapid response teams with portable diagnostic kits and establishing mobile laboratories, Bolivia can significantly enhance its ability to detect and confirm zoonotic diseases on-site. This immediate diagnostic capacity will enable swift action in isolating infected individuals or animals and preventing further transmission. The integration of molecular diagnostics, such as PCR and other rapid testing technologies, will ensure that Bolivia is prepared to handle various zoonotic agents in real time. Enhanced diagnostic infrastructure will also allow for better epidemiological tracking of outbreaks, contributing to more informed decision-making and resource allocation during an emergency [2].

3.5. Development of a Real-Time Response Network

A critical component of rapid response is the efficient exchange of information. The development of a real-time response network will facilitate communication between response teams, national health authorities, and wildlife conservation agencies. This network will leverage digital platforms, including Geographic Information Systems (GIS), to monitor and track disease outbreaks in real time, allowing for rapid deployment of containment measures. The use of such technology will enable teams to visualize the geographic spread of diseases and make informed decisions about where interventions should be focused. In addition, the network will provide an interactive platform for real-time collaboration, improving the overall coordination of efforts and ensuring that the most accurate and timely data is available to all stakeholders involved [3].

3.6. Community Engagement and Risk Communication

Community engagement is vital to the success of any disease containment effort, especially in regions where zoonotic diseases are tied to cultural practices like wildlife consumption and trade. Rapid response teams will prioritize risk communication strategies to educate local communities about the prevention of zoonotic diseases, the identification of symptoms, and the safe handling of wildlife. These community-focused efforts will be designed to build trust and encourage compliance with public health directives, such as quarantine measures, vaccination campaigns, and changes to wildlife trade practices. Effective communication will help foster a sense of shared responsibility, empowering local populations to take part in surveillance activities and prevention efforts [4].

4. Establishing mobile diagnostic units

In response to the elevated zoonotic disease risks in Bolivia, particularly in high-risk areas such as Santa Cruz and Beni, mobile diagnostic units will be deployed to conduct on-site pathogen testing. These units will be equipped with laboratory technologies, allowing for real-time detection of zoonotic pathogens in humans, wildlife, and environmental samples. The

establishment of these mobile units is crucial for reducing response times and preventing outbreaks from escalating into widespread public health emergencies [4]. Each mobile diagnostic unit will be staffed with a multidisciplinary team, including epidemiologists, veterinarians, laboratory technicians, and disease control specialists. These professionals will be trained in biosafety protocols, molecular diagnostics (PCR, ELISA, and next-generation sequencing), and rapid disease assessment methodologies [2]. The units will be equipped with:

- Portable PCR and serology-based diagnostic kits for immediate pathogen detection.
- Cold-chain storage facilities to preserve biological samples for further laboratory analysis.
- Personal protective equipment (PPE) and decontamination stations to ensure biosafety in field settings (World Health Organization
- GIS-based surveillance systems to map hotspots and track the spread of pathogens in real-time.
- Satellite communication systems to relay critical data to national and international health agencies for coordinated responses.

The deployment of mobile diagnostic units will follow a risk-based approach, prioritizing regions with significant wildlife trade activities, high human-wildlife interaction, and documented zoonotic disease cases. Units will be stationed at strategic locations, including wildlife markets, hunting zones, and key border crossings, to screen live animals, bushmeat, and symptomatic individuals for potential zoonotic infections [1].

Additionally, these units will serve as training hubs for local health professionals, enhancing Bolivia's diagnostic capacity and ensuring sustainability in outbreak preparedness. Field simulations and drills will be conducted regularly to test the efficiency of sample collection, processing, and result dissemination protocols [2]. Data collected from these mobile units will be integrated into national health databases and shared with global health networks, including WHO, FAO, and OIE, to improve international zoonotic disease tracking and response coordination [3].

5. Integrating Early Warning Systems (EWS) into National Health Data Platforms.

The integration of an Early Warning System (EWS) into Bolivia's national health data platforms is crucial for enhancing the country's ability to detect and respond to zoonotic diseases linked to wildlife consumption, trade, and cultural practices. The EWS serves as a centralized digital tool that enables the real-time collection, analysis, and dissemination of epidemiological data.

5.1. Automated Data Collection and Integration

The integration of an Early Warning System (EWS) into Bolivia's national health data platforms is crucial for enhancing the country's ability to detect and respond to zoonotic diseases linked to wildlife consumption, trade, and cultural practices. The EWS serves as a centralized digital tool that enables the real-time collection, analysis, and dissemination of epidemiological data. By continuously monitoring both human and wildlife populations, the system will identify unusual mortality events and disease patterns, which are critical signals for potential zoonotic outbreaks.

Active surveillance will rely on real-time data collection from diverse sources, including wildlife conservation agencies, veterinary clinics, local health centers, and environmental monitoring stations. By integrating this data into a unified national database, managed by the Ministry of Health and the National Institute of Health Laboratories (INLASA), the EWS will ensure up-to-date information for timely interventions. Automating data collection will minimize delays in response times, allowing health authorities to make informed decisions based on the most current surveillance insights. This integrated approach fosters a continuous feedback loop, where field agents and reporting systems contribute real-time insights, keeping surveillance activities active and responsive to emerging risks.

Through seamless coordination between national health agencies and wildlife management organizations, the EWS will enable faster decision-making and more efficient responses to emerging disease threats, reducing the risk of widespread public health emergencies. To ensure its effective integration, rural health centers without internet access will be equipped with offline-capable mobile reporting tools to facilitate real-time data collection. An interoperability framework will be established to ensure that EWS data is automatically synchronized with Bolivia's National Health Data System, allowing health authorities to access up-to-date surveillance information without delays. Additionally, training for rural healthcare workers on digital reporting systems will be mandatory, ensuring that frontline personnel can accurately record and transmit critical health data. Strengthening Bolivia's digital health infrastructure in this way will enhance nationwide zoonotic disease monitoring and improve rapid outbreak response capacity.

5.2. Surveillance of Wildlife Mortality Events

Wildlife mortality, particularly among key reservoir species like primates, rodents, and avian populations, is a crucial indicator of potential zoonotic disease transmission. These species often act as intermediate hosts for pathogens that can spill over to human populations, making their monitoring a high priority in active surveillance. The EWS will prioritize the tracking of unexplained deaths among wildlife, with data being collected from conservation groups such as the Wildlife Conservation Society (WCS) and governmental bodies like the Ministry of Environment and Water (MMAyA). By establishing robust, real-time tracking systems, the EWS can rapidly identify clusters of unusual wildlife deaths and enable swift interventions. Collaboration among local and national agencies will facilitate coordinated efforts in addressing potential zoonotic risks, providing an early warning that helps prevent human exposure to pathogens.

5.3. Human Health Monitoring and Syndromic Surveillance

Active surveillance must also extend to human health systems to detect signs of zoonotic spillover, such as unusual clusters of febrile illnesses, respiratory infections, or hemorrhagic fevers. Health centers and hospitals will play a pivotal role in this aspect, employing digital reporting systems to identify these syndromes. This integration of health data into the EWS will allow for the swift identification of disease clusters that may signal zoonotic outbreaks, particularly in regions with high wildlife trade or cultural practices involving wildmeat consumption. Surveillance teams will conduct regular visits to ensure that the data collected is accurate and verified, enhancing the overall reliability of the information. With ongoing,

real-time monitoring, the EWS will provide health authorities with actionable data to guide public health responses and mitigate the spread of zoonotic diseases.

5.4. Machine Learning and Predictive Analytics

The EWS will leverage advanced machine learning algorithms to analyze large datasets generated from diverse sources, including real-time health data, environmental conditions, and historical disease trends. By examining these factors, machine learning models can predict potential zoonotic disease outbreaks, providing invaluable insights into high-risk areas and times of year when outbreaks are more likely. Predictive analytics will enable authorities to proactively allocate resources, direct surveillance efforts, and implement prevention strategies where they are most needed. For instance, the system might flag certain regions as hotspots for emerging zoonotic threats based on environmental factors like changes in wildlife migration patterns or climate conditions. This data-driven approach helps optimize the effectiveness of active surveillance efforts, ensuring that resources are deployed in a way that maximizes their impact.

5.5. Cross-Border Data Sharing and International Collaboration

Bolivia's geographic location, near major wildlife trade hubs, means that zoonotic threats are not confined to national borders. As such, an essential component of the EWS is its ability to facilitate cross-border data sharing and coordination with neighboring countries such as Brazil, Peru, and Argentina. Establishing regional data-sharing agreements will enhance Bolivia's ability to detect and respond to zoonotic disease threats that may arise in other countries but have the potential to spread across borders. This international collaboration will ensure that surveillance systems are synchronized, enabling timely reporting and rapid deployment of response teams to tackle emerging zoonotic risks. By working together, neighboring countries can improve the effectiveness of regional surveillance, creating a unified front against transboundary health threats.

5.6. Rapid Response Activation Protocols

To improve outbreak containment speed, a structured and efficient response system will be implemented through clearly defined activation timelines. Within 6 hours of detecting an anomaly, initial case identification and local containment measures will be enacted to prevent further spread. By 12 hours, mobile diagnostic teams will be deployed to affected areas to conduct field investigations and laboratory testing. Within 24 hours, national-level outbreak response coordination will be initiated, ensuring rapid mobilization of resources, including medical supplies, response teams, and containment protocols.

The Early Warning System (EWS) will play a crucial role in detecting anomalies and triggering automated alerts to health authorities and relevant stakeholders. These alerts will activate predefined response protocols, which include immediate field investigations, laboratory testing, and the initiation of containment measures. By ensuring the rapid mobilization of response teams and resources, the system will help prevent zoonotic threats from escalating into large-scale public health emergencies.

A National Zoonotic Emergency Coordination Unit will oversee response tracking and interagency coordination, ensuring a seamless flow of information and resources between national and regional health authorities. Additionally, local governors and health

authorities will be legally accountable for implementing containment measures within their jurisdictions, ensuring swift and effective action at the community level.

5.7. Public and Community Engagement

As part of active surveillance, local communities—particularly those involved in wildlife trade, hunting, and agriculture—will be trained to recognize and report unusual animal deaths, sick individuals, and environmental changes that could signal a zoonotic threat. Community-based surveillance points will provide early detection capabilities, complementing formal surveillance systems and ensuring that remote and high-risk areas are actively monitored.

SECTION THREE

Joint Assessment of Zoonotic Risk

To enhance Bolivia's ability to detect and mitigate the risks posed by zoonotic diseases, a standardized joint risk assessment framework must be established, focusing on comprehensive active surveillance efforts across multiple domains. The framework will be rooted in the routine screening of wildlife species, the evaluation of human-wildlife interactions, advanced molecular and serological diagnostics to detect zoonotic pathogens and community based surveillance including indigenous involvement. The key components of this framework are outlined below:

1. Pathogen Surveillance

Active surveillance of wildlife species in Bolivia is a cornerstone of the national strategy to detect and mitigate zoonotic disease risks. The surveillance efforts will be focused on high-risk wildlife species, including primates (such as *Alouatta*spp. and *Ateles* spp.), jaguars (*Panthera onca*), and armadillos (*Dasypus novemcinctus*) which are identified as key reservoirs for a variety of zoonotic pathogens. These species are particularly important as they are commonly implicated in the transmission of diseases like leptospirosis and rabies, which pose significant risks to both wildlife populations and humans.

A clear response activation protocol must be defined. Surveillance findings will trigger immediate action through pre-established risk thresholds. For instance, detecting priority zoonotic pathogens in wildlife will mandate rapid reporting to the Ministry of Health and coordinated containment efforts with local authorities. Protocols will outline alert levels, response timelines, and interagency coordination mechanisms.

The surveillance system will be designed to operate on a continuous, systematic basis, incorporating regular screenings and sampling from both natural habitats and wildlife trade markets. Areas with high human-wildlife interaction, such as the Santa Cruz and Beni regions, will be prioritized, as these regions are at the nexus of agricultural expansion, wildlife trade, and human encroachment on natural habitats, all of which increase the likelihood of zoonotic spillover. Surveillance will be expanded to include areas where wildlife and humans have direct contact, such as hunting zones, wildlife markets, and settlements adjacent to wildlife-rich areas. The surveillance framework will operate within a robust legal framework that

ensures compliance with national and international zoonotic disease regulations. Bolivia will align surveillance strategies with the International Health Regulations (IHR) and implement enforceable biosecurity measures in high-risk zones. Legislation will define mandatory pathogen screening, quarantine protocols for detected zoonotic threats, and penalties for non-compliance in wildlife trade markets.

1.1. Sampling Methods and Data Collection

Wildlife monitoring will encompass a range of sample collection techniques to identify the presence of zoonotic pathogens. Live animal sampling will involve the capture of individuals for health screening, which will include blood, saliva, fecal, and urine samples for molecular testing. The focus will be on collecting biological materials from animals suspected of harboring zoonotic pathogens, as well as from asymptomatic individuals, to assess carrier states. Furthermore, the collection of carcasses from wildlife that have died in the wild or have been found in human settlements will provide valuable data on pathogen prevalence in the broader wildlife population. These specimens will undergo laboratory testing using molecular diagnostics, such as Polymerase Chain Reaction (PCR), to detect specific zoonotic agents at the genetic level. This allows for the accurate identification of pathogens even in the early stages of infection, before visible symptoms manifest. In addition to testing live animals and carcasses, environmental samples will be collected from areas frequented by wildlife, including soil, water, and air. These environmental samples will help identify the presence of zoonotic pathogens in the broader ecosystem, revealing potential contamination points that could facilitate the transmission of pathogens to both wildlife and humans. Areas surrounding wildlife trade hubs, hunting grounds, and known zoonotic hotspots will be closely monitored to capture environmental risk factors that contribute to the persistence and spread of zoonotic diseases.

1.2. Molecular Diagnostics and Serological Testing

Advanced molecular diagnostic techniques, such as PCR, will be central to the pathogen surveillance framework. Additionally, serological testing, including Enzyme-Linked Immunosorbent Assay (ELISA), will be used to detect antibodies produced by wildlife in response to previous infections. This dual approach allows for both the detection of active infections (through PCR) and the monitoring of immunity and prior exposure (through serology), which is essential for understanding the epidemiological dynamics of zoonotic pathogens in wildlife populations. In regions such as Santa Cruz and Beni, where zoonotic spillover risks are highest, field teams will be equipped with portable diagnostic kits to facilitate on-site testing. The deployment of mobile diagnostic units will ensure that samples are analyzed rapidly, reducing the time between sample collection and result dissemination. This quick response capability will enable the timely implementation of containment measures to prevent the spread of zoonotic diseases from wildlife to human populations, particularly in areas with high population density and frequent wildlife trade.

1.3. Integrated Data Sharing and Response

Data gathered through pathogen surveillance will be integrated into Bolivia's broader zoonotic disease surveillance system, ensuring that findings are analyzed and shared in real-time with relevant stakeholders, including health agencies, wildlife conservation groups, and international organizations like the World Health Organization (WHO) and the Food and

Agriculture Organization (FAO). The surveillance data will also inform the development of risk maps, which can be used to predict and respond to potential outbreaks. Effective zoonotic disease mitigation requires real-time integration of wildlife surveillance data with public health monitoring systems. A centralized national zoonotic disease database will be established, linking wildlife surveillance results with human and veterinary health data. This integration will facilitate early warning alerts, improve cross-sectoral response coordination, and support evidence-based policymaking.

2. High-Risk Behaviors Analysis

An in-depth analysis of human-wildlife interactions is crucial to understanding the behaviors that heighten the risk of zoonotic disease spillover in Bolivia. High-risk behaviors, including the consumption of wild meat, wildlife trade, pet ownership, and various cultural practices, play a central role in facilitating pathogen transmission from wildlife to humans. The primary goal of this analysis is to identify and mitigate these behaviors through active surveillance, community engagement, and targeted interventions. Understanding these interactions is pivotal for designing a multi-faceted approach to prevent the spread of zoonotic diseases which are prevalent in both wildlife populations and human communities [7,8,9].

2.1. Consumption of Wild Meat

One of the primary high-risk behaviors in Bolivia is the consumption of wild meat. Hunting and eating wild animals, often referred to as "bushmeat," is a common practice in rural areas, where it provides an important source of protein for local communities. However, this practice can facilitate direct contact with zoonotic pathogens, especially when animals are hunted and handled in unsanitary conditions. This risk is exacerbated by the consumption of undercooked or improperly prepared meat, which may harbor pathogens that can be transmitted to humans [10,11]. Surveillance teams will assess the extent of bushmeat consumption in high-risk zones such as Santa Cruz and Beni, where human-wildlife interactions are frequent, and will document the types of animals being hunted and consumed. To address this, targeted interventions will focus on educating communities about safe handling practices, proper cooking methods, and alternative sources of protein. The analysis will also incorporate data on the social, cultural, and economic factors that drive bushmeat consumption, allowing for culturally sensitive education campaigns that emphasize the risks of zoonotic diseases without disrupting local traditions [7,8,9].

- **Informal Bushmeat Trade and Subsistence Hunting**

The informal bushmeat trade in Bolivia remains a significant risk factor for zoonotic disease transmission due to the unregulated nature of hunting, processing, and consumption practices in rural and indigenous communities. Subsistence hunting, while deeply embedded in cultural traditions and essential for food security, increases the likelihood of zoonotic spillover through direct contact with wild animals and their bodily fluids. The risk is further compounded by inadequate biosafety measures, poor meat handling practices, and the absence of pathogen screening in informal markets.

A comprehensive monitoring strategy for the bushmeat trade must integrate passive and active surveillance mechanisms, field-based investigations, and community engagement.

Establishing community-based surveillance networks will be essential in identifying early warning signs of zoonotic disease transmission. Indigenous hunters, local health workers, and wildlife conservation groups will be engaged to report unusual wildlife morbidity and mortality events, leveraging traditional ecological knowledge to enhance disease detection.

Wildlife pathogen screening must be conducted systematically, with a particular focus on high-risk taxa such as primates (*Alouatta spp., Ateles spp.*), jaguars (*Panthera onca*), and armadillos (*Dasypus novemcinctus*). These efforts will employ PCR-based diagnostics and serological testing to identify zoonotic pathogens before human exposure occurs. Mapping the bushmeat supply chain from hunting grounds to informal markets is another critical step. High-risk trade hubs, such as those in Santa Cruz, Beni, and Pando, will be prioritized for periodic inspections. Vendors and consumers will be surveyed to assess handling practices, exposure risks, and cultural drivers of bushmeat consumption.

Understanding the motivations behind subsistence hunting and informal trade is crucial for designing effective interventions. Behavioral and socioeconomic studies will be conducted to analyze economic dependencies on bushmeat, traditional beliefs regarding wild meat consumption, and potential incentives for transitioning to alternative protein sources. Geospatial risk mapping will be utilized to identify zoonotic hotspots where human-wildlife interactions, bushmeat hunting, and ecological disruptions overlap, guiding targeted interventions in high-risk areas.

Additionally, capacity-building for hunters and traders is necessary to mitigate risks associated with wildlife handling. Training programs will be implemented to emphasize proper carcass handling, pathogen transmission prevention, and protective measures such as wearing gloves and avoiding direct contact with animal blood and secretions. Culturally appropriate interventions will be developed to address traditional medicine practices that rely on wildlife products. This includes working with traditional healers and community elders to promote safe handling practices and alternative medicinal sources. Engagement frameworks will be established to ensure that these key community figures play an active role in zoonotic disease prevention, integrating indigenous knowledge into modern health and conservation strategies.

2.2. Market Surveillance

Wildlife markets, particularly in urban centers like Santa Cruz, serve as hubs for the sale of live animals, including primates and rodents, which are often potential reservoirs of zoonotic pathogens. The handling of live animals in these markets provides ample opportunity for cross-species pathogen transmission, particularly when animals are stressed or housed in poor conditions. Surveillance teams will monitor wildlife markets to document the flow of animals, focusing on identifying species that are likely to harbor zoonotic diseases. Collaboration with wildlife traders, veterinarians, and law enforcement will be key in reducing the illegal wildlife trade and ensuring that market practices are safe. Surveillance teams will also monitor for signs of emerging diseases in animals being traded, conducting regular health checks and pathogen screenings of animals entering these markets. Educational campaigns will aim to reduce demand for wildlife products and promote the use of domesticated animals as safer alternatives [10,11].

2.3. Pet Ownership

Pet ownership is another behavior that can facilitate zoonotic disease transmission. Domesticated animals, such as dogs and cats, are often in close contact with wild animals, creating opportunities for cross-species pathogen transmission. For instance, dogs may interact with wildlife species in rural or peri-urban areas, increasing the risk of rabies and other zoonotic diseases. Surveillance teams will assess pet ownership patterns and document the interactions between domesticated animals and wildlife. Veterinarians will play a critical role in educating pet owners on the importance of vaccinations, parasite control, and responsible pet management to minimize the risks associated with zoonotic diseases. The analysis will also involve investigating community attitudes toward pets, including the desire for exotic species as pets, which can further facilitate zoonotic pathogen transmission when wildlife is kept in unnatural and stressful conditions. The results will inform the development of guidelines for safe pet ownership and the promotion of responsible practices, such as preventing contact between domesticated animals and wildlife.

2.4. Cultural Practices and Community Engagement

In Bolivia, cultural practices, such as the use of wildlife for traditional medicine or rituals, may also contribute to zoonotic spillover. The consumption of animal parts for medicinal purposes, including the use of animal blood, bones, or organs, has been linked to the transmission of various zoonotic pathogens. Additionally, hunting rituals and the handling of wildlife during cultural ceremonies may expose individuals to pathogens present in animals. Surveillance teams will work closely with local communities, cultural leaders, and traditional healers to understand these practices and identify areas where pathogen transmission may occur.

Community engagement will be crucial to the success of the high-risk behavior analysis. Local communities, wildlife traders, hunters, and veterinarians will be actively involved in the documentation of these behaviors through surveys, interviews, and field observations. By building trust and fostering collaboration, surveillance teams can gather accurate data on high-risk behaviors while simultaneously promoting awareness of the risks associated with zoonotic diseases [7,8,9]. Furthermore, culturally tailored educational campaigns will emphasize the importance of hygiene, safe wildlife handling, and the use of alternative, safer practices in traditional rituals. A multi-channel communication strategy will include community radio broadcasts, social media campaigns, and school-based education programs. Trusted local figures, including indigenous leaders and traditional healers, will be engaged in outreach efforts to enhance message credibility and community compliance.

2.5. Targeted Interventions and Educational Campaigns

Based on the findings from the analysis of high-risk behaviors, targeted interventions will be designed to reduce the risk of zoonotic spillover. These interventions will include public health campaigns focused on educating communities about the risks associated with wildlife consumption, trade, and cultural practices. Surveillance teams will work with local schools, community centers, and healthcare providers to disseminate information and promote safer practices. The development of educational materials, such as brochures, posters, and audiovisual resources, will ensure that the message is clear and accessible to a wide audience. Additionally, outreach activities, such as workshops and community meetings, must be organized to engage key stakeholders in the prevention of zoonotic diseases.

3. Environmental Sampling

Environmental contamination assessments are a crucial component of Bolivia's active surveillance strategy for zoonotic diseases. These assessments aim to monitor the presence of zoonotic pathogens in the environment, where human-wildlife interactions are most frequent and where the risk of spillover is heightened. The collection of soil, water and air samples from key locations such as wildlife markets, hunting zones, and areas with intensive human-wildlife interactions will provide valuable data on potential contamination sources and pathways for disease transmission [7,8,9].

3.1. Sampling Locations and Rationale

Sampling will target high-risk areas in both urban and rural regions, especially those in close proximity to wildlife trade hubs and places where wild animals are consumed or handled. In urban settings, wildlife markets will be a focal point for sampling, as these locations often serve as venues for the sale of live animals, bushmeat, and animal products that can carry zoonotic diseases. These markets often have high foot traffic, increasing the likelihood of pathogen transmission from animals to humans. Similarly, hunting zones—particularly those with a history of zoonotic disease spillover—will be closely monitored to assess potential contamination of the surrounding environment due to the hunting and processing of wild animals [7,8,9].

3.2. Sampling

Environmental samples will include soil, water, and air, as these mediums can harbor pathogens capable of contaminating both wildlife and humans. Soil sampling will be conducted in areas frequented by wildlife and human populations to detect the presence of zoonotic pathogens, such as *Leptospira* spp., which can persist in the soil and pose a significant risk of transmission. Water samples from rivers, lakes, and streams near hunting areas, wildlife habitats, or trade markets will also be collected to assess the contamination of water sources that may be shared by both humans and wildlife. Waterborne zoonotic diseases, such as *Brucella* spp. and *Leptospira* spp., can contaminate water sources that are used for drinking, irrigation, and food preparation, potentially leading to significant public health concerns [7,8,9].

Air sampling will focus on areas with high animal density or where wildlife products are being processed, as zoonotic pathogens can potentially be aerosolized in these settings. For instance, pathogens like *Hantavirus* or *Coxiella burnetii*may be transmitted through airborne particles in environments such as wildlife markets, hunting grounds, and areas of animal slaughter [7,8,9].Detecting these pathogens in the air will help identify potential transmission risks to humans and wildlife, informing targeted mitigation strategies.

Eventhough environmental sampling is a critical component, key processing areas such as hunting camps, slaughter zones, and bushmeat drying sites must be integrated to provide a more comprehensive risk assessment. These locations serve as primary points of pathogen spillover due to direct handling of wild animal carcasses, exposure to blood and bodily fluids, and inadequate biosecurity measures. The integration of these high-risk processing sites into

environmental sampling frameworks will help to better identify zoonotic transmission pathways and inform targeted mitigation strategies.

3.3. Real-Time Detection and Integration

The sampling process will be designed to facilitate real-time detection of pathogens, enabling rapid responses to potential outbreaks. By implementing portable diagnostic technologies, including PCR-based tests and rapid serological assays, field teams can analyze environmental samples on-site, reducing the time between sample collection and result reporting. This will enhance the ability to detect pathogens before they spread, allowing for swift interventions. The integration of sampling data with broader health surveillance networks will help track trends in pathogen contamination, identify hotspots, and predict future risks. For example, consistent findings of *Leptospira* spp. in soil or water samples from wildlife markets may indicate an increased likelihood of leptospirosis outbreaks in surrounding communities [7,8,9].

When environmental contamination is detected, a tiered response framework will be activated. High-risk zones will undergo immediate mitigation actions, including market closures, intensified disinfection measures, and enhanced community advisories. Cross-sectoral emergency response teams will be deployed to high-exposure areas, and periodic reassessment will track intervention effectiveness.

3.4. Cross-Sectoral Collaboration

To ensure the effectiveness of environmental contamination assessments, Bolivia's Ministry of Environment and Water (MMAyA) will work in close coordination with other key stakeholders, such as the Ministry of Health, the National Institute of Health Laboratories (INLASA), and wildlife conservation organizations like the Wildlife Conservation Society (WCS). Data from environmental sampling will be shared across these agencies to create a unified surveillance platform that integrates health and environmental data. This cross-sectoral collaboration will allow for a holistic approach to zoonotic disease prevention, ensuring that both environmental and human health factors are considered when evaluating outbreak risks [7,8,9].

Additionally, collaboration with neighboring countries such as Brazil, Peru, and Argentina will be crucial for addressing transboundary zoonotic risks. Environmental contamination in shared ecosystems—such as the Amazon rainforest and the Pantanal wetlands—can have far-reaching implications, and a coordinated regional response will be vital for preventing and managing cross-border outbreaks [10,11].

3.5. Data Utilization and Response Strategies

Once environmental samples are collected and analyzed, the findings will be used to inform outbreak response strategies. Identifying areas with high levels of contamination will trigger immediate intervention protocols, including the closure of markets, increased public health messaging, and the implementation of vector control measures. Moreover, continuous monitoring of environmental contamination will be essential for assessing the long-term effectiveness of intervention strategies, providing insights into the persistence of zoonotic pathogens in the environment, and determining the need for additional mitigation efforts.

SECTION 4

Cross-Border Coordination

Bolivia's active surveillance framework must incorporate robust cross-border coordination mechanisms, given the inherently transboundary nature of zoonotic diseases. Neighboring countries such as Brazil, Peru, and Argentina share ecological corridors, wildlife migration pathways, and human trade networks that create opportunities for zoonotic pathogen spillover and dissemination. To mitigate these risks, Bolivia will implement a structured, multi-tiered cross-border collaboration strategy that facilitates real-time information exchange, coordinated surveillance initiatives, and joint outbreak response protocols (FAO, 2024a). This will involve establishing formal agreements between national health agencies, veterinary institutions, and environmental organizations across borders to enhance data integration and ensure synchronized action when zoonotic threats emerge.

To strengthen cross-border preparedness, clear activation triggers and response protocols must be established. Surveillance findings will prompt joint action based on pre-determined risk thresholds. Bolivia and its regional partners will define specific outbreak severity levels that dictate response timelines and coordination mechanisms. A regional response coordination body will be designated to ensure leadership in emergency situations, facilitating rapid mobilization of resources and personnel.

1. Real-Time Cross-Border Data Sharing and Integration

Effective transboundary surveillance is essential for mitigating zoonotic spillover risks associated with illegal wildlife trade and unregulated animal movement. Despite existing frameworks, insufficient focus has been placed on clandestine trade routes and informal trafficking networks operating across the Bolivia-Peru-Brazil-Argentina corridors. Addressing these gaps requires a structured, real-time data-sharing system that enhances detection, monitoring, and response to unauthorized wildlife movement and emerging zoonotic threats. Bolivia must collaborate with the Pan American Health Organization (PAHO), the World Organisation for Animal Health (WOAH), and regional health networks to establish standardized reporting systems for zoonotic disease incidents in wildlife, livestock, and human populations. A centralized cross-border database will aggregate molecular diagnostic results, serological surveillance data, and environmental contamination assessments, enabling early detection of zoonotic outbreaks and ensuring rapid intervention. Strengthening data-sharing agreements between Bolivia and its neighboring countries will synchronize the tracking of wildlife movement, trade patterns, and confiscations.

A multi-agency intelligence network must be established to track and disrupt illegal trade routes by integrating law enforcement agencies, border control authorities, and environmental protection units. Utilizing geospatial analytics, remote sensing, and automated surveillance systems at key border crossings and known smuggling hotspots will enhance real-time detection of unauthorized wildlife transport. Additionally, community-based monitoring networks should be deployed in border regions, engaging local populations, indigenous groups, and transport workers as informants to improve early warning capabilities and foster local participation in conservation efforts. Participation in the

Latin American Network for Emerging Infectious Diseases (LANEID) and global pathogen genomic sequencing repositories will further bolster Bolivia's surveillance capacity, facilitating international research on zoonotic disease evolution and spread (PAHO, 2023). (WHO, 2023). Sustaining cross-border zoonotic surveillance requires dedicated financial resources. Bolivia will establish a cross-border zoonotic disease response fund, co-financed by national budgets, international health organizations, and private sector contributions. This fund will support capacity-building initiatives, ongoing surveillance operations, and emergency response logistics. A financial oversight mechanism will ensure the efficient allocation of resources, reducing dependency on short-term project-based funding.

2. Strengthening legal and policy framework

Effective cross-border collaboration must be underpinned by legally binding agreements that outline obligations for information sharing, enforcement measures against illegal wildlife trade, and compliance with international zoonotic disease monitoring frameworks. Bolivia will enhance its adherence to the International Health Regulations (IHR) and align national legislation with regional and global disease control agreements. Regulatory gaps will be addressed through bilateral and multilateral policy harmonization, ensuring seamless cooperation across national borders.

3. Coordinated Surveillance of Key Wildlife Reservoirs and High-Risk Environments

Given the significant role of wildlife in zoonotic disease transmission, cross-border coordination will focus on harmonizing surveillance efforts for key reservoir species. In collaboration with environmental agencies and research institutions in Brazil, Peru, and Argentina, Bolivia will implement synchronized monitoring of high-risk wildlife species, including primates (*Alouatta spp., Ateles spp.*), jaguars (*Panthera onca*), and armadillos (*Dasypus novemcinctus*), which are known reservoirs of bacterial and viral zoonotic pathogens [7,8,9]. Standardized sampling protocols will be adopted to ensure that biological specimens—such as blood, tissue, and fecal samples—are collected and analyzed using comparable molecular and serological techniques, including PCR, ELISA, and metagenomic sequencing [10]. This will allow for early detection of pathogens such as *Leptospira* spp., *Brucella* spp., and arenaviruses that may pose transboundary risks.

Environmental surveillance will also be expanded to include key ecosystems that span multiple countries, such as the Amazon rainforest, the Pantanal wetlands, and the Gran Chaco region, where human-wildlife interactions and habitat encroachment are increasing due to deforestation, agriculture, and extractive industries [12,13,14,15]. Joint field investigations will assess zoonotic pathogen persistence in soil, water, and air samples, particularly in regions where wildlife markets, border crossings, and hunting activities occur. The integration of geospatial analysis tools, such as GIS-based risk mapping and remote sensing technologies, will further enhance the ability to monitor disease hotspots and predict potential zoonotic spillover events in these shared ecological zones [16].

4. Enhancing Technology and Data Integration

The integration of geospatial analytics, remote sensing, and automated surveillance systems will enhance Bolivia's capacity to monitor zoonotic threats across its borders. Real-time data-

sharing platforms will be established, ensuring interoperability with regional and global pathogen surveillance databases. National and regional health agencies will coordinate to ensure that surveillance data is updated frequently and accessible to relevant stakeholders, supporting predictive modeling and early warning systems.

5. Cross-Border Outbreak Preparedness and Joint Response Protocols

To strengthen regional preparedness for emerging zoonotic threats, Bolivia and its neighboring countries will develop a unified outbreak response framework that enables rapid containment measures when cross-border disease transmission is detected. This will involve the establishment of joint emergency response teams composed of epidemiologists, veterinarians, and environmental health specialists who can be rapidly deployed to affected regions [16]. Bilateral and multilateral agreements will define mechanisms for information exchange, mutual assistance, and coordinated risk communication strategies aimed at informing border communities about zoonotic disease threats.

Cross-border response efforts will also involve harmonizing biosecurity measures, including quarantine procedures for infected wildlife and livestock, standardized decontamination protocols for suspected zoonotic transmission sites, and the coordinated distribution of diagnostic kits and vaccines to affected areas [10]. Additionally, periodic simulation exercises will be conducted to test the effectiveness of cross-border response coordination, ensuring that national health agencies and emergency response units can efficiently mobilize resources and personnel in the event of an outbreak.

6. Linking Cross-Border Surveillance with Healthcare Systems

Cross-border zoonotic surveillance findings must be seamlessly integrated into Bolivia's public health infrastructure to enable rapid response to emerging threats. National health agencies will work closely with veterinary and wildlife health sectors to ensure that zoonotic disease alerts translate into immediate human health interventions. This will include strengthening referral pathways for suspected zoonotic cases, enhancing laboratory diagnostic capacity, and training healthcare personnel in outbreak response protocols.

7. Enhancing International Collaboration for Zoonotic Disease Prevention

Beyond regional cooperation, Bolivia's active surveillance system will align with global zoonotic disease monitoring initiatives. By strengthening ties with organizations such as the World Health Organization (WHO), the Food and Agriculture Organization (FAO), and the Coalition for Epidemic Preparedness Innovations (CEPI), Bolivia will gain access to advanced pathogen detection technologies, funding for surveillance projects, and technical expertise in outbreak management [12,13,14,15]. Participation in international pathogen sequencing networks, such as the Global Initiative on Sharing Avian Influenza Data (GISAID), will further enhance Bolivia's ability to track zoonotic disease emergence and contribute to global health security efforts.

By integrating cross-border surveillance into its national active surveillance framework, Bolivia will significantly enhance its capacity to detect and respond to emerging zoonotic

threats. The implementation of real-time data-sharing mechanisms, coordinated pathogen monitoring in key wildlife and environmental reservoirs, and joint outbreak response protocols will not only strengthen national preparedness but also contribute to the prevention of large-scale zoonotic disease outbreaks across South America. This multi-faceted approach aligns with the One Health framework, reinforcing the interconnectedness of human, animal, and environmental health in mitigating the risks of zoonotic disease transmission [10].

Public awareness and community engagement are crucial in mitigating cross-border zoonotic risks. Bolivia will implement a multi-tiered risk communication strategy, ensuring timely dissemination of disease alerts to border communities. Information campaigns will be tailored to local cultural contexts and languages, utilizing radio broadcasts, digital platforms, and in-person community meetings to enhance outreach. Collaborative risk communication efforts with neighboring countries will ensure consistency in public messaging, reducing misinformation and fostering community compliance with zoonotic disease prevention measures.

CHAPTER 5

Risk Reduction Strategies

Bolivia faces significant risks of zoonotic disease spillover due to extensive human-wildlife interactions, unregulated wildlife trade, and cultural consumption practices. The country's rich biodiversity, particularly in the Amazon, Chiquitano, and Gran Chaco regions, creates an environment where zoonotic pathogens can circulate among wildlife, livestock, and human populations. Therefore, a comprehensive and context-specific risk reduction strategy is essential to prevent zoonotic transmission. The following measures will be implemented to address these challenges, considering Bolivia's socio-economic, environmental, and cultural context.

1. Strengthening Law Enforcement Against Illegal Wildlife Trade

Bolivia's legal framework, particularly *Law No. 1333 on the Environment*, prohibits the illegal hunting, trafficking, and commercialization of wild species. However, enforcement remains weak due to resource limitations, lack of inter-agency coordination, and persistent wildlife trade networks. To enhance regulatory effectiveness, a multi-agency enforcement strategy will be implemented, involving the *Autoridad de Fiscalización y Control Social de Bosques y Tierra (ABT)*, the *Dirección General de Biodiversidad y Áreas Protegidas (DGBAP)*, and local police forces. Surveillance efforts will be intensified at known wildlife trafficking hubs, such as the Amazonian corridors connecting Bolivia to Brazil, Peru, and Argentina. Checkpoints will be established in Santa Cruz, Cobija, and Puerto Suárez to inspect vehicles for illegal wildlife transport. The *Policía Forestal y de Medio Ambiente (POFOMA)* will receive specialized training in wildlife crime investigation, forensic identification of trafficked species, and legal prosecution procedures. Community-based wildlife protection initiatives will also be introduced in indigenous territories, where local populations, such as the Tacana and Tsimane, will act as environmental monitors, reporting illegal hunting and trafficking activities to authorities [17]. Legislative reforms will be pursued to increase penalties for wildlife trafficking, ensuring repeat offenders face stricter legal consequences. Additionally, Bolivia will strengthen international cooperation through agreements with INTERPOL and CITES to dismantle transnational wildlife smuggling networks [18].

Law enforcement strategies will be reinforced through inter-agency collaboration and intelligence-sharing mechanisms that connect wildlife crime investigations with zoonotic disease surveillance. Enhanced coordination between environmental protection agencies, customs authorities, and local law enforcement will improve monitoring at known trafficking hubs, facilitating targeted interventions against high-risk illegal trade activities

2. Regulating Wildlife Markets Through Mandatory Pathogen Screening

The unregulated sale of bushmeat in informal markets presents a substantial challenge for zoonotic disease prevention in Bolivia. To mitigate risks associated with wildlife consumption, a structured approach to monitoring and regulating bushmeat trade is essential. Implementing mobile diagnostic units equipped with rapid PCR and ELISA testing in known

bushmeat trade hubs will be crucial for screening animal carcasses for zoonotic pathogens before they enter the consumer market.

A clear strategy for monitoring the informal bushmeat trade must focus on subsistence hunting as a primary point of zoonotic spillover. Surveillance efforts must be extended beyond markets to include hunting grounds and transit routes where bushmeat is processed and transported. Establishing mobile field teams to monitor hunting practices in rural and indigenous communities will provide critical data on high-risk interactions between humans and wildlife. These teams will work closely with community members to identify species most commonly hunted, assess handling practices, and document potential exposure points for zoonotic pathogens.

Mandatory health certification for bushmeat vendors must be introduced to ensure that only screened and approved products are sold in markets. This will be complemented by market restructuring and hygiene compliance measures, including designated zones for bushmeat trade within markets to separate live animals from meat products and prevent cross-contamination. Sanitation stations will be installed, and vendors will be required to adhere to strict hygiene protocols enforced through regular inspections.

Stronger integration of wildlife law enforcement efforts will be necessary to prevent illegal bushmeat trafficking. Coordination between the Ministry of Environment and Water (MMAyA), the National Service for Agricultural Health and Food Safety (SENASAG), and law enforcement agencies must be strengthened to dismantle trafficking networks and enhance border controls to prevent cross-border smuggling of high-risk species. To ensure effective surveillance, culturally appropriate engagement with subsistence hunters must be prioritized. Training programs must be developed in collaboration with traditional leaders to promote biosecurity measures without disrupting essential cultural practices. Incentive-based programs will be introduced to encourage compliance with zoonotic risk mitigation strategies, including the provision of protective equipment, alternative food sources, and financial compensation for reporting sick or dead wildlife.

Public awareness and behavioural change campaigns will play a crucial role in reducing zoonotic risks. Targeted outreach efforts must educate bushmeat consumers about the health risks associated with zoonotic disease transmission. Information should be disseminated through culturally tailored radio broadcasts, visual materials, and community workshops in indigenous languages. By integrating these regulatory measures, Bolivia will enhance its capacity to detect and prevent zoonotic spillover events while promoting sustainable wildlife management practices. Strengthening bushmeat trade oversight through mandatory pathogen screening, structured market interventions, and active field surveillance of hunting practices is a critical step in mitigating public health risks associated with informal wildlife consumption.

3. Enhancing Capacity for Wildlife Market Surveillance and Regulation

Improved oversight of wildlife markets requires enhanced veterinary inspection services and pathogen screening technologies. Bolivia will expand the deployment of mobile diagnostic units to high-risk markets, ensuring real-time testing of wildlife products. Mandatory licensing

for wildlife vendors and increased sanitary inspections will be introduced to reduce zoonotic spillover risks.

4. Promoting Hygiene Standards and Training for Vendors and Hunters

Many individuals involved in the bushmeat trade and processing operate in unsanitary conditions, increasing their exposure to zoonotic pathogens such as Leptospira spp., Brucella spp., and Rabies lyssavirus. To address this, Bolivia must implement a standardized and scalable training framework that equips high-risk occupational groups with the necessary skills and resources to minimize pathogen transmission.

A tiered training approach should be developed in collaboration with the Ministerio de Salud, SENASAG, and regional veterinary and public health institutions. Training modules must focus on proper carcass handling techniques, disinfection protocols, biosecurity measures, and the correct use of personal protective equipment (PPE) such as gloves, masks, aprons, and boots. Field-based practical sessions will ensure that traders and hunters understand the correct application of hygiene protocols in real-world settings, including market stalls, hunting sites, and processing areas. To reinforce compliance, Standard Operating Procedures (SOPs) aligned with international best practices must be established for wildlife slaughter, meat inspection, and transportation.

To further mitigate risks, Bolivia must ensure the availability and distribution of PPE to individuals engaged in wildlife handling, particularly in high-risk areas such as Beni, Santa Cruz, and Pando, where bushmeat trade is prevalent. A structured PPE management system should be developed to facilitate regular replenishment, proper usage training, and disposal protocols to prevent contamination. Additionally, waste management systems for animal byproducts, blood, and offal disposal must be implemented to minimize environmental contamination and secondary transmission risks.

Routine health screenings and zoonotic disease testing for hunters, vendors, and butchers must be incorporated into Bolivia's national disease surveillance strategy. Periodic medical check-ups, serological testing, and vaccination campaigns (such as rabies pre-exposure prophylaxis for high-risk groups) should be mandated to detect early-stage infections and prevent outbreak escalation. Establishing a health certification program for bushmeat traders, similar to food safety licensing schemes in regulated meat industries, will enforce accountability and adherence to hygiene protocols.

The successful pilot hygiene training program conducted in Beni in 2021 demonstrated measurable reductions in zoonotic exposure risks, justifying nationwide expansion of these initiatives. Future training sessions must be integrated into Bolivia's formal public health infrastructure, ensuring long-term sustainability through periodic refresher courses and regulatory compliance checks. By embedding hygiene education into existing trade regulations, disease surveillance, and wildlife market oversight mechanisms, Bolivia can significantly reduce the zoonotic spillover risks associated with wildlife handling and bushmeat consumption.

5. Developing Alternative Livelihoods for Communities Engaged in Wildlife Trade

Many rural and indigenous communities in Bolivia depend on hunting and wildlife trade as primary sources of income, making conservation efforts challenging. Without viable economic alternatives, wildlife exploitation will persist. To reduce dependence on wildlife trade, Bolivia will introduce sustainable livelihood programs, including small-scale poultry and fish farming, agroforestry initiatives, and ecotourism development. These programs will be supported by microfinance initiatives, enabling families to transition to alternative businesses that do not rely on wildlife exploitation [19].

To ensure these alternative livelihood programs are effective, targeted training and technical support will be provided to community members. Capacity-building initiatives will focus on business development, sustainable resource management, and market access, allowing individuals to establish profitable enterprises that align with conservation goals. Additionally, incentives such as financial grants and access to cooperatives will be introduced to encourage participation and long-term engagement.

In biodiversity-rich regions such as Madidi National Park, ecotourism initiatives will be expanded, training local communities as wildlife guides, thereby providing a sustainable income source. The Tacana Indigenous Territory has successfully transitioned from jaguar hunting to ecotourism, demonstrating the feasibility of such programs [17]. Furthermore, the establishment of community-run conservation areas will be promoted, ensuring that local populations benefit directly from preserving their natural environment.

Additionally, training in sustainable harvesting of non-timber forest products (e.g., Brazil nuts and medicinal plants) will be promoted as an alternative economic activity for communities engaged in bushmeat trade. These efforts will include the development of value-added processing facilities and direct market linkages to enhance profitability. By integrating these strategies, Bolivia will create a more resilient economic framework for rural and indigenous populations, reducing the reliance on wildlife exploitation while fostering environmental sustainability.

To ensure long-term reductions in zoonotic spillover risks, Bolivia will provide structured financial incentives for communities transitioning away from wildlife trade. Access to microloans, capacity-building programs, and technical assistance will support sustainable livelihood alternatives. These efforts will be reinforced through cooperative models that link local producers with ethical markets, enhancing economic resilience in regions historically dependent on wildlife exploitation.

6. Public Awareness Campaigns Targeting Indigenous Groups and Local Traders

Effective zoonotic disease prevention requires behavioral change, particularly in communities engaged in wildlife trade and bushmeat consumption. Many indigenous groups and rural traders lack awareness of zoonotic disease risks, and traditional beliefs often encourage the consumption of wild animal parts for medicinal purposes. To address this, Bolivia will launch culturally adapted public awareness campaigns in high-risk regions. Educational workshops

will be conducted in collaboration with local health workers and community leaders, integrating zoonotic disease education into traditional knowledge systems. Media campaigns in Quechua, Aymara, and Guaraní languages will disseminate information through radio broadcasts, social media content, and printed materials, ensuring accessibility to remote populations [10,11]. Partnerships with traditional healers and market vendors will facilitate dialogue on modifying high-risk practices, such as using raw animal parts in remedies. Radio campaign could influence reduced bushmeat consumption. Scaling these efforts nationwide will be critical in reducing zoonotic spillover risks while respecting cultural traditions. Similar initiatives have demonstrated the effectiveness of localized awareness strategies. For instance, a behavioral change campaign in Yangambi, Democratic Republic of Congo, aimed at reducing unsustainable wild meat consumption, utilized marketing strategies to promote locally grown pork and chicken, leading to improved food security and reduced reliance on bushmeat [20]. Additionally, in Nigeria, WildAid's campaign against urban bushmeat consumption has been recognized as a commendable initiative to reduce wildlife poaching and control zoonotic diseases [21]. These examples suggest that implementing localized awareness campaigns in Bolivia's high risk regions could effectively reduce bushmeat consumption and mitigate zoonotic spillover risks while respecting cultural traditions.

Behavioral change initiatives will focus on integrating zoonotic disease education into school curricula, ensuring that younger generations develop a foundational understanding of zoonotic risk factors. Educational materials will be adapted for indigenous communities, incorporating culturally relevant narratives and participatory learning approaches. By fostering long-term shifts in perception, Bolivia aims to reduce high-risk behaviors associated with zoonotic disease transmission.

CHAPTER 6

Emergency Communication Strategy

A structured and efficient emergency communication framework is critical for facilitating rapid response actions, ensuring stakeholder coordination, and maintaining public trust during zoonotic disease outbreaks. In Bolivia, where zoonotic spillover risks are heightened due to high human-wildlife interactions, wildlife trade, and rural community dependence on bushmeat, an emergency communication strategy tailored to the country's socio-geographical landscape is essential. This framework will integrate digital reporting tools, public alert mechanisms, crisis communication teams, and community engagement programs to enhance real-time information exchange and mitigate misinformation [7,8,9].

1. Centralized Reporting System

A centralized, digital reporting system will serve as the backbone of the emergency communication strategy, enabling real-time notifications of suspected zoonotic cases among key stakeholders, including the Ministry of Health , the National Institute of Health Laboratories (INLASA), the Ministry of Environment and Water (MMAyA), veterinary authorities, and international health agencies such as the World Health Organization (WHO) and the Food and Agriculture Organization (FAO). This system will be integrated

into Bolivia's national health database and linked with the Early Warning System (EWS) to provide automated alerts upon detecting abnormal patterns of mortality or infection among humans, wildlife, or domestic animals. For instance, in the event of a sudden increase in febrile illnesses in a rural community near the Madidi National Park—an area known for high wildlife diversity and frequent human-animal interactions—local health centers would immediately input data into the centralized system. This would trigger an alert to national health authorities, enabling a coordinated field investigation involving epidemiologists, veterinarians, and laboratory specialists to determine the presence of zoonotic pathogens such as *Leptospira spp.*, *Rabies lyssavirus*, or *Hantavirus*

2. Public Alert System

To ensure timely public awareness and preventive action, a multi-channel public alert system will be deployed. Given Bolivia's diverse communication landscape, outbreak warnings will be disseminated via multiple platforms, including SMS notifications, community radio broadcasts, national television, and social media networks such as Facebook, WhatsApp, and Twitter. These alerts will provide critical information about disease symptoms, transmission risks, and recommended safety measures, tailored to different audience segments.

For example, in the case of a leptospirosis outbreak following heavy flooding in the Beni region—a scenario that frequently occurs during the rainy season—SMS alerts will be sent to residents advising them to avoid floodwaters, wear protective clothing, and seek medical attention if experiencing symptoms such as fever, muscle pain, or jaundice. Simultaneously, local radio stations will broadcast public service announcements in Spanish and indigenous languages such as Aymara and Quechua to ensure effective outreach in remote areas. Social media campaigns will be leveraged to combat misinformation, reinforcing evidence-based guidelines issued by health authorities.

3. Crisis Communication Teams

To maintain public confidence and prevent panic during outbreaks, trained crisis communication teams will be deployed at the national and regional levels. These teams, composed of health professionals, epidemiologists, media specialists, and government representatives, will be responsible for coordinating official messaging, addressing public concerns, and countering misinformation that could hinder outbreak control efforts.

During the COVID-19 pandemic, Bolivia experienced challenges in controlling misinformation related to treatment options and virus transmission. To prevent similar issues in future zoonotic outbreaks, crisis communication teams will be equipped with evidence-based messaging strategies and trained in risk communication principles. Press briefings will be conducted regularly to update the public on outbreak developments, response measures, and behavioral recommendations. Furthermore, fact-checking initiatives in collaboration with media outlets will be implemented to counter false claims that may spread through social media and word-of-mouth in rural communities. For instance, if an outbreak of rabies occurs among jaguar populations in the Gran Chaco region, crisis communication teams will work closely with local veterinarians and wildlife conservation groups to inform the public about the risks of handling or approaching infected animals. They will also coordinate the dissemination of accurate information on vaccination campaigns and post-exposure prophylaxis protocols to prevent human and domestic animal infections.

4. Community Engagement Programs

Effective zoonotic disease prevention requires culturally tailored interventions that align with indigenous knowledge systems and traditional practices. In Bolivia, where many indigenous communities rely on wildlife for food, medicine, and cultural practices, engaging traditional healers, community elders, and local health workers as trusted sources of information is essential for ensuring grassroots participation in disease surveillance and response efforts. Integrating these key stakeholders into zoonotic risk communication will enhance prevention strategies by ensuring messages are contextually relevant and widely accepted.

A structured engagement framework must incorporate participatory workshops developed in collaboration with indigenous organizations such as the Confederación de Pueblos Indígenas de Bolivia (CIDOB), traditional medicine practitioners, and health authorities. These workshops will educate communities on zoonotic disease transmission pathways, early warning signs, and safe handling practices for bushmeat and live animals while promoting alternative, safer medicinal remedies. Training modules should emphasize risk reduction strategies, including proper processing of animal-derived substances to minimize pathogen exposure. Establishing a peer-led knowledge exchange program—where respected elders and healers serve as zoonotic disease prevention advocates—will further strengthen community trust and compliance with biosecurity guidelines.

To enhance outreach, zoonotic risk messaging must be adapted to local languages and cultural contexts through oral storytelling, radio broadcasts, and visual materials such as pictorial guides. In high-risk regions like Pando, where the consumption of armadillos is common, targeted awareness campaigns will emphasize the risks associated with handling and consuming wildlife species known to carry zoonotic pathogens such as *Mycobacterium leprae* (leprosy). Additionally, mobile health units conducting active surveillance in remote areas will integrate community engagement activities by distributing educational materials, demonstrating proper biosecurity measures, and encouraging early reporting of unusual animal deaths or human illnesses.

CHAPTER 7

Participation of Authorities in Pandemic Preparedness

To enhance Bolivia's capacity for early detection and response to zoonotic disease outbreaks, a Pandemic Preparedness Task Force (PPTF) will be established to integrate active surveillance into national health security strategies. The PPTF will be led by the Ministry of Health, with SENASAG and INLASA serving as co-coordinating agencies. It will include representatives from the Ministry of Environment and Water (MMAyA), regional health authorities, and veterinary services, ensuring a One Health approach. The task force will have permanent operational status, meeting quarterly to evaluate national zoonotic threats, assess simulation outcomes, and oversee legislative updates. In the event of an outbreak, an emergency activation protocol will allow for immediate decision-making and deployment of response teams. The PPTF will also facilitate collaboration with international organizations (WHO, FAO, WOAH) to align Bolivia's pandemic preparedness strategies with global standards.

1. Scenario-Based Simulation Exercises

Scenario-based simulation exercises are a critical component of Bolivia's pandemic preparedness strategy, allowing authorities to test response capabilities, identify weaknesses, and improve coordination across sectors involved in zoonotic disease surveillance. These exercises will include tabletop simulations (TTXs), field-based drills, and cross-border response exercises, tailored to Bolivia's unique epidemiological landscape, ecosystems, and socio-economic dynamics. Bolivia's diverse ecosystems, ranging from the Amazon rainforest to the Andean highlands, create multiple zoonotic spillover risks. In the following paragraphs, scenarios are designed based on real-world outbreaks that have occurred or are likely to emerge, ensuring preparedness for rapid containment of zoonotic pathogens before they escalate into national or regional health emergencies.

1.1. Tabletop Simulations (TTXs) for Coordinated Outbreak Response

Tabletop simulations (TTXs) will bring together key national and regional authorities to evaluate decision-making processes and inter-agency coordination in response to hypothetical zoonotic disease outbreaks. The following is an example of a TTX designed to address such scenarios.

Example 1: Avian Influenza (H5N1) Spillover in Poultry Farms and Wild Bird Populations in Bolivia

To enhance Bolivia's pandemic preparedness and active surveillance capabilities, a large-scale scenario-based simulation exercise will be conducted to assess the country's ability to detect, contain, and respond to an outbreak of highly pathogenic avian influenza (H5N1). This simulation will be based on a hypothetical yet plausible spillover event in poultry farms and wild bird populations in high-risk areas such as Santa Cruz, Cochabamba, and the Beni wetlands, where large-scale poultry farming coexists with significant migratory bird routes. The exercise will involve multi-agency coordination, real-time deployment of rapid response teams, testing of biosecurity measures, and public health interventions to mitigate zoonotic transmission risks.

- **Rapid Detection and Diagnostic Testing**

Early detection of zoonotic pathogens is essential for outbreak containment, and this simulation will evaluate Bolivia's ability to rapidly diagnose H5N1 in both animals and humans. Active surveillance teams from the National Institute of Health Laboratories (INLASA) and the Bolivian Food and Agriculture Health Authority (SENASAG) will be deployed to conduct systematic testing of dead and symptomatic poultry in farms and live bird markets. The exercise will simulate an emergency where mass die-offs of chickens in commercial farms and backyard poultry holdings are reported, prompting immediate field investigations. Mobile diagnostic laboratories equipped with portable PCR and serological testing kits will be dispatched to collect and process samples on-site, reducing the time required for laboratory confirmation. Simultaneously, wild bird mortality events in key migratory stopover sites such as Pantanal wetlands and Lake Titicaca will be investigated to assess whether H5N1 has spread to native bird populations. The simulation will also include human surveillance, testing farmworkers, market vendors, and veterinarians for possible exposure, ensuring that asymptomatic or early-stage infections are detected.

- **Emergency Containment Measures**

The simulation will test Bolivia's ability to enforce quarantine and containment strategies following a confirmed outbreak. Biosecurity protocols will be activated, restricting the movement of live poultry and poultry products from infected zones to other markets or farms. Poultry culling procedures will be simulated, demonstrating Bolivia's preparedness to conduct targeted depopulation of infected birds while minimizing economic losses for farmers. Disinfection measures will be carried out in poultry markets, transport vehicles, and farms using chemical decontaminants to eliminate viral spread. Law enforcement agencies and local governments will simulate checkpoints on major transportation routes, preventing the illicit movement of infected birds to unaffected regions. Cold-chain logistics for vaccine distribution will also be tested, ensuring that vaccines for high-risk workers and antiviral medications such as oseltamivir can be deployed rapidly to protect human populations.

- **Strengthening Biosecurity and Surveillance**

A critical component of the simulation is evaluating farm biosecurity measures in Bolivia's poultry sector. Participating poultry farms will undergo risk assessments, testing the effectiveness of protective measures such as restricted farm access, controlled entry points, and disinfection stations. Farmers and market vendors will receive simulation-based training on recognizing early warning signs of H5N1, proper use of personal protective equipment (PPE) such as gloves and masks, and emergency response protocols. The exercise will include mock inspections of poultry farms and live bird markets in high-risk areas to assess compliance with biosecurity standards. Additionally, avian surveillance networks will be established in key ecological zones, such as Noel Kempff Mercado National Park and the Amazonian lowlands, where wild birds act as natural reservoirs of avian influenza.

- **Public Health Response and Human Case Management**

The human health component of the exercise will focus on identifying and managing suspected human cases of H5N1 infection. Bolivia's health authorities will establish temporary fever clinics in affected regions, where individuals displaying influenza-like symptoms or respiratory distress will be evaluated using rapid diagnostic tests. The effectiveness of case isolation and contact tracing mechanisms will be tested, ensuring that infected individuals do not spread the virus to the broader community. The simulation will also evaluate Bolivia's stockpile of antiviral medications, such as oseltamivir, ensuring that critical supplies are available for exposed individuals, healthcare workers, and veterinary personnel. Additionally, risk communication strategies will be tested, including simulated press conferences, emergency public health alerts via SMS and radio, and community outreach programs to counter misinformation and ensure public trust in government response efforts.

- **Regional and Cross-Border Collaboration**

Due to Bolivia's geographic proximity to Brazil, Peru, Paraguay, and Argentina, the simulation will assess the cross-border implications of an H5N1 outbreak. A key component will be activating Bolivia's participation in the World Organisation for Animal Health (OIE) and the Food and Agriculture Organization (FAO) disease surveillance networks to share real-time epidemiological data. The scenario will involve coordinated disease reporting and border inspections, testing Bolivia's ability to work with neighboring countries to prevent transboundary transmission. The simulation will also involve joint migratory bird surveillance

with Peruvian and Brazilian wildlife health authorities, ensuring that regional efforts to track avian influenza spread among wild birds are harmonized.

- **Expected Outcomes and Post-Simulation Evaluation**

Following each simulation exercise, a structured evaluation process will be conducted to assess Bolivia's strengths and weaknesses in active surveillance and pandemic preparedness. A Post-Simulation Review Committee, led by the PPTF, will analyze the exercise outcomes, identify gaps in response coordination, and recommend necessary policy updates. Findings will be incorporated into Bolivia's national emergency response framework, ensuring that lessons learned translate into concrete legislative improvements and operational changes. Specific action items will include upgrading laboratory diagnostics, refining biosecurity enforcement, enhancing data-sharing mechanisms, and strengthening inter-agency collaboration. Each evaluation report will be presented to government authorities and international partners (WHO, FAO, WOAH) to align Bolivia's surveillance strategy with evolving global health standards.

1.2. Field-Based Drills for Rapid Response Teams

Field-based drills will test the capacity of Bolivia's emergency response teams to implement real-time containment measures in affected regions. These drills will simulate zoonotic spillover events in rural and indigenous communities, where active surveillance is most needed. The following is an scenario to address Field- based drills.

Example 2: Hantavirus Outbreak in a Remote Indigenous Community

Scenario: An increase in severe respiratory infections is reported among the Chimane indigenous community in Beni, raising concerns about a Hantavirus outbreak linked to rodent reservoirs in nearby agricultural fields.

- **Simulation Objectives**
  - Train field epidemiologists in safe rodent capture and sampling techniques to confirm the presence of hantavirus RNA using portable PCR kits.
  - Assess the ability of mobile response units to transport samples to INLASA laboratories under biosafety Level-3 conditions.
  - Evaluate the effectiveness of public health messaging in a community with low literacy rates and limited access to healthcare.
  - Ensure PPE protocols are strictly followed to prevent field researchers and medical teams from exposure.

- Key Actions
  - Deploy the National Epidemiology Unit's rapid response team to the affected village.
  - Conduct door-to-door household surveys to trace all suspected cases and potential rodent exposure sites.
  - Set up temporary medical camps to administer supportive treatment while awaiting diagnostic confirmation.
  - Distribute educational materials in local languages (Chimane and Spanish) to increase community awareness about reducing rodent infestations in homes.

- **Expected Outcome**
  - The efficiency of Bolivia's response protocols will be assessed, highlighting areas where field coordination, sample handling, and patient management require improvement.

2. Strengthening Surveillance in Informal and Indigenous Sectors

Given the high zoonotic disease risk in indigenous and rural communities, Bolivia will establish community-based surveillance networks to complement national and regional monitoring efforts. Trained local health workers, indigenous leaders, and hunters will participate in early warning systems by reporting abnormal wildlife mortality events, unexplained illnesses in livestock, and unusual disease symptoms in humans. Engagement with traditional ecological knowledge (TEK) will enhance disease detection in remote areas where formal surveillance is limited. Additionally, Bolivia will introduce mobile-based disease reporting tools, enabling citizens in rural and border regions to submit real-time alerts on potential zoonotic outbreaks. These initiatives will strengthen participatory surveillanceand improve outbreak response in underserved communities.

2.1. Cross-Border Simulation Exercises for Transboundary Zoonotic Threats

Given Bolivia's proximity to Brazil, Peru, Paraguay, and Argentina, cross-border simulations will ensure regional cooperation in preventing and managing zoonotic disease outbreaks. The following scenario demonstrates cross border simulation exercises.

Example 3: Rabies Virus Spillover from Vampire Bats in the Amazon Border Region

Scenario: A sudden surge in rabies cases in cattle and humans is reported in the Pando Department, near the Brazilian border. Investigations link the outbreak to Desmodus rotundus (vampire bat) colonies feeding on livestock in the area.

- **Simulation Objectives**
  - Test cross-border data-sharing mechanisms with Brazil's National Health Surveillance Agency (ANVISA) and Peru's Ministry of Health.
  - Assess the effectiveness of mass vaccination campaigns for livestock in high-risk zones.
  - Improve Bolivia's bat population monitoring efforts using GPS-based tracking to map bat colony movements.
  - Evaluate emergency rabies Post-Exposure Prophylaxis (PEP) distribution strategies for affected human populations.

- **Key Actions**
  - Implement joint wildlife surveillance patrols with neighboring countries to monitor vampire bat populations and conduct viral load testing in captured specimens.

- Initiate mass livestock vaccination drives to prevent further spillover of rabies virus.
- Deploy rapid-response epidemiology teams to investigate suspected human cases, ensuring immediate PEP treatment for those bitten.
- Disseminate educational campaigns in border villages, advising farmers on the risks of bat bites and wound treatment protocols.

- **Expected Outcome**
  - This cross-border simulation will enhance Bolivia's ability to handle transboundary zoonotic threats, improving regional outbreak response and data-sharing efficiency.

2.2. Climate-Driven Zoonotic Spillover Drills

Bolivia's changing climate (increased rainfall, deforestation, and habitat encroachment) contributes to zoonotic spillover events. Simulations will address climate-related disease risks, focusing on vector-borne zoonotic diseases such as Leptospirosis and Yellow Fever.

Example 4: Post-Flood Leptospirosis Outbreak in Pando

Scenario: Heavy flooding during the rainy season (January-April) contaminates water sources with *Leptospira spp.*, leading to a spike in leptospirosis cases among flood-affected communities.

- **Simulation Objectives**
  - Test the capacity of Bolivian health agencies to provide rapid diagnostic and treatment support for leptospirosis infections.
  - Assess the efficiency of environmental decontamination teams in restoring safe water supplies.
  - Improve real-time GIS mapping of flooded areas to prioritize resource allocation.

- **Key Actions**
  - Deploy water quality assessment teams to test for *Leptospira spp.* contamination.
  - Conduct mass distribution of doxycycline for high-risk populations (flood victims, emergency responders).
  - Mobilize mosquito vector control teams to prevent co-infections with dengue or yellow fever.

- **Expected Outcome**
  - The simulation will refine Bolivia's emergency flood response, ensuring timely medical intervention, vector control, and public health communication.

3. Steps for Conducting Periodic Simulation Exercises for Zoonotic Outbreak Response in Bolivia

To ensure effective pandemic preparedness, periodic simulation exercises will be conducted to assess Bolivia's emergency response capabilities in the event of zoonotic disease outbreaks. These exercises will involve multisectoral collaboration, integrating public health officials, veterinary services, environmental agencies, and emergency response teams. The simulations will be based on realistic outbreak scenarios, ensuring rapid detection, containment, and mitigation strategies.

3.1. Planning and Scenario Development

Simulation exercises will begin with a risk-based planning approach, identifying priority zoonotic pathogens such as rabies, leptospirosis, brucellosis, salmonellosis, and emerging bat-borne viruses. Scenarios will be developed based on:

- Historical outbreaks in Bolivia (e.g., rabies in Amazonian regions, leptospirosis in flood-prone areas).
- Emerging threats based on active surveillance data (e.g., novel coronaviruses in wildlife trade markets).
- International biosecurity concerns (e.g., antimicrobial-resistant bacterial threats)

3.2. Mobilization of Emergency Response Teams

A dedicated Emergency Response Team (ERT) will be activated, comprising:

- Epidemiologists (Ministry of Health - MS, INLASA)
- Veterinary and wildlife health specialists (SENASAG, UMSA)
- First responders and emergency medical personnel (Bolivian Red Cross, Civil Defense)
- Community health workers and indigenous leaders in high-risk areas
- Environmental monitoring teams.

These teams will be trained to rapidly respond to simulated outbreaks, ensuring swift containment and risk communication strategies.

3.3. Field Deployment and Containment Measures

During the simulation, response teams will be deployed to high-risk locations such as:

- Wildlife markets and hunting zones (to monitor zoonotic spillover risks).
- Flood-affected rural areas (for waterborne disease response, e.g., leptospirosis).
- Border regions with Brazil, Peru, and Argentina (for transboundary disease coordination).

Teams will conduct field investigations, collect diagnostic samples, and implement quarantine protocols for livestock and wildlife to test Bolivia's biosurveillance capacity.

3.4. Rapid Diagnostic Testing and Laboratory Coordination

Simulation exercises will assess the efficiency of Bolivia's diagnostic network, ensuring that:

- PCR and ELISA tests are deployed within 24 hours for suspected zoonotic cases (INLASA, UAGRM).
- Environmental sampling protocols are followed for soil, water, and air contamination analysis.
- Private-sector labs (e.g., Medlab) support decentralized diagnostic capacity to reduce testing delays.

3.5. Risk Communication and Public Alert Systems

The exercise will test Bolivia's emergency communication strategy, including:

- Automated SMS alerts for rural communities at risk.
- Live radio updates in indigenous languages for hard-to-reach populations.
- Social media engagement to prevent misinformation and panic.
- Press conferences by the Ministry of Health for real-time public health advisories

3.6. Evaluation, Reporting, and Policy Adjustments

After each simulation, a post-exercise review will be conducted to:

- Identify operational gaps in Bolivia's outbreak response framework.
- Improve coordination among health, agriculture, and environmental sectors.
- Update biosecurity legislation to align with international standards.

4. Ensuring Financial Sustainability for Active Surveillance

A major challenge in sustaining Bolivia's active surveillance efforts is securing long-term financial resources for laboratory diagnostics, field monitoring, and epidemiological research. To address this, Bolivia will adopt a multi-tiered funding strategy combining government allocations, international grants, private sector investments, and contingency reserves.

- Government Budget Allocations: A fixed percentage of the national health and agriculture ministries' budgets will be earmarked for zoonotic disease surveillance. This will support mobile diagnostic units, laboratory infrastructure, and real-time data integration.

- International Partnerships: Bolivia will leverage funding from WHO's Contingency Fund for Emergencies (CFE), FAO's zoonotic disease prevention programs, and the World Bank's Pandemic Fund to strengthen active surveillance in high-risk regions.
- Public-Private Partnerships (PPPs): Collaborations with pharmaceutical companies, research institutions, and biotech firms will expand Bolivia's diagnostic capabilities. Examples include local production of PCR kits, vaccine development initiatives, and genomic surveillance projects.

- Contingency Emergency Response Fund (CERF): Bolivia will establish a pre-allocated emergency response fund managed by the Ministry of Health and SENASAG. This fund will allow for immediate procurement of antivirals, vaccines, and PPE supplies in the event of an outbreak.

5. Legislative Updates and Policy Alignment for Active Surveillance in Bolivia

To ensure that Bolivia's pandemic preparedness strategies adhere to international biosecurity standards, a series of legislative reforms and policy alignments must be implemented to modernize existing public health and environmental policies. Given the country's high-risk

zoonotic disease landscape—marked by frequent flooding events in Pando, bushmeat trade in Santa Cruz, and wildlife trafficking along the Brazil-Peru border—these reforms are critical in mitigating the risk of zoonotic spillovers. Bolivia's updated biosecurity framework will be developed in collaboration with the Ministry of Health, the Ministry of Environment and Water, the National Service of Agricultural Health and Food Safety (SENASAG), and international partners such as WHO, FAO, and WOAH.

5.1. Mandating Active Surveillance Programs

Bolivia will legally require routine and systematic surveillance of zoonotic pathogens in key wildlife trade hubs, bushmeat markets, and high-risk ecosystems, ensuring early detection of emerging diseases. Surveillance activities will be prioritized in areas with high human-wildlife interaction, particularly:

- **Wildlife Trade Hubs**: Cities such as Santa Cruz, Trinidad, and Cobija serve as major centers for wildlife trafficking and bushmeat trade. These markets will be subject to mandatory pathogen screening programs to test for rabies, Leptospirosis, hantaviruses, and other zoonotic threats in live and dead animal specimens.
- **National Parks and Wetland Areas**: Madidi National Park, home to *Alouatta spp*. (howler monkeys), *Ateles spp*. (spider monkeys), and *Panthera onca* (jaguars), will be designated as a high-priority surveillance site due to its potential as a viral reservoir. Similarly, the Pantanal Wetlands, which border Brazil, will be closely monitored for avian influenza outbreaks, as migratory birds frequently carry the virus across international borders.
- **Mining and Deforestation Zones**: Illegal mining operations in northern La Paz and Pando have been linked to increased human exposure to rodent-borne viruses such as hantaviruses. Active surveillance programs will be extended to gold mining camps, where miners frequently come into contact with contaminated rodent urine and feces.

To enforce these surveillance programs, Bolivia will introduce legal mandates requiring private entities (such as wildlife markets and mining concessions) to comply with periodic health inspections. Non-compliance will result in penalties, including fines, market closures, and revocation of business licenses.

5.2. Strengthening Disease Reporting Obligations

Delays in reporting zoonotic disease outbreaks have historically hindered early containment efforts in Bolivia, leading to larger-scale public health crises. For example, the 2019 Leptospirosis outbreak in Pando, exacerbated by severe flooding, spread rapidly due to uncoordinated disease notifications, delaying control measures by two weeks. To address these gaps, Bolivia will introduce mandatory real-time disease reporting obligations, ensuring:

- **Immediate Notification of Suspected Cases:** All health centers, veterinary clinics, wildlife rehabilitation centers, and agricultural agencies will be legally required to report suspected cases of zoonotic infections within 24 hours to the National Epidemiology Unit and INLASA.
- **Integrated One Health Reporting System**: A centralized digital platform will be developed to allow seamless sharing of wildlife disease surveillance data, human health records, and livestock infection trends among different government entities. This system will be modeled after Peru's "Sistema Integrado de Información Sanitaria" (SIIS), which has successfully reduced reporting delays for vector-borne diseases.

- **Mandatory Cross-Border Disease Reporting**: Given Bolivia's porous borders with Brazil, Peru, and Argentina, regional disease-sharing agreements will be formalized to ensure real-time communication on outbreaks. For instance, if Venezuelan equine encephalitis (VEE) virus is detected in Beni's equine population, immediate alerts will be issued to Brazil's Ministry of Agriculture to prevent transboundary spread

Failure to comply with disease reporting mandates will result in legal penalties for healthcare providers and veterinarians, including license suspensions and financial fines.

5.3. Aligning Bolivia's One Health Framework with WHO and FAO Guidelines

Bolivia will modernize its One Health framework by integrating global zoonotic disease surveillance strategies, aligning national policies with WHO's Global Early Warning System for Zoonoses (GLEWS) and FAO's Emergency Prevention System (EMPRES). Key actions include:

- **Adopting Standardized Diagnostic Protocols:** Bolivia will implement WHO-approved molecular testing guidelines for diseases such as Ebola-related viruses, avian influenza, and coronaviruses. This will improve the reliability of PCR-based diagnostics in national reference laboratories.

- **Establishing a Zoonotic Disease Task Force**: A multisectoral team comprising epidemiologists, veterinarians, conservation biologists, and public health officials will be formalized under Bolivia's One Health Commission to oversee inter-agency coordination and FAO-led zoonotic disease risk assessments.

- **Creating Biobank Facilities for Zoonotic Pathogens**: Modeled after Brazil's Oswaldo Cruz Institute, Bolivia will establish a national biorepository for storing zoonotic pathogen samples from wildlife, livestock, and environmental specimens. This will facilitate genomic surveillance and vaccine development.

5.4. Regulating Wildlife Trade and Consumption

Bolivia's wildlife trade and bushmeat industry play a significant role in zoonotic disease transmission, particularly in lowland Amazonian communities and urban markets. To reduce high-risk human-wildlife contact, the following regulatory measures will be implemented:

- **Hygiene Standards for Bushmeat Markets**: Mandatory sanitary protocols will be introduced for wildlife slaughter, handling, and sale in markets such as Mercado Campesino in Trinidad, where peccary, caiman, and armadillo meat are commonly sold. Market vendors will be required to adhere to hygiene certification programs, similar to Brazil's "Programa de Inspeção de Produtos de Origem Animal" (PISPOA).

- **Ban on High-Risk Wildlife Species in Trade**: The commercialization of armadillos (*Dasypus novemcinctus*), known reservoirs of *Mycobacterium leprae* (leprosy), will be prohibited in urban markets to mitigate zoonotic spillover risks.

- **Wildlife Trafficking Enforcement Task Force**: A specialized enforcement unit will be established within Bolivia's Environmental Police, tasked with conducting covert operations and market inspections to dismantle illegal wildlife trade networks.

Failure to comply with wildlife trade regulations will result in market closures, product confiscations, and legal penalties, ensuring that Bolivia meets its CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) commitments.

5.5. Establishing sustainable funding mechanisms

A major obstacle to maintaining long-term active surveillance for zoonotic diseases in Bolivia is securing consistent financial resources to support laboratory diagnostics, field monitoring, and epidemiological research. Given Bolivia's high-risk zoonotic disease landscape, which includes threats such as Hantavirus, Leptospirosis, and Rabies, ensuring sustainable funding is critical for early detection and outbreak prevention. To address this challenge, Bolivia will implement a multi-tiered funding strategy, leveraging government resources, international grants, private sector investments, and contingency funds.

5.6. Dedicated Government Budget Allocations

To ensure long-term financial sustainability, the Bolivian government will allocate a designated percentage of the national health and agriculture ministries' budgets toward zoonotic disease surveillance and prevention. The Ministry of Health and the National Institute of Health Laboratories (INLASA) will receive specific budget lines for:

- **Field Epidemiology and Diagnostic Capacity**: Supporting mobile diagnostic units deployed in Santa Cruz, Beni, and Pando, where bushmeat trade and high human-wildlife interactions increase the risk of zoonotic spillover. This will ensure continuous sample collection and laboratory testing for pathogens such as *Leptospira spp., Arenaviruses*, and *Brucella spp*.

- **Wildlife Disease Surveillance:** Funding will be allocated to the Ministry of Environment and Water (MMAyA) and National Protected Areas Service (SERNAP) to conduct routine screening of primates, jaguars, and armadillos in protected areas such as Madidi National Park and Kaa-Iya del Gran Chaco National Park.

- **Data Integration and Early Warning Systems**: Investments will be made in Bolivia's national health surveillance database, ensuring real-time integration of field-collected data into a centralized platform accessible to epidemiologists, veterinarians, and policy makers. This will strengthen syndromic surveillance for unusual disease patterns in both humans and wildlife.

The implementation of earmarked budgets for zoonotic disease control will be aligned with Bolivia's National Health Plan 2025, ensuring that active surveillance remains a public health priority.

5.7. International Grants and Partnerships

Bolivia will actively seek financial support from global health and development organizations to strengthen active surveillance initiatives, particularly in regions with high zoonotic spillover risks. Key funding sources include:

- **The World Bank's Pandemic Fund**: Bolivia will apply for funding to develop a One Health surveillance framework, integrating human, animal, and environmental health monitoring to prevent zoonotic spillovers in the Amazon Basin.

- **The Global Fund for Disease Preparedness**: Support from this fund will be directed toward training epidemiologists and veterinarians in advanced molecular diagnostics and establishing biosafety level 2+ laboratories in La Paz and Santa Cruz.

- **WHO's Contingency Fund for Emergencies (CFE):** In the event of an emerging zoonotic threat, WHO funding could be used to mobilize emergency response teams and deploy point-of-care diagnostic tools to affected regions.

A real-world example of such international funding is the $10 million FAO-funded initiative in the Gran Chaco region, which supports indigenous communities in tracking zoonotic diseases linked to wildlife consumption. The project is currently improving early warning surveillance for viral hemorrhagic fevers in Bolivia, Paraguay, and Argentina. By leveraging these international resources, Bolivia will expand its surveillance capacity beyond urban centers, ensuring that rural and indigenous populations benefit from early outbreak detection and rapid response interventions.

5.8. Public-Private Partnerships (PPPs) for Diagnostics and Disease Modeling

To enhance Bolivia's diagnostic capacity, the government will partner with the private sector, including pharmaceutical companies, research institutions, and biotechnology firms, to co-fund innovations in disease detection and risk modeling. Examples of successful PPP models include:

- **INLASA-UMSA Collaboration for Rapid PCR Testing**: The National Institute of Health Laboratories (INLASA) and the Universidad Mayor de San Andrés (UMSA) recently developed a field-deployable PCR test for Bolivian Hemorrhagic Fever (BHF). This partnership reduced testing turnaround times from 72 hours to less than 8 hours, significantly improving outbreak response.

- **Partnerships with Biotech Firms for Rapid Diagnostics**: Bolivia will collaborate with international biotech companies such as BioMérieux and Roche Diagnostics to introduce portable PCR and ELISA-based testing kits for Hantavirus, Leptospirosis, and Brucellosis, which are endemic in the Yungas region and Chapare Province.

- **Predictive Disease Modeling with Academic Institutions**:Research centers such as the Bolivian Center for Tropical Diseases (CBET) will work with private-sector to map zoonotic disease hotspots using machine learning algorithms. This will help predict spillover risks from wildlife markets and inform targeted surveillance interventions.

Expanding PPP initiatives will ensure Bolivia remains at the forefront of diagnostic innovation, reducing reliance on external laboratories for zoonotic disease confirmation.

5.9. Contingency Emergency Response Funding (CERF)

Bolivia will establish a Contingency Emergency Response Fund (CERF) to enable rapid deployment of resources in response to zoonotic disease outbreaks. The fund will be managed by the Ministry of Health and SENASAG and will be activated when early warning systems detect high-risk zoonotic events. Key functions of CERF include:

- **Immediate Procurement of Antivirals and Vaccines**: If an avian influenza (H5N1) outbreak is detected in Santa Cruz poultry farms, the CERF will fund the mass distribution of antiviral medications, vaccines for poultry workers, and disinfection measures to prevent further spread.

- **Rapid Deployment of Field Epidemiology Teams:** In the case of a suspected Hantavirus outbreak in a rural Beni community, CERF will facilitate the immediate dispatch of epidemiologists, PPE supplies, and mobile testing units to contain the situation**.**

- **Expansion of Temporary Quarantine Facilities:** If an emerging zoonotic pathogen is detected in illegal wildlife trade routes along the Bolivia-Brazil border, CERF funding will allow for the rapid construction of wildlife quarantine stations, reducing spillover risks to humans.

Bolivia's CERF model will be structured similarly to WHO's Emergency Contingency Fund, ensuring that resources are pre-allocated for immediate deployment, rather than awaiting bureaucratic approvals during crises.

6. Engaging the private sector in Diagnostics and Vaccine Development for Zoonotic Diseases and Pandemic Preparedness in Bolivia

Bolivia recognizes the critical role of the private sector, including pharmaceutical companies, biotechnology firms, and research institutions, in strengthening zoonotic disease diagnostics and vaccine development. Given the country's high-risk epidemiological landscape, particularly in Amazonian regions (Beni, Pando, and Santa Cruz) where human-wildlife interactions are frequent, a robust public-private partnership (PPP) strategy is necessary to enhance diagnostic capabilities and accelerate vaccine research. These efforts will not only improve Bolivia's national response capacity but also reduce dependency on international laboratories and imported vaccines, ensuring faster and more cost-effective interventions. Furthermore, Bolivia's active surveillance programs will integrate the World Health Organization (WHO) Priority Pathogens List, which identifies bacteria, viruses, and parasites with pandemic potential, to strengthen early detection and vaccine preparedness. By focusing on regional adaptation of WHO-recommended strategies, Bolivia will strengthen pandemic preparedness and One Health approaches.

6.1. Strengthening Local Diagnostic Capabilities

One of the major bottlenecks in Bolivia's zoonotic disease surveillance has been the limited availability of high-quality diagnostic facilities, particularly in rural and remote areas where disease spillover events are most likely to occur. To address this, Bolivia will incentivize private laboratories to invest in zoonotic disease testing services, facilitating rapid and on-site diagnostics that can detect high-priority pathogens such as hantaviruses, Leptospira spp., and arboviruses (e.g., Zika, Dengue, and Yellow Fever). A notable example of a successful PPP initiative is the collaboration between Medlab Bolivia and the National Institute of Health Laboratories (INLASA), which has resulted in the development of portable PCR kits for field-based hantavirus testing. These kits are now being deployed in Beni and Pando, where recent hantavirus pulmonary syndrome (HPS) outbreaks have posed significant public health concerns.

Furthermore, efforts will be made to equip veterinary diagnostic centers and private laboratories with next-generation sequencing (NGS) technologies to facilitate the genomic surveillance of emerging zoonotic pathogens. For instance, an NGS facility in Santa Cruz could sequence viral genomes from bat and rodent reservoirs to track potential mutations that increase human transmissibility. To further decentralize diagnostic capacity, Bolivia will explore partnerships with international diagnostic companies such as BioMérieux (France) and Fiocruz (Brazil) to establish local manufacturing units for PCR reagents and ELISA test kits, reducing reliance on costly imports and ensuring a stable supply of diagnostic materials.

6.2. Vaccine Research for five (5) priority Zoonoses in Bolivia

The development of region-specific vaccines for zoonotic diseases remains a public health and agricultural priority in Bolivia, particularly for rabies, brucellosis, leptospirosis, salmonellosis, and toxoplasmosis. These diseases not only pose direct threats to human health but also have severe economic consequences for farmers and indigenous communities, whose livelihoods depend on livestock production. Given Bolivia's diverse ecosystems and extensive human-wildlife-livestock interactions, strategic vaccine development and deployment are essential to mitigating the risks posed by these zoonotic pathogens.

- **Rabies Vaccine Development for Vampire Bat-Transmitted Rabies**

Rabies remains a significant concern in Bolivia's Amazon and Chaco regions, where vampire bats (*Desmodus rotundus*) serve as the primary reservoir for the rabies virus. Frequent outbreaks have resulted in substantial livestock losses and human fatalities, particularly among rural and indigenous populations. To combat this issue, Bolivian veterinary pharmaceutical companies, in collaboration with INLASA and Universidad Mayor de San Andrés (UMSA), are developing a species-specific oral rabies vaccine that can be integrated into bait stations and distributed in bat roosting sites. This targeted vaccination strategy has been successfully tested in Brazil and Mexico, demonstrating a reduction in bat-to-human transmission by decreasing rabies prevalence in bat populations. Additionally, efforts are being made to expand the rabies vaccination program for domestic animals (dogs and cattle), focusing on high-risk rural areas, where human exposure is most prevalent. This initiative aligns with global One Health strategies that emphasize the importance of vaccinating domestic animals as a means of reducing human cases of rabies.

- **Brucellosis Vaccine for Livestock and Dairy Workers**

Brucellosis, caused by *Brucella abortus* and *Brucella melitensis*, poses a major challenge for Bolivia's cattle, sheep, and goat industries, particularly in Cochabamba, Tarija, and Chuquisaca, where dairy and meat production are central to the economy. The disease leads to reproductive failure in livestock and presents severe occupational health risks to farmers, slaughterhouse workers, and veterinarians. To address this, Bolivia is advancing the development and distribution of the RB51 brucellosis vaccine for cattle and the REV-1 vaccine for sheep and goats.

Research institutions such as UMSA and Universidad Autónoma Gabriel René Moreno (UAGRM) are collaborating with international vaccine manufacturers to improve the efficacy of these vaccines and adapt them to Bolivia's specific epidemiological conditions (MS, 2023). Additionally, mass vaccination campaigns will be integrated into Bolivia's livestock health programs, with government subsidies provided to small-scale farmers to ensure widespread vaccine accessibility. These efforts align with Bolivia's National Plan for Brucellosis Control, which aims to eradicate the disease from commercial dairy farms by 2035.

- **Leptospirosis Vaccine for High-Risk Flood-Prone Regions**

Leptospirosis is a waterborne zoonotic disease that has become increasingly prevalent in flood-prone areas such as Pando, Beni, and parts of Santa Cruz, where contaminated water sources increase human exposure to Leptospira spp. from rodents, livestock, and wildlife (e.g., armadillos and capybaras). Given the rising incidence of leptospirosis following heavy rainfall and flooding events, Bolivia will collaborate with Instituto Butantan (Brazil) and Bio-Manguinhos (Brazil) to develop a region-specific leptospirosis vaccine for humans, cattle, and dogs. The vaccine will target the most common Leptospira serovars detected in Bolivia, particularly *L. interrogans* serovar, *Ictero haemorrhagiae* and *L. borgpetersenii* serovar. Additionally, Bolivia plans to expand vaccination coverage in livestock populations, particularly in dairy farms and pig production units, where leptospirosis causes significant reproductive losses. Community-based vaccination initiatives will be launched in flood-affected rural areas, prioritizing farm workers, veterinarians, and populations living near contaminated water bodies.

- **Salmonellosis Vaccine for Poultry and Livestock Sector**

Salmonellosis, caused by Salmonella spp., is a major foodborne zoonotic disease that poses public health risks and threatens Bolivia's poultry and livestock industries. Outbreaks of non-typhoidal Salmonella (NTS), particularly Salmonella Enteritidis and Salmonella Typhimurium, have been documented in poultry farms in Santa Cruz and Cochabamba, leading to economic losses due to trade restrictions and public health concerns. In response, Bolivia is implementing a national vaccination program for commercial poultry farms, utilizing live-attenuated and inactivated Salmonella vaccines to reduce shedding and transmission within flocks. Collaboration with private vaccine manufacturers, such as CEVA Animal Health and HIPRA, will facilitate the production of region-specific Salmonella vaccines adapted to Bolivia's poultry sector. To complement these efforts, food safety regulations will be strengthened to enforce mandatory vaccination programs for large-scale poultry producers, while promoting biosecurity measures to prevent cross-contamination in livestock farms, slaughterhouses, and food processing facilities.

- **Toxoplasmosis Vaccine for Pregnant Women and Livestock Producers**

Toxoplasmosis, caused by the protozoan Toxoplasma gondii, represents a major public health concern in Bolivia, particularly among pregnant women, immunocompromised individuals, and livestock producers. Transmission occurs through ingestion of contaminated food, water, or undercooked meat, as well as direct contact with infected cat feces Given the high seroprevalence of *T. gondii* in Bolivia's rural communities, Bolivia will prioritize the development of a toxoplasmosis vaccine for small ruminants (sheep and goats) to reduce the transmission of oocysts from livestock to humans. The vaccine, developed in collaboration with international partners such as the University of Buenos Aires and INTA Argentina, will focus on reducing congenital transmission in pregnant animals, thereby minimizing zoonotic spillover risks. Additionally, Bolivia will explore the feasibility of a human toxoplasmosis vaccine, particularly for high-risk populations, including pregnant women and immunosuppressed individuals. Pilot studies will be conducted in La Paz and Cochabamba, where high prevalence rates of congenital toxoplasmosis have been reported.

CHAPTER 8

Pandemic Preparedness Strategy for WHO priority Zoonotic Pathogens.

The World Health Organization's (WHO) list of zoonotic pathogens with pandemic potential, including bacteria, viruses, and parasites, provides a strategic framework for prioritizing Bolivia's biosurveillance activities. Given Bolivia's high biodiversity, extensive wildlife-livestock interactions, and vulnerability to transboundary infections, integrating active monitoring of these pathogens will be critical in strengthening early detection and outbreak response capabilities. The following paragraphs explain active surveillance strategies for key zoonotic pathogens identifed by the W.H.O with pandemic potential.

1. Bacterial Surveillance in High-Risk Zones

Bacteria such as Vibrio cholerae, Yersinia pestis, Mycobacterium tuberculosis, Salmonella enterica, and Shigella dysenteriae have been implicated in previous outbreaks in Bolivia's urban and rural regions, often linked to poor sanitation, foodborne transmission, and environmental contamination.

- *Vibrio cholerae* and *Shigella dysenteriae* (Waterborne Pathogens): Surveillance efforts will target flood-prone areas in Beni, Pando, and Santa Cruz, where contaminated water sources following extreme weather events heighten the risk of cholera and dysentery outbreaks. Environmental sampling will focus on rivers, lakes, and irrigation systems to monitor bacterial load and antimicrobial resistance trends.

- *Yersinia pestis* (Plague) Surveillance: The Altiplano region (e.g., Potosí and Oruro) has historical records of plague associated with rodent populations. Active rodent surveillance and serological testing of rural communities and domestic animals will be conducted to assess potential resurgence risks.

- *Salmonella enterica* (Foodborne Transmission): Routine microbial screening in livestock slaughterhouses, dairy farms, and food processing units will help detect pathogenic Salmonella strains, particularly in Santa Cruz and Cochabamba, where Bolivia's poultry and cattle industries are concentrated.

- *Mycobacterium tuberculosis* (Bovine TB): Bolivia's meat and dairy sector (Cochabamba, Tarija) faces persistent challenges with bovine tuberculosis. Annual testing campaigns in cattle farms, live animal markets, and abattoirs will enhance early detection and outbreak containment strategies

2. Viral Pathogen Surveillance in Wildlife and Human Populations

Viruses such as Arenavirus, Coronavirus, Hantavirus, Orthomyxovirus (Influenza), Paramyxovirus, and Flavivirus (e.g., Dengue, Yellow Fever, Zika) are of paramount concern due to Bolivia's dynamic ecosystems, high mosquito vector densities, and wildlife reservoirs.

- Hantavirus Surveillance in Amazonian and Andean Regions: Hantavirus outbreaks have been reported in Beni and Chapare, associated with rodent populations. Active rodent trapping, serological testing, and environmental sampling in agricultural zones and rural households will be expanded to detect viral circulation.

- Coronavirus and Paramyxovirus Monitoring in Bats and Wildlife Trade Markets: Given the global emergence of novel coronaviruses (SARS-CoV-2, MERS-CoV) and henipaviruses, Bolivia will establish bat virome surveillance programs in Madidi National Park, Noel Kempff Mercado National Park, and wildlife trade markets in Santa Cruz to analyze spillover risks.

- Orthomyxovirus (Influenza) and Avian Influenza Surveillance: The poultry industry in Santa Cruz and Cochabamba will undergo routine avian influenza screening, particularly for highly pathogenic H5N1 strains. Cross-border coordination with Brazil, Peru, and Argentina will strengthen influenza pandemic preparedness.

- Flavivirus Surveillance (Dengue, Zika, and Yellow Fever): Vector surveillance programs will map mosquito populations (*Aedes spp., Culex spp*.) in urban centers, border zones, and indigenous communities, ensuring early vector control interventions.

3. Parasitic Pathogen Surveillance

Parasitic diseases such as *Plasmodium spp*. (Malaria), *Toxoplasma gondii* (Toxoplasmosis), and foodborne parasitic infections remain understudied but highly relevant to Bolivia's One Health approach.

- *Plasmodium spp*. (Malaria Surveillance): Active malaria surveillance will be reinforced in border areas with Brazil and Peru, where *Plasmodium vivax* and *Plasmodium falciparum* transmission is highest. Early case detection using rapid diagnostic tests (RDTs) in Amazonian communities will be paired with mosquito control strategies.

- *Toxoplasma gondii* Surveillance in Pregnant Women and Livestock: Routine toxoplasmosis screening will be incorporated into maternal health programs in La Paz and Cochabamba, focusing on congenital infection risks. Simultaneously, serological testing of sheep and goats will help prevent zoonotic transmission in livestock-dependent communities.

CHAPTER 9

Monitoring and Evaluation (M&E) Framework

The purpose of this M&E framework is to assess the effectiveness of Bolivia's active surveillance strategies for zoonotic diseases linked to the wildlife trade. This framework ensures that interventions align with One Health principles, incorporating human, animal, and environmental health sectors into a cohesive monitoring strategy. Additionally, it incorporates culturally sensitive approaches to engage indigenous and rural communities, ensuring their active participation in disease surveillance and response.

The primary objectives of this M&E framework are to evaluate the efficiency of early detection mechanisms, measure the effectiveness of risk assessment protocols, and ensure community engagement in zoonotic disease surveillance. It aims to monitor the enforcement of policies and the coordination between governmental and non-governmental organizations (NGOs) while identifying areas for improvement. By implementing robust evaluation criteria, the framework ensures continuous refinement of active surveillance strategies, enhancing Bolivia's preparedness and response capabilities against zoonotic disease threats.

1. Key Indicators

To measure the effectiveness of Bolivia's active surveillance system, a combination of quantitative and qualitative indicators will be utilized.

1.1. Early Detection and Response

Early detection and rapid response are critical components of an effective surveillance system. The framework will evaluate the average time taken to detect and confirm zoonotic cases, aiming for a less than 48-hour window from the initial symptom report to laboratory confirmation. The deployment of mobile diagnostic units will be assessed by monitoring the number of field operations conducted per year, with a target of covering at least ten high-risk locations annually. Additionally, the rate of successful containment of zoonotic disease outbreaks will be measured, with a goal of containing over 80% of outbreaks within two weeks of detection. This percentage is based on regional epidemiological data, response capacity, and international best practices for zoonotic disease control, ensuring a balance between feasibility and ambitious improvement.

1.2. Surveillance and Risk Assessment

Surveillance efforts must cover critical wildlife trade hubs, hunting areas, and human-wildlife contact points. The percentage of wildlife trade hubs under active pathogen surveillance is a key indicator, with a goal of achieving 90% monitoring coverage across Bolivia's major wildlife

trade and border crossings. The 90% monitoring coverage goal ensures near-complete oversight of Bolivia's wildlife trade and border crossings, minimizing undetected zoonotic risks. The framework will also track the number of serological and molecular diagnostic tests conducted per year, with an expected minimum of 5,000 tests targeting key zoonotic species and high-risk human populations. The 5,000 tests per year target is based on epidemiological modeling, resource availability, and international benchmarks for effective pathogen surveillance. Another crucial measure is the detection efficiency of illegal wildlife trade cases, which should be maintained at 70% or higher within priority surveillance regions. The 70% detection efficiency ensures a high probability of identifying illegal trade, balancing feasibility and enforcement capabilities.

1.3. Community Engagement & Cultural Sensitivity

Community involvement is fundamental to successful disease surveillance, particularly in Bolivia's indigenous and rural populations. The M&E framework will assess the percentage of indigenous communities actively participating in surveillance programs, targeting a 60% engagement rate in high-risk zones. The 60% engagement rate ensures a critical mass of indigenous communities actively participating in surveillance efforts, increasing disease reporting accuracy and fostering trust. This figure is based on feasibility assessments of outreach programs and past engagement trends in Bolivia's public health initiatives.

The number of community-led disease reporting cases will be monitored, with a goal of increasing local contributions by at least 30% annually through trained local informant networks. The 30% annual increase in community-led disease reporting is set to expand local contributions gradually, ensuring a sustainable and scalable surveillance system. Training local informants strengthens real-time disease detection in remote areas, bridging gaps in formal surveillance networks.

Furthermore, the effectiveness of culturally tailored public health campaigns will be measured through pre-and post-intervention surveys that assess knowledge retention and behavioral change regarding zoonotic disease prevention. Pre-and post-intervention surveys will be conducted through structured questionnaires and interviews in indigenous communities. Before interventions, baseline assessments will measure existing knowledge on zoonotic disease risks, transmission routes, and prevention practices. After interventions, follow-up surveys will evaluate knowledge retention, behavior adoption (e.g., improved hygiene, reduced bushmeat consumption), and community engagement in reporting cases. The surveys will be culturally adapted, using local languages, visual aids, and trusted community leaders to ensure meaningful participation and accurate responses.

1.4. Policy and Institutional Coordination

Strong institutional coordination is crucial for a seamless surveillance system. The M&E framework will measure the degree of data sharing across governmental and non-governmental entities, with a compliance target of over 85% in real-time reporting systems. The 85% compliance target for real-time reporting ensures a high level of data accuracy, consistency, and timeliness, which is critical for effective outbreak response and decision-making. This threshold is based on international public health standards and Bolivia's capacity to integrate digital reporting systems across sectors.

Additionally, the frequency of inter-agency coordination meetings will be tracked, with quarterly reviews to ensure synchronized responses. Compliance with wildlife trade regulations and biosecurity measures will also be monitored, aiming for an 80% adherence rate among traders, market operators, and high-risk communities. The 80% adherence rate for wildlife trade and biosecurity measures is set to balance regulatory enforcement feasibility with achievable compliance among traders and high-risk communities. It ensures a substantial reduction in zoonotic transmission risks while considering enforcement capabilities and socio-economic factors

2. Data Collection Methods

A combination of primary and secondary data sources will be used to ensure comprehensive surveillance and evaluation. The following proposed approach integrates diverse data sources and methodologies to develop a comprehensive risk assessment framework:

2.1. Field Surveys & Questionnaires

Field surveys and questionnaires represent a core component of active surveillance in identifying zoonotic disease risks and human behaviors associated with wildlife trade and consumption. Conducting these surveys in wildlife markets, rural health centers, and indigenous communities allows for the direct collection of data related to both the prevalence of zoonotic diseases in human populations and the behavioral risks associated with wildlife handling and consumption. In particular, by targeting wildlife markets, where wildmeat is sold, and rural health centers, where cases of zoonotic diseases such as Hantavirus or leptospirosis are reported, it is possible to obtain detailed insights into the patterns of disease transmission between humans and animals. The questionnaires will also capture information on cultural practices within indigenous communities, helping to assess the role of traditional knowledge and customs in influencing wildlife consumption. Additionally, these surveys will document risk behaviors, such as the methods used to slaughter or process wild animals, as these activities are often linked to the potential for zoonotic spillover. Comprehensive data from these surveys will serve as the foundation for understanding how zoonotic diseases emerge and spread in Bolivia's diverse ecosystems and human communities. Below are some examples of questions that could be included in the questionnaires:

2.1.1. Wildlife Market Questionnaire (for traders and consumers)

Demographic Information:

1. Age: ____
2. Gender: Male / Female / Other
3. Location (village/city/town): ____
4. Years involved in wildlife trade: ____

Wildlife Trade Practices

5. What types of wild animals do you trade? (e.g., mammals, birds, reptiles, amphibians)
   ☐ Mammals

☐ Birds
☐ Reptiles
☐ Amphibians
☐ Other (please specify): _____

6. Where do you source the wildlife you trade? (Select all that apply)
   ☐ Local hunters
   ☐ Wildlife farms
   ☐ Forests or natural habitats
   ☐ Other markets

7. How do you slaughter or prepare the wild animals for sale?
   ☐ Slaughtered by the vendor
   ☐ Slaughtered by the customer
   ☐ Processed for meat (e.g., gutted, skinned)
   ☐ Other (please specify): _____

8. What methods do you use to store or preserve the wildmeat?
   ☐ Refrigeration
   ☐ Freezing
   ☐ Drying
   ☐ Salting
   ☐ Other (please specify): _____

9. Have you ever been informed about zoonotic diseases from wild animals?
   ☐ Yes
   ☐ No
   If yes, which diseases have you heard of? _____

Health and Safety

10. Have you or anyone around you experienced symptoms such as fever, fatigue, or body aches after handling wildmeat?
    ☐ Yes
    ☐ No
    If yes, please describe: _____

11. Do you use any protective gear when handling wild animals or wildmeat?
    ☐ Yes, always
    ☐ Sometimes
    ☐ No protection used

12. Have there been any cases in the market where animals were suspected of having disease symptoms (e.g., abnormal behavior, sores, difficulty moving)?
    ☐ Yes

☐ No
If yes, please provide details: _____

2.1.2. Rural Health Center Questionnaire (for healthcare providers)

General Information:

1. How many zoonotic disease cases have you treated in the past year?
   ☐ 0
   ☐ 1–5
   ☐ 6–10
   ☐ 11 or more

2. What zoonotic diseases are most commonly reported in your community? (Select all that apply)
   ☐ Hantavirus
   ☐ Leptospirosis
   ☐ Rabies
   ☐ Tuberculosis
   ☐ Other (please specify): _____

Zoonotic Disease Symptom Tracking:

3. Have any patients reported recent contact with wild animals or wildmeat prior to illness?
   ☐ Yes
   ☐ No
   If yes, describe the type of contact: _____

4. What symptoms have you observed in patients potentially linked to zoonotic infections? (Select all that apply)
   ☐ Fever
   ☐ Cough
   ☐ Vomiting
   ☐ Abdominal pain
   ☐ Skin rashes
   ☐ Neurological symptoms (e.g., confusion, paralysis)
   ☐ Other (please specify): _____

5. How do you typically diagnose zoonotic diseases in your facility?
   ☐ Clinical symptoms
   ☐ Laboratory tests
   ☐ Both

6. Have you encountered any outbreaks of zoonotic diseases linked to wildmeat consumption in the past year?
   ☐ Yes
   ☐ No
   If yes, please describe the situation: _____

Preventive Measures

7. Are you aware of any public health campaigns or educational programs regarding zoonotic diseases in your region?
   ☐ Yes
   ☐ No

8. If yes, how effective do you think these campaigns have been in educating the community?
   ☐ Very effective
   ☐ Somewhat effective
   ☐ Not effective

2.1.3. Indigenous Community Questionnaire (for community members)

Cultural Practices:

1. Do you or your family consume wild animals as part of your diet?
   ☐ Yes
   ☐ No
   If yes, which animals do you typically consume? (e.g., deer, wild pigs, birds)

2. How do you obtain wild animals for consumption? (Select all that apply)
   ☐ Hunting
   ☐ Trapping
   ☐ Trading
   ☐ Other (please specify): _____

3. How do you typically prepare wildmeat for consumption?
   ☐ Cooking (boiling, frying, grilling)
   ☐ Smoking or drying
   ☐ Raw (e.g., in salads, dishes)
   ☐ Other (please specify): _____

4. Are there specific times of year when wild animals are hunted more frequently?
   ☐ Yes
   ☐ No
   If yes, when? _____

5. Do you use any traditional methods to check the health of animals before consumption?
   ☐ Yes
   ☐ No
   If yes, please describe: _____

6. Are you aware of any diseases that can be transmitted from wild animals to humans?
   ☐ Yes
   ☐ No
   If yes, which diseases? _____

Health and Safety

7. In the past 12 months, have you or someone in your family experienced any symptoms such as fever, body aches, or respiratory problems after consuming wildmeat or handling wild animals?
   ☐ Yes
   ☐ No
   If yes, please describe the symptoms: _____

8. Do you use any protective measures (e.g., gloves, masks) when handling wild animals or wildmeat?
   ☐ Yes, always
   ☐ Sometimes
   ☐ No protection used

9. Have there been any cases in your community where wild animals or wildmeat were suspected to be the source of an illness?
   ☐ Yes
   ☐ No
   If yes, please describe: _____

2.1.4. Follow-Up Questions Across All Groups:

1. Do you think there are any challenges in accessing healthcare if you experience symptoms after handling wild animals or wildmeat?
   ☐ Yes
   ☐ No
   If yes, please describe: _____

2. How do you think the risk of zoonotic diseases from wildlife trade and consumption can be reduced in your community?

3. Laboratory and Health Facility Reports

Laboratory and health facility reports are essential secondary data sources in monitoring zoonotic diseases circulating within wildlife, livestock, and human populations. Collaboration with institutions such as INLASA (National Institute of Laboratorial Health) and regional veterinary laboratories provides valuable insights into the prevalence of pathogens that can be transmitted from animals to humans. These reports will focus on diseases such as Brucella, Salmonella, and viral infections like rabies, which may be found in wildlife species commonly consumed by humans. By analyzing laboratory reports, it is possible to track the presence and spread of zoonotic pathogens within both wildlife and livestock populations, offering a critical perspective on the circulation of potential risks before they spill over to humans. Reports from SENASAG (National Service for Agricultural Health and Food Safety), as well as regional veterinary laboratories, will further contribute by identifying wildlife diseases and conducting diagnostic testing of wildlife, domestic animals, and humans who may exhibit symptoms of zoonotic infections. Laboratory data will be systematically analyzed to detect trends in pathogen distribution and to identify regions or wildlife species at higher risk for zoonotic transmission, thereby guiding preventive measures and risk management interventions.

4. Community-Based Monitoring

Community-based monitoring, leveraging local knowledge networks and indigenous health workers, is a vital tool for the early detection of zoonotic disease outbreaks and understanding local ecological dynamics. Indigenous communities, often living in close proximity to wildlife habitats, possess valuable observational skills regarding animal health and behavior, which can aid in identifying signs of unusual wildlife mortality or disease symptoms. Trained community health workers will be equipped with tools to report on zoonotic disease symptoms in both humans and animals, ensuring the real-time collection of data on emerging health threats. This decentralized approach allows for the rapid identification of disease outbreaks in remote areas, where traditional surveillance systems may have limited reach. The monitoring system will involve community-based reporting of wildlife health indicators, such as signs of infection, as well as any unusual mortality events in wildlife populations. This grassroots level of surveillance will also help identify human-wildlife interactions, such as hunting or consumption patterns, that may pose a heightened risk for zoonotic disease transmission.

5. GIS and Remote Sensing Data

Geospatial information systems (GIS) and remote sensing data provide powerful tools for tracking and understanding the relationship between environmental factors and zoonotic disease risk in Bolivia. GIS allows for the integration of ecological data with epidemiological information, facilitating the identification of key zoonotic risk hotspots, particularly in areas where habitat destruction or wildlife migration patterns may increase human-wildlife interactions. Satellite imagery and remote sensing technologies can be used to monitor deforestation, urban expansion, and land use changes, all of which impact wildlife habitats and influence the movement of wildlife species. These changes often lead to increased human-wildlife contact, thereby raising the potential for zoonotic spillover. GIS can be used to map out these areas of risk, overlaying them with data from wildlife migration routes and

population density, allowing for predictive modeling of zoonotic disease hotspots. Additionally, remote sensing tools can track deforestation rates, shifts in vegetation, and alterations in animal habitats, which are critical in understanding the ecological dynamics that contribute to the risk of disease transmission.

6. Stakeholder Interviews & Focus Groups

Stakeholder interviews and focus groups are crucial for gathering qualitative data from a diverse range of actors involved in wildlife trade, health surveillance, and zoonotic disease management. Engaging government officials, non-governmental organizations (NGOs), wildlife traders, and indigenous leaders through interviews and focus groups ensures a participatory approach to the evaluation and understanding of zoonotic risks. Government officials, including representatives from the Ministry of Health, SENASAG, and other relevant agencies, provide valuable insights into the current policies, regulations, and enforcement practices surrounding wildlife trade and zoonotic disease management. NGOs, particularly those focused on conservation and public health, offer an understanding of the challenges faced on the ground and potential areas for policy improvement. Traders and indigenous leaders provide a different perspective, often revealing traditional practices or hidden risk factors that may not be immediately apparent in formal health systems. Through these participatory sessions, stakeholders can voice their concerns, share knowledge, and collaborate on designing effective solutions to reduce the risks of zoonotic disease transmission. The qualitative data gathered through these interviews will complement quantitative surveillance efforts and provide a more comprehensive understanding of the sociocultural factors that influence wildlife trade and zoonotic spillover.

7. Routine Reports and Policy Reviews

Routine reports and policy reviews are integral components in assessing the effectiveness of regulatory measures, wildlife trade enforcement, and zoonotic risk management strategies. Regular monitoring of policy implementation, including inspections of wildlife markets, transport systems, and consumption practices, allows for the continuous evaluation of existing regulations and their impact on public health and wildlife conservation. Reports from agencies such as SENASAG and the Ministry of Environment can provide detailed accounts of enforcement activities, compliance levels, and areas where illegal wildlife trade persists despite regulations. These routine reports will also evaluate the effectiveness of public health responses, monitoring compliance with health safety standards in markets and food establishments, and assessing the impact of any zoonotic disease outbreaks. Periodic policy reviews will focus on the gaps in enforcement and the adequacy of existing laws to mitigate zoonotic risks, with special attention paid to the effectiveness of wildlife protection laws, trade regulations, and public health policies. Through these reviews, stakeholders can identify areas for improvement, advocate for stronger regulations, and ensure that the necessary resources are allocated to reduce the risks associated with wildlife trade and consumption.

8. Integration and Evaluation

By systematically integrating primary and secondary data sources—such as field surveys, laboratory reports, community-based monitoring, GIS data, stakeholder input, and routine

policy reviews—this approach creates a robust surveillance system. This system will not only help identify zoonotic disease threats but also contribute to the development of effective prevention and response strategies in Bolivia. Regular evaluations will assess the accuracy of the data collected, the effectiveness of interventions, and the ability of the system to adapt to emerging threats, ultimately enhancing public health security and wildlife conservation efforts across the country.

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