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Integrating Human and Animal Health in the STOP Spillover Outbreak Scenarios

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Abstract

Objectives: To generate and employ scenarios of sentinel human and animal outbreak cases in local contexts that integrate human and animal health interests and practices and facilitate outbreak risk management readiness.

Methods: We conducted a scoping review of past outbreaks and the strengths and weaknesses of response efforts in USAID STOP Spillover program countries. This information and iterative query-and-response with country teams and local stakeholders led to curated outbreak scenarios emphasizing One Health human:animal interfaces at sub-national levels.

Results: Two core scenarios were generated adapted to each of 4 countries' pathogen priorities and workflows in Africa and Asia, anchoring on sub-national outbreak response triggered by either an animal or human health event. Country teams subsequently used these scenarios in a variety of local preparedness discussions and simulations. The process of creating outbreak scenarios encourages discussion and review of current country practices and procedures. Guideline documents and lessons learned do not necessarily reflect how workflows occur in outbreak response in countries at highest risk for spillover events.

Conclusions: Discussion-based engagement across One Health stakeholders can improve sub-national coordination, clarify guidelines and responsibilities, and provide a space for interagency cooperation through use of scenarios in tabletop and other exercises.

At least 3 quarters of emerging infectious diseases (EID) have a zoonotic origin.[1] Rates of EID have significantly risen over time even after accounting for reporting bias.[1] As the human experience evolves, outbreaks increase.[2] Changes in land use leading to deforestation and habitat fragmentation is a leading cause of zoonotic disease emergence and spread around the world. Urbanization of wildlife habitats, agricultural intensification, and human encroachment into ecosystems with high wildlife diversity become pathways that provide opportunities for pathogen spillover between animals and humans. Human interactions with wildlife such as hunting and selling animals in live and wet markets (LWMs) and consumption of wild meat, also can provide opportunities for spillover. These influences come together in ways that sometimes are difficult to predict.[3]

To address the growing concern of health emergencies resulting from spillover, the United States Agency for International Development (USAID) funded Strategies to Prevent (STOP) Spillover, a global consortium comprising professionals with expertise in human, animal, and environmental health.[4,5] The STOP Spillover consortium has worked with existing stakeholders from 7 countries in Africa and Asia to help strengthen their capacity to identify, assess, and monitor risks associated with emerging zoonotic viruses, as well as to develop and evaluate community-level risk reduction interventions.

One goal of STOP Spillover is to mitigate the amplification and spread of priority zoonotic viral diseases should a spillover event occur. To increase preparedness and response for spillover events, we conducted reviews of prior outbreak response efforts to inform the development of scenarios for use in outbreak simulation exercises and other engagements, in which stakeholders could explore responsibilities, authorities, and accountabilities in plausible outbreak settings, encouraging discussion of operational procedures and identification of gaps. These index-case driven scenarios were informed by the needs of each specific country. Here, we present our methodology for scenario development to meet the diverse needs of Cambodia, Liberia, Sierra Leone, and Uganda, anchored on each country's self-identified priority pathogen upon which the

broader STOP Spillover program preparedness activities were focused. We also describe subsequent uses by select countries.

Materials and Methods

The scenario development process prioritized multi-stakeholder interactions at sub-national levels in the earliest phases of outbreak identification, risk assessment, and response—early action towards early control (Appendix Figure 1).

Scoping Review

The first step of scenario development was to conduct a scoping review of the indexed and gray literature. The review focused on outbreaks from the previous 10 years in STOP Spillover and near neighbor countries from the consortia's priority pathogens (e.g., filoviruses, coronaviruses, avian influenza, Nipah virus, yellow fever virus, and dengue virus) to better understand the nature of infectious disease outbreaks and outbreak response practiced in each country. Search terms used include name of country being evaluated, "outbreak," "infectious disease," "outbreak response," "outbreak management," and other outbreak related MeSH terms. Searches were conducted in PubMed, Google, and Google Scholar, as well as agency webpages for governmental and non-governmental white papers, International Health Regulations (IHR) emergency committee reviews, and World Health Organization (WHO) Disease Outbreak News reports. The review focused on lessons learned from the initial phase of each emergency. Thematic capture of event identification highlighted preparedness and response at the human:animal interface, rather than later stages of emergencies where human-to-human transmission aspects of outbreaks is the focus.

Scenario Data Form Construction and Completion

The scoping review informed construction of a scenario data form (Table 1; Appendix) structured into 4 themes: the facts of the outbreak (e.g., location; details of exposure and the index case); risk assessment tools (e.g., biological specimen collection, testing, and transport; case finding); outbreak response (e.g., reporting and declaration authorities; contact tracing); and scenario development. Scenario data forms were pre-populated with findings from the scoping review. Virtual meetings by email, file exchange, and teleconference were conducted iteratively. Scenarios were designed using information gathered through the scoping review, and incorporated aspects of initial and subsequent actions in both human and animal health responses. Narrative action descriptions were followed by open-ended questions to prompt engagement discussions.

Results

Two types of scenarios were generated, one focused on the occurrence of a human sentinel case, and the other on an animal sentinel case. This resulted in 6 scenarios across Cambodia, Liberia, Sierra Leone, and Uganda (Table 2; Appendix) focused on a country-selected priority pathogen: novel coronavirus (Cambodia human and animal triggered events), Lassa virus (Liberia and Sierra Leone human triggered events), Marburg virus (Liberia animal triggered event), and Ebola virus (Uganda human triggered event).

Table 1. Inputs received from the Scenario Data Form from each country

Category	Input	Description
Scenario Specifics	What is the interface location?	City or county hotspot for potential spillover events as determined by STOP Spillover activities.
	What is the pathogen of interest?	Pathogen identified as being high risk for spillover events in that country as determined by STOP Spillover activities.
Samples	Who tests samples?	Lab responsible for testing specimens with suspected high-risk pathogens at the interface location. Is there a separate lab for human vs. animal related specimens?
	How are samples transported?	Is there a contracted courier for samples thought to contain high risk pathogens? If not, who would be contacted to effect transport? How are the samples transported? Does this differ between human and animal related specimen?
	Who receives lab results?	Who do the labs communicate results to and by what means?
Outbreak response	Who declares an infectious disease outbreak?	What office or person has the authority to declare an outbreak among humans? Among animals?
	Who manages interdepartmental coordination?	Is there an emergency system in place for managing outbreaks? Who leads and manages this?
	What departments are responsible for additional resources?	What departments authorize, coordinate and disperse additional resources including personnel, medical equipment, funds, etc.?
	Who manages public communication?	Through what department does public health communication flow and how does the public receive emergency or general communications?
	What barriers exist at the interface location?	Information may include logistical challenges of the geographic location, lack of medical personnel, etc.
Scenario development	Where are community members most likely to first seek health care?	What type of facility and health provider are community member likely to seek when ill? In other words, where and by whom are outbreaks most likely to be identified?
	What else would be useful to know to design a useful outbreak scenario?	Information may include how and by whom the scenario will be utilized, or whether they wish to target specific scenarios or situations that have been problematic in the past.

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Table 2. Overview of scenarios by country

Country	Pathogen	Human/animal triggered	Outbreak trigger event
Kingdom of Cambodia	Novel Coronavirus	Human	A family present severely ill at a local clinic with signs of fever, shortness of breath, and vomiting.
		Animal	Routine bat surveillance at a guano farm yields positivity for novel coronavirus with high risk for human spillover.
Liberia	Lassa virus	Human	A family presents to a local clinic severely dehydrated with signs of fever, vomiting, and diarrhea; blood samples are sent for testing, but results are not expected imminently.
	Marburg virus	Animal	Wild, raw meat is found being illegally sold at a local market; upon questioning of the seller, it is discovered that the animals were hunted in a neighboring country and transported over the border for sale; samples of the meat are sent for testing.
Sierra Leone	Lassa virus	Human	A family presents to a local clinic severely dehydrated with signs of fever, vomiting, and diarrhea; blood samples are sent for testing, but results are not expected imminently.
Uganda	Ebola virus	Human	A family presents to a local clinic severely dehydrated with signs of fever, vomiting, and diarrhea; blood samples are sent for testing, but results are not expected imminently.

Scenarios were used by countries in a variety of ways. While 6 scenarios were developed across 4 countries, this report focuses on outputs from the most impactful. The STOP Spillover team in Sierra Leone conducted an outbreak risk management workshop in 2023, which featured a tabletop scenario exercise with One Health stakeholders in Kenema District, known for experiencing spillover events.[6,7] This involved step-wise presentation of the scenario in a small group format, prompting discussion on current practice, gap identification, and potential next steps among diverse actors in outbreak risk management in the country. According to stakeholders, the scenario exercise provided valuable insights and opportunities for enhancing coordination among district and community response structures, ensuring timely and effective responses to emergencies. Three systemic outbreak response gaps were identified during the scenario exercise with recommendations for remediation including i) prepositioning rapid diagnostic tests for Lassa fever in health centers of high-risk zones to address delays in sample testing; ii) implementation of incident management training to ensure that district teams have proficiency working within the Incident Management System; and, iii) education and engagement with community stakeholders to address pathogen exposure risks and rodent control measures during crop harvesting. Later, in March 2024, another scenario exercise was conducted in Dodo Chiefdom in Kenema District of Sierra Leone which engaged town chiefs, community health workers, women's leaders, youth, community health aids, bike riders, and others.[8] Multiple gaps in outbreak response were identified as a result of the tabletop scenario including i) lack of isolation facilities, ii) inadequate strategies to address misinformation in the face of outbreak response, and iii) inconsistent routine health care services during outbreak response. The Operations Lead of Public Health Emergency Response Department at the Health Ministry commented, "we came to improve the knowledge of the communities on how outbreaks begin and how it spreads faster and the means to stop it spread further." In Sierra Leone, 3 other community level simulation exercises were conducted in Tunkya, Nomo and Koya chiefdoms.

In September of 2023, The Kingdom of Cambodia conducted a workshop attended by forty participants including local stakeholders and representatives from country ministries and international non-governmental organizations (NGOs) related to One Health.[9] One objective of the multi-day workshop was to test outbreak risk management coordination and conduct a tabletop exercise employing the scenario. Stakeholders attending the workshop acknowledged gaps in risk management such as a need for creation and education surrounding standard operating procedures for bat guano handling, and training on infectious diseases originating in bats.

Discussion

Scenario-based simulation is an important part of emergency preparedness and has been shown to enhance response in an emergency when practiced regularly.[10] Simulation exercises can range from full-scale active simulations where participants roleplay events in a simulated environment to elicit natural reactions to injects that prompt behaviors and decision making, to guided tabletop scenario exercises such as described in this paper. While full-scale simulations are most beneficial in identifying readiness and response gaps, the cost and time allotted to planning and conducting these creates barriers for resource strapped, underfunded countries to utilize them. In communities with limited outbreak response systems and resources to conduct large-scale simulations, discussion-based scenario exercises can improve coordination, clarify guidelines and responsibilities, and provide a space for interagency cooperation. This was demonstrated in the workshops led by STOP Spillover Sierra Leone and Cambodia.

Aside from the practical use of scenarios in country, there are other outcomes associated with the process of their creation. The scoping review and scenario data form completion led to a better understanding of strengths and weaknesses in current outbreak risk management systems. While country teams often agreed with prepopulated answers to the scenario data form, discrepancies prompted discussion between stakeholders, from the community to governmental levels.

Due to concern for the increasing rates of zoonotic disease spillover events, there has been increased focus on prevention, detection, and early response for high-impact diseases originating at the animal:human interface. It is our hope that the methodology shared here along with examples of both human and animal triggered outbreak scenarios will aid those working in emerging infectious disease hotspots to create discussion-based scenarios that

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can be tailored to other settings and provide the context to employ them. Tailored scenario exercises can be used to facilitate discussion among small groups of key One Health stakeholders, or as part of a larger multi-day workshop engaging a broader audience that includes community members who may be most at risk of exposure or those serving in roles at increased risk of exposure.

Conclusions

The STOP Spillover consortium and their local partners continue to demonstrate that being present and engaged in risk management activities affords opportunities to increase readiness for emergent infectious disease events. Scenario development that incorporates both written guidance and local understanding of how spillover outbreak risk management is conducted aids discourse necessary to find gaps and identify next steps for improvement. This is best accomplished when addressing both human and animal health sentinel case events in concert with One Health coordination processes.

Supplementary material. The supplementary material for this article can be found at http://doi.org/10.1017/dmp.2025.101.

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