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Framework for institutional pandemic preparedness: insights from an interdisciplinary simulation exercise

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Abstract

Collaboration is essential within multidisciplinary institutions for effective pandemic preparedness. This report describes a joint pandemic simulation exercise conducted by an interdisciplinary institution with internal and external partners, aiming to test information sharing, decision-making, coordination mechanisms, as well as to identify lessons learned and future perspectives. The exercise demonstrated strengths, including the responsiveness of research operations, functional coordination across institutions, connectivity with hospitals and local governments, and rapid transition to emergency mode. It also revealed gaps, such as insufficient emergency research frameworks, unclear command-and-control structures, fragmented information-sharing and communication flows, and challenges in centralizing public information dissemination. Proposed perspectives to address these gaps include governance enhancements, operational readiness improvements within and across institutions, and capacity-level responses encompassing research and public policy. The exercise confirmed the value of pandemic exercises for reinforcing collaborative relationships, structurally linking research, public health, and policy, and designing systems grounded in interdisciplinary integration.

Keywords

COVID-19; institutional response; interdisciplinary collaboration; pandemic preparedness; simulation exercise

Main text

When a pandemic emerges, institutional responses are required across various domains, including healthcare systems, vaccine development, public policy measures, and risk communication. The World Health Organization has emphasized that pandemic responses must be agile and adaptive across sectors and that preparedness is essential for effectiveness, based on lessons from COVID-19.[1] The Centers for Disease Control and Prevention has also highlighted the importance of establishing early warning and response surveillance systems, fostering inter-institutional collaboration, and systematizing personnel development and training for emergencies.[2,3] However, COVID-19 revealed structural fragmentation between research, public health, and policy, indicating that interdisciplinary institutionalization during peacetime remains insufficient.[4]

The Center for Infectious Disease Research and Education (CiDER) at the University of Osaka is an interdisciplinary institution bringing together experts from multiple fields. Its activities include basic research and development, training of healthcare professionals, public policy engagement, and risk communication for citizens and healthcare providers. It collaborates with Center for Advanced Modalities and Drug Delivery System (CAMaD), which promotes vaccine development research under the same umbrella. It also collaborates on regional infectious disease countermeasures with university units and external public–private–academic partners, including research institutes, hospitals, public health centers, and local governments (Table 1). The aim of the exercise was to examine how information sharing, decision-making processes, initiation of research activities, healthcare system coordination, and policy responses would function under a simulated infectious disease emergency jointly implemented by CiDER with CAMaD, and other internal and external partners. This paper reports on the lessons and future perspectives identified through this interdisciplinary and interagency collaboration.

The exercise scenario involved an outbreak of highly pathogenic H5N1 avian influenza originating in a Southeast Asian country in December 2025 (Figure 1), followed by spread to neighboring countries. On January 7, 2026, hypothetical positive cases were reported at an international airport in Osaka Prefecture, Japan. Emergency meetings were immediately convened within CiDER and CAMaD to initiate a coordinated cross-sectoral response involving research, public health, healthcare, and policy experts. After mathematical modelling predictions of the spread of infection in Japan were shared, division representatives reviewed and confirmed their response procedures. The basic research division conducted training on sharing viral sequence information, collecting clinical specimens, and procuring research materials from external suppliers. Meanwhile, the healthcare personnel training division coordinated healthcare operational preparedness, including drafting guidance for healthcare workers, liaising with designated infectious disease hospitals and the local public health center, supporting hospital infection-control responses, reviewing patient-flow separation and bed availability, and planning clinical specimen collection. At the policy and communication level, the public policy and information dissemination division simulated requests for pandemic preparedness to relevant domestic and international academic societies including those in health, economics, psychology, and risk science. The division also simulated enhanced wastewater surveillance at airports and wastewater treatment plants through collaboration with the regional health research institute, local governments, and another university. Furthermore, risk communication messages for the public and healthcare workers were jointly reviewed and developed across divisions. In parallel, CAMaD transitioned to an emergency response structure and initiated missions including vaccine development. In collaboration with the university's safety management and administrative units, a president-chaired pandemic task force was established as part of the exercise.

This exercise confirmed strengths including the responsiveness of research operations, functional coordination between institutions, connectivity with hospitals and local governments, and the speed of transition decisions during a pandemic. The exercise demonstrated that research institutes, healthcare institutions, public health authorities, and policy stakeholders could initiate coordinated responses simultaneously. In particular, from the healthcare operations perspective, the exercise demonstrated rapid drafting of clinician-facing guidance, early information exchange with designated infectious disease hospitals and the local public health center, and immediate review of hospital infection-control operations and bed availability. However, the simulation exercise identified multiple governance, operational, and science–policy interface gaps. These findings and corresponding system

redesign priorities are summarized in Table 2. Command-and-control hierarchies remained insufficiently defined. Communication flows were fragmented, and decision-making processes lacked clearly structured progress-tracking mechanisms. Time constraints limited the ability to identify actionable evidence, and information sharing across internal and external institutions remained insufficiently developed. Operational workflows for specimen and sample transport between institutions were insufficiently standardized. In parallel, pathogen-specific contingency manuals and predefined supplier frameworks had not been established. Emergency information dissemination proved difficult to centralize, particularly when multidisciplinary perspectives generated divergent interpretations and when no rapid message clearance mechanism existed. Mechanisms to support emergent research—especially rapid funding allocation and expedited ethics review—were also underdeveloped.

These findings underscore the need for institutional redesign for pandemic preparedness during peacetime. At the governance capacity level, clear delegation hierarchies and centralized emergency communication mechanisms must be established, supported by dedicated communication platforms and structured reporting workflows. At the operational readiness level, frameworks should be established to enable effective sharing of evidence-based information for emergency decision-making among stakeholders, along with the identification of relevant recipient institutions and the standardization of emergency contact procedures. Furthermore, inter-institutional transport routes and pathogen-specific response manuals—including predefined supplier networks—require formal institutionalization. At the science–policy response-capacity level, emergency communications should be centralized through a rapid multidisciplinary message clearance system, while continuously available funding streams and accelerated ethics review pathways must be secured to enable timely emergent research. This institutional foundation is essential for enabling research activities and policy responses to proceed in parallel during the early stages of a pandemic.

This exercise demonstrated the structural feasibility of integrating research, public health, and policy within a single institutional framework. However, it also highlighted ambiguities in detailed operational workflows and responsibilities, leading to the identification of countermeasures. These findings suggest that pandemic preparedness should not rely solely on the accumulation of individual countermeasures but should be developed as an institutional design that integrates research, public health, healthcare, and policy responses. The exercise underscored the value of pandemic simulations in informing institutional design grounded on interdisciplinary integration. Such simulations can help identify institutional vulnerabilities before real crises occur and provide a practical mechanism for continuously evaluating and improving preparedness for future pandemics.

Table 1. Participating organizations and assigned functions in the pandemic simulation exercise.

Institution	Department	Division / Unit	Assigned function in the simulation exercise
The University of Osaka	Center for Infectious Disease Education and Research (CiDER)	CiDER administrative and planning office	Coordinated the overall simulation exercise and interdisciplinary outbreak response planning
		Division of Microbiology and Immunology	Provided expertise on pathogen biology and laboratory research coordination
		Division of Fostering Required Medical Human Resources	Led healthcare operational preparedness, including development of guidance for healthcare workers, coordination with designated infectious disease hospitals and the local public health center, hospital infection-control and patient-flow planning, bed-capacity review, and planning for clinical specimen collection
		Division of Scientific Information and Public Policy	Facilitated science–policy communication and evidence translation for decision-making
	Center for Advanced Modalities and Drug Delivery System (CAMaD)		Coordinated a top-down institutional restructuring to respond to emergencies for vaccine research and development
	Department of Safety and Hygiene		Coordinated institutional biosafety management and emergency response procedures
	The University of Osaka Hospital		Managed simulated clinical case response and hospital preparedness
	Research Institute for Microbial Diseases		Coordinated virological research activities and genomic data sharing
Osaka Institute of Public Health			Conducted public health surveillance and laboratory diagnostic coordination
Rinku General Medical Center			Participated in expert information exchange on clinical management, referral coordination, and potential collaborative use of clinical specimens
Osaka City General Hospital			Participated in expert information exchange on clinical management, referral coordination, and potential collaborative use of clinical specimens
Suita City Public Health Center			Coordinated local public health response pathways and dissemination of alerts/information to community medical institutions in the jurisdiction
The Research Foundation for Microbial Diseases of Osaka University			Participated as an observer and provided institutional coordination support

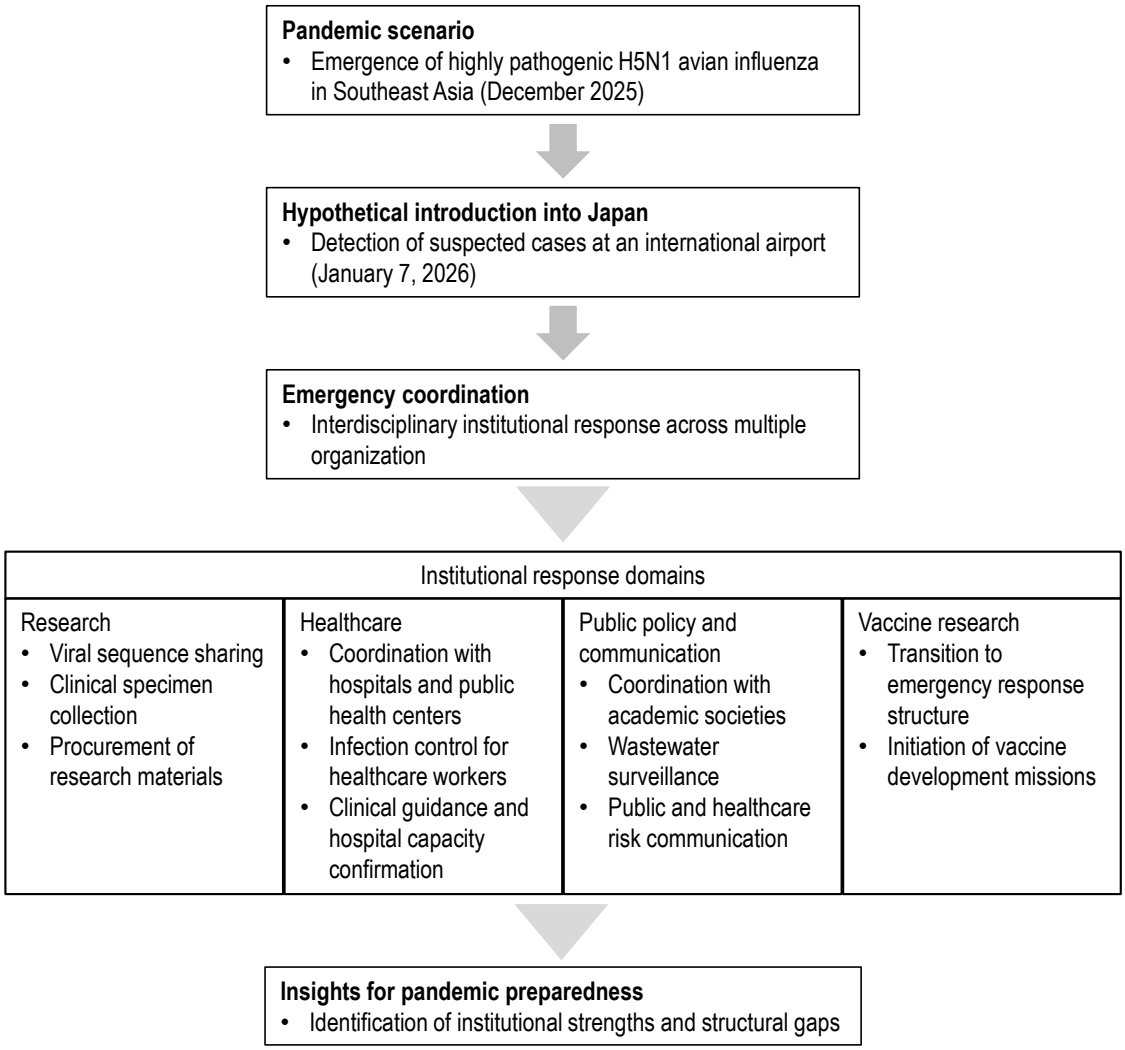

Figure 1. Overview of the pandemic simulation exercise conducted by CiDER at the University of Osaka. The simulation modeled the emergence of highly pathogenic H5N1 avian influenza in Southeast Asia and its hypothetical introduction into Japan. Following the detection of simulated cases at an international airport, emergency meetings were convened and response activities were initiated across multiple domains, including basic research, healthcare coordination, public policy and communication, and vaccine development. The exercise examined how information sharing, decision-making, and operational coordination functioned across these domains, and generated insights into institutional strengths and structural gaps relevant to pandemic preparedness.

Table 2. Governance, operational, and science–policy capacity gaps identified during the pandemic simulation exercise and corresponding redesign priorities.

Domain	Identified gap	Implications	Redesign priority
Governance capacity	Ambiguity in the emergency command chain and succession of decision-making authority	Resulting in delayed decision-making and uncertainty in leadership during crisis response	Establish clearly defined command-and-control structures and succession planning
	Inadequate information-sharing and communication flow across participating units	Causing prolonged meetings and delays in operational decision-making	Introduce dedicated emergency communication systems and streamlined reporting workflows
	Lack of structured progress-tracking and task allocation mechanisms	Making it difficult to monitor response activities and coordinate responsibilities	Implement clear task-tracking systems defining responsibilities, timelines, and deliverables
Operational readiness	Need to establish a platform for sharing actionable evidence	Limiting the ability to gather evidence-based information due to time constraints	Establish a platform for effective sharing of evidence relevant to emergency decision-making among institution members
	Need to establish a network of relevant institutions for alert dissemination	Necessitating expansion of the scope of internal and external institutions receiving information	Compile a list of relevant institutions and standardize emergency contact procedures
	Absence of clearly defined specimen transport systems between institutions	Potentially causing delays or confusion in laboratory diagnostics and pathogen analysis	Formalize specimen transport routes, operational procedures, and inter-institutional responsibilities
	Lack of pathogen-specific response procedures and contingency planning	Reducing operational readiness for emerging pathogen events	Develop comprehensive pathogen-specific emergency response manuals
	Absence of predefined suppliers and procurement procedures for critical research materials (e.g., synthetic DNA)	Delaying initiation of research activities during outbreaks	Establish pre-approved procurement frameworks and designated suppliers
Science–policy response capacity	Fragmented information dissemination channels across departments	Increasing risk of inconsistent public communication and reduced institutional credibility	Centralize official communication channels and establish coordinated message clearance processes
	Unclear governance for emergency communications, including boundaries between individual and institutional messaging	Potentially causing confusion in public messaging during crises	Define governance structures and authorization processes for institutional communication
	Lack of dedicated funding mechanisms for emergent research during outbreaks	Delaying initiation of urgent research activities	Establish continuously available emergency research funding mechanisms
	Absence of rapid ethics review mechanisms for urgent outbreak-related research	Delaying initiation of critical research studies	Implement expedited ethics review systems for emergency research

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Ethics
Ethical approval was not required, as this manuscript constitutes an activity report.

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Declaration of interests
This study was supported by *The Nippon Foundation–The University of Osaka Project for Infectious Disease Prevention*. Otherwise, the authors declare no competing interests.

AI Statement
The authors used DeepL and ChatGPT to improve the English language of the manuscript. The manuscript was originally drafted by the authors, who critically reviewed and edited all AI-assisted revisions. The authors take full responsibility for the content of this publication.

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