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Dynamics of Interorganizational Public Health Emergency Management Networks: Following the 2015 MERS Response in South Korea

Kyungwoo Kim, PhD[1] and Kyujin Jung, PhD[2]

Abstract

We investigated public health emergency management networks during the recent outbreak of Middle East respiratory syndrome coronavirus that affected more than 17000 people in South Korea. We administered a survey to 169 organizations in order to map the pattern of communication and response networks during the Middle East respiratory syndrome outbreak. We also conducted 11 semistructured interviews with national, regional, and local government officials to comprehend inhibiting and facilitating factors in risk communication and response to the system. National ministries or agencies play central roles in coordinating and supporting the overall response, and local and regional governments or agencies interact with other governments and agencies. Governmental agencies coordinating and/or supporting the outbreak response had difficulties in communicating with other agencies because of the ambiguity of the nature of the infectious disease, slow information disclosure, differences in the organizational priorities, different information standards, and the limitations of the information system. To better respond to a virus outbreak, government agencies need to improve hierarchical communication among different levels of governments, horizontal communication and cooperation between same types or different types of agencies, and information systems.

Keywords

public health emergency management networks, Middle East respiratory syndrome, interorganizational dynamics, risk communication, South Korea

Introduction

Responding to a novel infectious disease involves the importance of interorganizational communication. Such a disease presents with high ambiguity and great uncertainty regarding its viral nature and the appropriate response to it.[1] During such an outbreak, responders may have

[1]University of North Texas, Denton, TX, USA
[2]Sungkyunkwan University, Seoul, Republic of Korea

Corresponding Author:
Kyujin Jung, Department of Public Administration, Sungkyunkwan University, 40510 Faculty Hall, 25-2 Sungkyunkwan-ro, Jongno-gu, Seoul 03063, Republic of Korea.
Email: kjung1@skku.edu

no clear understanding of the number of cases and the contagion path. Even though public officials understand the disease's nature, they might not be adequately familiar with the disease transmission path, but need to rely on information from other public organizations in other jurisdictions.

In the summer of 2015, South Korean society suffered an outbreak of Middle East respiratory syndrome (MERS), caused by a coronavirus (CoV or MERSCoV) that severely affects the lungs and breathing tubes.[2] Common MERS symptoms include severe shortness of breath, fever, and cough. The virus is transmitted through people's close contact, and 30% or 40% of patients die. After MERS was first reported in Saudi Arabia in 2012, other cases were identified in nearby countries.

Because communication is crucial during such an outbreak, this article examines the dynamics of public health emergency management networks among governmental agencies during the MERS response in South Korea. To map and analyze communication network patterns during the outbreak response, we administered a survey to 169 organizations. To comprehend more deeply inhibiting and facilitating factors in risk communication and response systems, we also conducted 11 semistructured interviews with national ministry officials and regional and local government officials and health department staff. This article aims to enhance the understandings of the networked response among South Korea governmental agencies to mitigate the risk of MERS outbreak.

Outbreak of MERS in South Korea

On May 20, 2015, the first MERS case in South Korea was reported when a 76-year-old man visited 4 hospitals after a business trip to Middle East Asian countries.[3] The fourth hospital reported his symptoms to the South Korea Centers for Disease Control and Prevention (CDC), the national disease control agency. After an investigation, the South Korean government isolated the patient's family members and 64 clinicians. The quarantine range did not comprehensively cover all who could have been infected by the first patient, and it also excluded infected people.[4] The government's initial response did not effectively control the disease's transmission among patients because the virus was transmitted from untargeted people to hospital patients or visitors.

As shown in Figure 1, continued transmission led to increased numbers of MERS patients over time. As of July 5, 2015, the outbreak involved quarantining approximately 17 000 people, and 186 cases were confirmed as MERS infection. The outbreak affected 3 metropolitan regions and 5 provinces. On July 27, 2015, the national government decided to implement follow-up measures based on experts' consensus that South Korea would have no more MERS infection.[5] In addition to the quarantine of over 1700 people (usually 14 days at home), consequentially 36 patients died. It was the second highest mortality in the world.[6]

Response to the virus involved national agencies, regional and local governments, and police and fire agencies, all of which suffered problems in risk communication. The principal national agency reluctantly disclosed which hospitals the first MERS patient visited, but not until 18 days after he was identified.[7] After more people tested positive for MERS, the Ministry of Health and Welfare disclosed those hospitals with MERS patients. Then, the government designated MERS-free hospitals nationally to respond to the general public's safety concerns. Eventually, the Seoul Metropolitan City Government expressed dissatisfaction with the national agencies' response actions.[8] Growing concern about infectious disease transmission highlighted formal and informal risk communication among national and subnational governments and governmental agencies that coordinate or support outbreak response efforts. As shown in Figure 2, preliminary analysis shows that the network among hospitals and patients expanded over time.

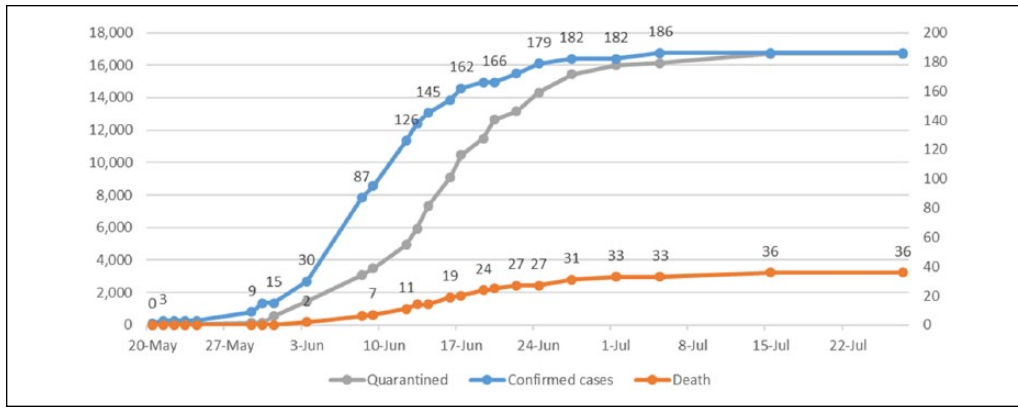

Figure 1. Trends of Middle East respiratory syndrome (MERS) infection, South Korea, 2015.
Data source: South Korea Ministry of Health and Welfare (2015): www.MERS.go.kr. Graphs are based on the regular official report of the Korea Centers for Disease Control and Prevention.
Note: color version of the figure is available online

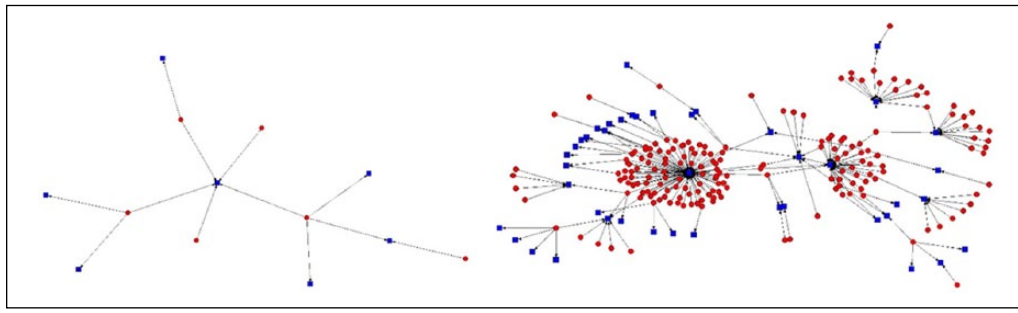

Figure 2. Middle East respiratory syndrome (MERS) outbreak communication networks among hospitals and patients in South Korea.
Data source: Ministry of Health and Welfare of South Korea (2015). May 29, 2015 (left), and July 27, 2015 (right); blue nodes: patients; red nodes: hospitals.
Note: color version of the figure is available online.

Methods

This study adopted a mixed-methods approach with a network survey and semistructured interviews to investigate the dynamics of interagency communication and collaboration during the MERS outbreak response. The study used survey data collected from South Korean national and subnational governments in January and February 2016. A list of 169 governmental organizations was constructed: 3 ministries or national agencies, 10 regional governments or agencies, 50 district or county governments, 58 local police agencies, and 48 local fire agencies. Ministries or national agencies were responsible for coordinating or supporting MERS outbreak response efforts at the national level. Selected subnational governments and local agencies were responsible for jurisdictions where MERS patients were identified or stayed. Subnational governments also coordinated the outbreak response by cooperating with regional or local agencies, including local police and fire agencies. The survey was administered to selected governmental organizations via email. To improve the response rate, reminder calls were made 9 or 10 times. Responding organizations included 3 national ministries or agencies, 7 regional governments or agencies, 38 district or county governments, 47 police agencies, and 32 fire agencies.

Table 1. Summary of Communication Network Statistics for Middle East Respiratory Syndrome Outbreak Response, South Korea, 2015.

Attributes	Receiving Value	Sending Value
Number of organizations in networks	169	169
Number of ties	321	255
Collaborators per organization (average degree)	1.902	1.507
Average distance (among reachable pairs)	2.602	2.280
Distance-based cohesion	0.499	0.419
Density	0.010	0.009

To capture patterns of communication among surveyed organizations, the survey asked the following questions: (1) From which organization did your organization directly receive information regarding MERS (eg, patient, people under quarantine, hospital, and response entity) during the outbreak? (2) To which organization did your organization directly send information regarding MERS (eg, patient, people under quarantine, hospital, and response entity) during the outbreak? When a respondent named an organization, it was coded as "1" or otherwise, "0." Based on survey responses, 2 square matrixes were constructed, that is, 169 × 169 directed matrixes that represent observed network data (ie, 127 survey responses) and unobserved network data (ie, 42 survey nonresponses).

In addition, one of the authors visited South Korea in January 2016 to conduct face-to-face semistructured interviews with public officials involved in the outbreak response. The purpose was to comprehend inhibiting and facilitating factors in risk communication and response systems to the MERS outbreak. The interviewer asked following questions: (1) Which 5 organizations were the most important information providers? (2) How did the interviewee's organization seek and disseminate information? (3) Please rate how much the interviewee's organization trusted the sources you mentioned. (4) If there was a difference in the interviewee's organization's perception of trust regarding sources, why was that? (5) How did the organization disseminate this information to other organizations? (6) How did the organization disseminate this information to jurisdictional residents?

Results

This research establishes 2 network diagrams for sending and receiving, respectively, communication network data. Table 1 presents summary statistics for 127 South Korean governmental organizations, among which are 321 (receiving) and 255 (sending) intergovernmental ties. On average, a governmental organization communicates with 1.9 and 1.5 other governmental organizations.

Figure 3 presents the interagency communication network structure for South Korea's MERS outbreak response. Larger nodes indicate that the actor has a greater number of ties that send information to or receive information from other actors. Network diagrams show that national ministries or agencies play central roles in coordinating and supporting the overall response, and local and regional governments or agencies interact with other governments and agencies.

Sociograms suggest that local agencies greatly rely on regional or national agencies to obtain core information during a national-scale emergency. The virus outbreak was not limited to 1 or 2 regions, but covered a broader area because of the infectious disease transmission's transboundary nature. Interviews with public health officials at regional and local governments stressed the importance of transparent information sharing by the South Korean CDC and the national health ministry. Interviewed officials reported that more timely information sharing by the national government could have reduced the number of MERS victims.

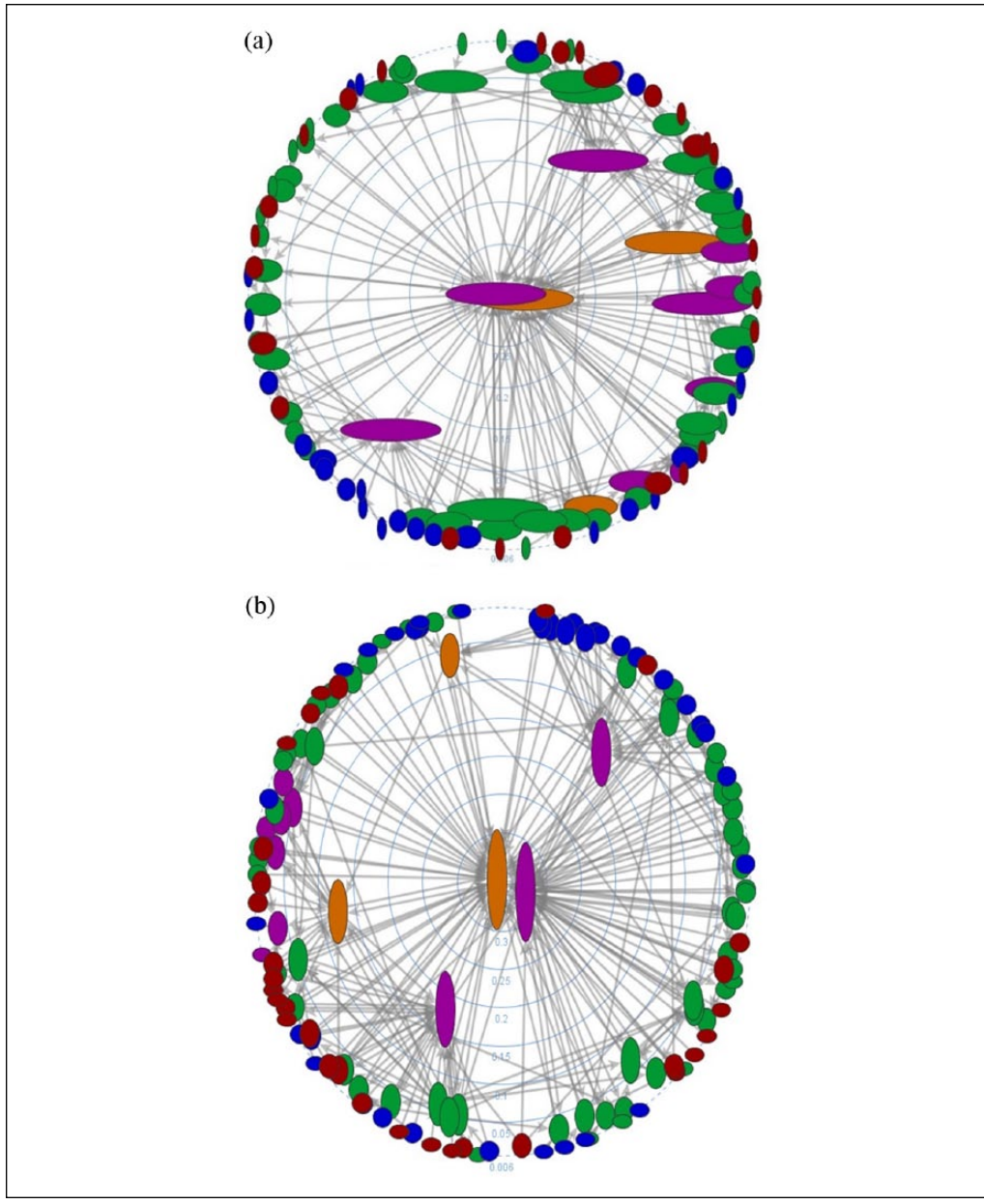

Figure 3. South Korean interagency communication networks in the 2015 Middle East respiratory syndrome (MERS) outbreak: (a) Communication sending network. (b) Communication receiving network.
Note: Orange node: national agency; violet node: regional agency; green node: local government (public health agencies); red node: fire agency; blue node: police agency.
Note: color version of the figure is available online.

In addition, local governmental agencies tended to communicate with other local agencies, and Seoul-based governmental organizations may provide risk information for local agencies in other regions. In fact, the metropolitan region had the first MERS patients, 52 of them. Because the region has nationally leading hospitals, residents from other regions had visited there for treatment, and some hospital visitors tested positive for the virus infection.

Semistructured interview results provide contextual understanding of interagency communication or collaboration during the outbreak response. First, interorganizational risk communication occurred hierarchically as well as horizontally. National agencies communicated with other national agencies or upper level subnational governments. Lower level subnational governments communicated risk information to national agencies or other local governments. Interviews with local health agencies showed that communication between local agencies and Korean CDC officials had mixed effects on local jurisdictions' outbreak response. One local official reported that the Korean CDC sent its personnel to communicate directly with his local government, whose jurisdiction had a MERS patient. The official said, "The CDC officials were helpful in responding to public health jurisdictions because national officials provided guidance to deal with problems." On the other hand, another local official stated that it was difficult for the local health agency to follow CDC officials' guidance, stating, "National officials tried to realize direction from upper level officials without considering the reality of local response settings."

Second, government officials seemed to rely more on official government information than on media reports. Interviewees reported that national ministry and agency officials used information from the responsible ministry, and interviewed officials agreed that government information is usually more accurate than media coverage. Most national and subnational officials reported that government information is the primary source for recognizing the outbreak and taking response actions. One national agency reported that the agency used media coverage to check public perception of the agency's response.

Third, national and subnational governments used online and offline means to communicate with external organizations and the public. Most interviewees reported that their organizations used the telephone, email, and official letters to communicate risk information to various ministries and subnational governments. For immediate outbreak response, interviewees indicated that organizations preferred telephone and email to formal paper communication. One national agency staff member reported that, to facilitate communication with the national ministry, the agency sent personnel to correspond with the national ministry that coordinates government-wide response.

Fourth, interviewees reported that national ministries and subnational governments mainly used press briefings, web pages, and social media to communicate outbreak response information to the general public. National ministries shared national-level information with the public, while subnational governments provided information focused on regional or local jurisdictions (eg, numbers of MERS patients and people under quarantine in the jurisdictions).

One researcher asked the same interviewees about critical problems in the MERS outbreak response. Most interviewees indicated that the responsible ministry did not immediately share risk information with other ministries and subnational governments after the outbreak began.

Information Sharing

One informant reported that the responsible ministry had not been able to disclose information immediately because the ministry needed time to develop the subsequent response measures. Two other interviewees from subnational governments reported that organizations sought information about hospitals with MERS patients before the responsible ministry disclosed that information. Officials reported that slow information sharing was not beneficial for rapidly preventing the spread of the virus.

Limitations of Information System

Interviewees reported that governmental organizations experienced several problems even after the responsible ministry disclosed information about patients and hospitals. First, 2 interviewees

mentioned that the public health information system for sharing information about high-risk patients and people who had contact with MERS patients was problematic. Local- and regional-level public health agencies could not update information about people who contacted MERS-infected patients to the public health information system without reporting to the national disease control agency. Neither did the system allow health agencies to input detailed information during the response period. The system's slow updates and limited information were not helpful for sharing outbreak information among local health agencies and proactively preventing the disease's spread.

Insufficient Personnel

Two other interviewees reported that national and subnational governments did not have sufficient personnel to prevent the spread of the infectious disease. The national government and the South Korean CDC had 34 epidemic investigators to confirm a MERS-infection case, but only 2 of them actually had the needed expertise. In addition, because the national government did not immediately delegate authority to confirm viral infection of high-risk patients to subnational governments, subnational governments relied on the national government's limited expertise. Thus, 18 days after identifying the first patient, the government confirmed the infection. In addition, although local governments' health agencies were to monitor people who had come in contact with MERS-infected patients, those agencies did not have sufficient personnel to perform the task. Therefore, the limited number of personnel hindered South Korean society's immediate prevention efforts. Indeed, after subnational governments were delegated to confirm MERS infection, they involved medical doctors and nurses from public and private hospitals and university professors for epidemic investigation.

Lack of Resources

South Korean governments at various levels lacked facilities for responding to the MERS outbreak. One ministry official and one subnational government official reported that governmental organizations had problems hospitalizing MERS-infected patients. The ministry official reported that the ministry and its agencies could not provide adequate assistance to subnational governments requesting assistance during the initial response because the governmental organization had limited resources for treating governmental organizations' members. A subnational government official mentioned that the responsible national agency did not have the capability to provide patient facilities, and the jurisdiction did not have designated public or private facilities to treat MERS-infected patients. The subnational government resolved the lack of hospital facilities by forcing other patients to leave a public hospital facility and by importing negative pressure beds.

Intraorganizational and Interorganizational Cooperation

During the outbreak response, South Korean governments had difficulties in intraorganizational and interorganizational cooperation. One subnational government official reported that the responsible department had difficulties in obtaining important resources from other same-government departments previous to the governmental chief's leadership of the outbreak response. After the governmental chief coordinated the subnational government's response, other departments actively cooperated with the public health department. The other subnational government official reported that the outbreak response did not systematically cooperate with local health agencies, the South Korean CDC, and police and fire authorities, because those agencies have differing reporting and command lines. One official from the national agency confirmed that

local agencies also had difficulties collaborating with local health agencies. The local official also reported that local governments experienced confusion sharing information about the quarantine period and termination dates because governmental agencies lacked an information standard for reporting quarantine beginning and ending dates.

Similarly, one ministry official mentioned that ministries had difficulties gaining cooperation from other ministries during the initial response period. During that period, other ministries were passive in cooperating with the ministry when the health ministry was coordinating the overall response. After the prime minister had led government-wide meetings on the outbreak response, other ministries became more cooperative. Another ministry official reported that during the initial response period, the ministry was unable to communicate with the health ministry.

Discussion

After the analysis of communication during the 2015 MERS response in South Korea, this study provides key theoretical and practical implications; the study identifies not only the South Korean government's challenges during the immediate response but also opportunities to improve risk communication systems for managing similar infectious diseases. Semistructured interviews and surveys identified obstacles responsible for the slow outbreak response. They can also provide important guidance for the Korean and other governments, highlighting better protective actions for other potential virus infections.

This study enhances the understanding of the networked response during a virus outbreak. Most previous research has examined participants in natural disaster responses and organizations that play central response roles.[9-14] The study of the public health emergency network during the MERS response can contribute to understanding of interorganizational communication in responding to other outbreaks of infectious disease like Zika and Ebola viruses that might broadly impact multiple countries and regions.

The results and findings imply that national and subnational governments should improve interagency cooperation and risk communication and the functioning of information systems to strengthen the capacity of the governments to respond to a future virus outbreak. First, all government levels and sectors should cooperate to exchange information quickly regarding transmission of infectious disease. Since transmission of a novel infectious disease involves great uncertainty and ambiguity, public health officials should be able to rely on officials of other jurisdictions or upper level governments to understand the virus transmission path.[1] Even though local jurisdictions might not initially suffer a virus outbreak within their boundaries, residents who travel to an outbreak location can become infected and carry the disease home. Certainly, the current state of transportation enables residents, however unintentionally, to aggravate an infectious disease's transmission. To understand the regional or national overall transmission path and to prepare for potential transmission into a jurisdiction, local public health agencies should communicate with regional government officials, and state public health agencies should communicate with their national governments.

Second, national and subnational governments are to improve the ability of functional agencies to communicate with other functional agencies to facilitate the joint efforts to mitigate the risk of a future virus outbreak. Although public health agencies are mainly responsible for responding to a virus outbreak, the response also requires cooperation with other agencies, such as fire and police agencies. Personnel from public health, fire, and police agencies have different backgrounds of professionalization, terminology, and perspectives. Such differences generate difficulties in communicating the outbreak response. One South Korea official asserted that a standardized reporting format among governmental agencies might facilitate sharing accurate information and timely response to future outbreaks. Moreover, transparent information sharing

among governmental agencies and the public can reduce anxiety about the ambiguity of infectious disease transmission.

Third, national and subnational agencies need to maintain well the functions of a disease surveillance information system. South Korea and other countries rely on information systems that expedite disease information sharing among public health agencies in usual time. A national disease control authority needs to test whether its information system will work smoothly even during a public health emergency like the MERS outbreak, which require instant updates of disease information. Well-maintained information systems will allow national and subnational governments to comprehend transmission paths immediately and clearly and to take adequate actions to mitigate the risk of a future virus outbreak.

This article, despite critical implications stated above, has limitations. First, the article does not provide theoretical understandings of interorganizational network in the public health emergency. The article focuses on the description of the overall aspects of the networked response among South Korea public agencies during the 2015 MERS outbreak rather than theoretical explanations. The article does not tell why certain communication strategies are prevalent or are helpful for improving the agencies' virus response. In addition, the study might not be generalizable to all South Korea areas. The findings are based on the surveys of governmental agencies in jurisdictions with MERS-confirmed cases. The jurisdictions with the cases might have greater needs of communication and cooperation than those without the cases.

Conclusion

Interagency communication is critical for timely response to a novel infectious disease outbreak that is likely to affect various regions. The study of interagency communication networks' dynamics during the MERS response in South Korea suggests that public health agencies and supporting agencies should strive to facilitate efficient information exchange. Standard and timely information sharing and risk communication can facilitate better responses to infectious disease transmission and prevent further transmission into multiple jurisdictions.[15] Challenges such as infectious disease's ambiguous nature, information systems' limitations, and differing organizational priorities for communicating and cooperating with other agencies are challenges that governmental agencies of all levels and types should be ready and able to overcome.

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ORCID iD

Kyujin Jung https://orcid.org/0000-0002-2241-2415

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