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Surveillance System for Infectious Disease Prevention and Management: Direction of Korea's Infectious Disease Surveillance System

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ABSTRACT

Emerging infectious diseases have risen sharply due to population growth, urbanization, travel, trade, and environmental changes, with outbreaks like severe acute respiratory syndrome, Middle East respiratory syndrome, and coronavirus disease 2019 highlighting the global need for effective surveillance systems. Various infectious disease surveillance systems are applied depending on the surveillance objectives, target populations, and geographical scope. While Korea has a robust surveillance system, challenges remain in integrating data, enhancing coordination, and improving response efficiency. This article reviews the types and roles of infectious disease surveillance systems through a literature review and proposes strategies for improving Korea's surveillance system by comparing it with those of other countries, including the World Health Organization (WHO). To strengthen Korea's surveillance framework, a comprehensive strategy should be implemented to interconnect multiple surveillance mechanisms and enhance real-time data sharing. A centralized data platform must integrate these systems, leveraging artificial intelligence and big data analytics for faster outbreak analysis. International collaboration through data-sharing networks with the WHO, European Center for Disease Prevention and Control, and U.S Centers for Disease Control and Prevention is essential, along with standardized reporting formats to improve interoperability.

Keywords: Epidemiological Monitoring; Infectious Disease; Pandemic Preparedness; South Korea; Surveillance System

THE BACKGROUND OF SURVEILLANCE SYSTEM

Emerging infectious diseases have increased significantly over the past 50 years due to population growth, urbanization, increased travel and trade, socioeconomic disparities, and changes in human-environment interactions.[1] Outbreaks of severe acute respiratory syndrome (SARS) in 2003, H1N1 influenza in 2009, Middle East respiratory syndrome (MERS) in 2012, as well as outbreaks of Ebola and avian influenza, have underscored the global impact of infectious diseases.[2] The emergence of coronavirus disease (COVID-19) in 2019, which spread across multiple Asian countries and prompted the World Health Organization (WHO) to declare a Public Health Emergency of International Concern in

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January 2020 — followed by a pandemic declaration in March 2020 — highlighted the critical importance of systematic infectious disease surveillance and response systems.[3] This global crisis demonstrated the necessity of establishing a rapid, coordinated, and effective surveillance system as an essential component of public health.

An infectious disease surveillance system systematically collects, analyzes, and interprets data on disease occurrences, providing vital information to policymakers and public health professionals. These data help identify causes, transmission patterns, and high-risk populations, which in turn facilitates the development of prevention and response strategies.[4]

Korea has progressively developed a systematic surveillance and response framework through its experience in managing domestic and global infectious disease crises. MERS, first reported in Saudi Arabia in 2012, spread to Korea in 2015 after a confirmed case in a traveler returning from the Middle East. The outbreak mainly affected medical institutions, resulting in a total of 186 confirmed cases nationwide. At that time, the health authorities classified MERS as a Group 1 infectious disease and designated major outbreak areas, including the Middle East, as high-risk quarantine zones. A surveillance system was established, requiring individuals who had traveled to the Middle East or had contact with confirmed patients to report any symptoms within 14 days.[5,6]

As of 2022, a total of 341 suspected MERS cases were reported through the surveillance system. During the winter months of January and February, 103 cases were reported, accounting for 30.2% of the annual total. The number of reported cases then declined but surged again from October to December, with 211 cases reported, making up 61.9% of the total cases (**Fig. 1**). This pattern appears linked to the government's implementation of a simultaneous COVID-19 and MERS response system in March 2022. Following the winter season, the number of suspected MERS reports remained stable. However, a sharp rise in Middle Eastern travelers and the onset of the influenza season contributed to an increase in reported cases in late 2022.[6]

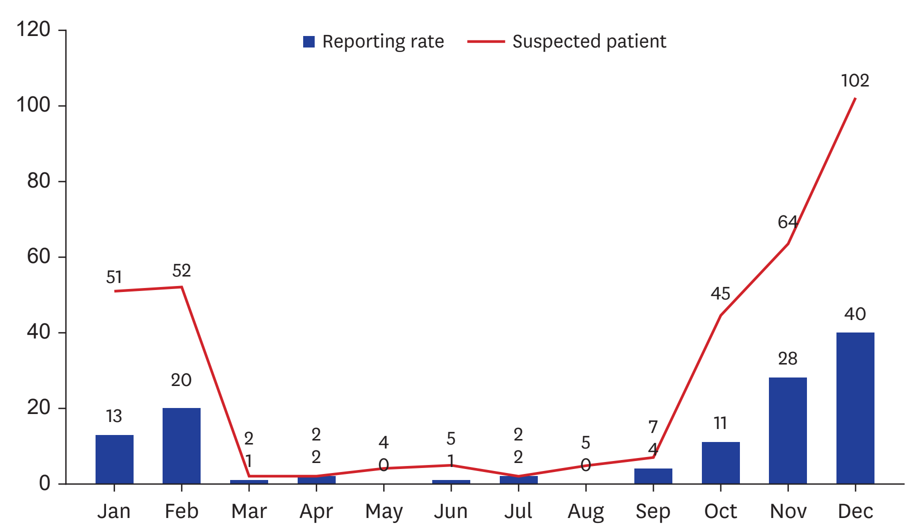

Fig. 1. 2022 Monthly Middle East respiratory syndrome suspicion report and suspected patient status.

The MERS outbreak underscores the importance of an infectious disease surveillance system. By operating a surveillance system, health authorities strengthen monitoring of international arrivals through enhanced quarantine inspections.

It is also crucial to operate an optimized surveillance system tailored to specific surveillance objectives and target populations in response to the increasing threat of infectious diseases. To achieve this, an in-depth review of existing surveillance systems is necessary to evaluate their roles and limitations.

EVOLUTION AND LEGAL FRAMEWORK OF KOREA'S INFECTIOUS DISEASE SURVEILLANCE SYSTEM

Korea's infectious disease surveillance system has evolved significantly, shaped by both national and global health crises. Following the Korean War in the 1950s, the country faced repeated outbreaks of waterborne diseases,[7] leading to the establishment of its first legal framework for infectious disease control with the enactment of the Prevention of Contagious Disease Act in 1954.[8]

During the 1980s and 1990s, Korea encountered sporadic cases of emerging and re-emerging infectious diseases,[9] necessitating improved surveillance measures. In 1995, the establishment of the Ministry of Health and Social Affairs (currently, the Ministry of Health and Welfare) marked the beginning of a comprehensive public health administration system.[10]

In 2000, the Prevention of Contagious Disease Act was renamed the Infectious Disease Control and Prevention Act, introducing a classification system that categorized infectious diseases into four groups based on severity and transmission risk. However, early reporting mechanisms had limitations,[11] as underreporting hindered the development of effective outbreak response strategies.[8,12]

As Korea modernized, various systems for the prevention and control of infectious diseases were introduced. The existing Prevention of Contagious Disease Act was replaced by the Infectious Disease Prevention and Control Act (2010), which provided comprehensive regulations on disease prevention, surveillance, quarantine, and management.[8] In addition, a risk response system for infectious disease was implemented to enhance national and global preparedness.

The initial response to the COVID-19 pandemic in early 2020 was influenced not only by past experiences with frequent infectious disease outbreaks but also by structural challenges within the Ministry of Health and Welfare. These challenges included difficulties in independently making policy decisions related to infectious diseases, as well as limitations in healthcare workforce capacity and financial support for large-scale responses.[13]

In June 2020, the Korean government proposed a bill to elevate the KCDC to an independent agency. The Government Organization Act and the Organization Amendment Bill for the Korea Disease Control and Prevention Agency (KDCA) and the Ministry of Health and Welfare were subsequently passed in the National Assembly.[14] In September 2020, KCDC was officially upgraded to the KDCA, strengthening its independence and operational capabilities.[15] This restructuring significantly expanded the organization's personnel and resources. In addition to infectious disease prevention, control, and quarantine efforts, the KDCA was granted overall authority over epidemiological investigations, vaccine development, and health risk management.[5] Currently, the KDCA is responsible for overseeing infectious diseases, chronic illnesses, and other health risks, marking a milestone in Korea's ability to formulate policies, allocate resources efficiently, and establish a globally recognized disease management system.[16,17]

The Infectious Disease Control and Prevention Act, which has been revised several times since its enactment in 1995, aims to detect occurrences early and spread of infectious diseases.[18] It establishes a comprehensive quarantine system to minimize public health risks and provides the foundation for infectious disease reporting, epidemiological investigations, vaccination programs, and crisis response systems. According to Article 2 of the Infectious Disease Control and Prevention Act, infectious diseases are classified, and management levels are determined based on factors such as fatality rates and transmissibility, as shown in **Supplementary Table 1**. The Act imposes reporting obligations on physicians, practitioners of Korean medicine, medical institutions, and specimen testing facilities. Furthermore, it mandates systematic data collection, analysis, and dissemination through the infectious disease information system, ensuring efficient management of disease-related information.[19,20]

To establish a national vaccination plan and system, Article 33-4 of the Infectious Disease Control and Prevention Act mandates compliance with the Personal Information Protection Act when handling personal information related to vaccination. This includes details such as the personal information of vaccine recipients, the names of vaccinators, the type of vaccine administered, the date and time of vaccination, as well as reports and notifications of adverse reactions following vaccination. Additionally, the Quarantine Act governs quarantine operations at airports, ports, and other entry points to prevent the spread of infectious diseases from abroad. It specifies diseases subject to quarantine and outlines the epidemiological investigations and testing procedures required during quarantine.[21]

The Framework Act on the Management of Disasters and Safety classifies infectious diseases as a form of national disaster and stipulates the establishment of the Central Disaster and Safety Countermeasures Headquarters in the event of a large-scale infectious disease outbreak.[22] Furthermore, it formalizes a cooperation system between the central government and local governments to ensure coordinated responses. Infectious diseases are also incorporated into the national crisis management system, which consists of 302 manuals that guide emergency response procedures.[23]

INFECTIOUS DISEASE SURVEILLANCE SYSTEMS: STRUCTURE AND CLASSIFICATION

Infectious disease surveillance refers to the process of continuously and systematically collecting data related to infectious diseases, pathogens, and vectors, analyzing and interpreting the data, and timely disseminating the results to the public for the prevention and control of infectious diseases (**Table 1**).[24]

Mandatory and sentinel surveillance

A mandatory surveillance system requires healthcare providers and laboratories to report specific infectious diseases to public health authorities without delay.[25] This system is crucial

Table 1. The various types of infectious disease surveillance systems

Type	Definition	Advantages	Disadvantages
Mandatory	All cases of a particular disease must be reported.	- Complete data for accurate disease monitoring.	- High resource and cost. - Difficulty implements in large populations.
Sentinel	A subset of the population is selected for monitoring, with results extrapolated to the whole population.	- Less resource. - Intensive than mandatory surveillance. - Can provide reliable data with fewer resources.	- May not capture all cases, leading to potential underreporting. - Can introduce sampling bias.
Syndromic	Surveillance based on reported symptoms or syndromes rather than confirmed diagnoses.	- Early detection of outbreaks. - Faster response time.	- May lead to false positives or negatives due to symptom overlap. - Less accurate than laboratory-confirmed cases.
Event-based	Monitoring reports of unusual events or outbreaks from various sources, including news and social media.	- Can detect outbreaks in real time. - Low cost and resource requirements.	- May generate false alarms. - Data may lack quality and consistency.
Laboratory-based	Surveillance through laboratory-confirmed tests and diagnoses.	- High accuracy and reliability. - Provides detailed information on pathogens and trends.	- Expensive and requires specialized facilities. - May be slow due to diagnostic processes.

for tracking high-priority diseases that pose significant public health threats. For example, the United Kingdom implemented mandatory surveillance in 2001 following a sharp rise in bloodstream infections caused by methicillin-resistant Staphylococcus aureus.[26]

In the case of Korea's sentinel surveillance system, it is operated through designated sentinel surveillance institutions in accordance with infectious diseases under Article 2, Paragraph 16, Subparagraph 2 of the Infectious Disease Control and Prevention Act. While the severity of the diseases under surveillance is relatively low, the system requires continuous monitoring due to the high incidence of cases.[24]

Syndromic and event-based surveillance

Syndromic surveillance monitors symptoms or patterns that may indicate the early stages of an outbreak. Instead of relying on laboratory confirmation, this system analyzes real-time health data, including emergency department visits, pharmacy sales, and absenteeism rates in schools and workplaces.[27-30] For example, the U.S. Centers for Disease Control and Prevention (U.S. CDC) utilizes real-time medical data from BioSense, and Google Flu Trends previously predicted influenza outbreaks using search data. However, syndromic surveillance has limitations, as it can be difficult to determine the exact cause of symptoms, leading to false positives or misclassification. Additionally, many symptoms are non-specific, making it hard to distinguish between infectious and non-infectious factors.[31-33]

Event-based surveillance monitors infectious disease outbreaks by incorporating unofficial information sources alongside standardized data collected through traditional surveillance systems. It analyzes unstructured data such as media sources (both online and offline news) and community activity, to identify early warning signs of outbreaks. By combining this data with official information, event-based surveillance enhances public health response capabilities.[34,35] Examples of event-based surveillance systems include ProMED-Mail, a global network that tracks infectious disease news worldwide, and HealthMap, which utilizes online data to generate real-time infectious disease maps.[36] The KDCA operates an Emergency Operations Center that continuously collects event-based data to enhance preparedness for public health crises. By sharing rapid assessment data with relevant organizations, it provides a foundation for multidisciplinary rapid response efforts during international public health emergency.[37] Despite its benefits, event-based surveillance faces challenges related to data reliability and accuracy, as rumors and misinformation can complicate outbreak detection and analysis.[38]

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Laboratory-based surveillance

Laboratory-based surveillance enables the precise diagnosis of infectious diseases by directly detecting pathogens (e.g., salmonellosis and shigellosis) through laboratory testing methods. This system provides objective data on pathogen characteristics, allowing for the early detection of emerging infectious diseases and drug-resistant bacteria.[39] Laboratory-based surveillance uses techniques such as microbial cultures, polymerase chain reaction, antigen-antibody testing, and genetic sequencing to identify pathogens. A major international laboratory network is the Global Influenza Surveillance and Response System (GISRS), which analyzes influenza virus samples collected globally to monitor new virus strains and provide early warnings for seasonal and novel influenza outbreaks.[40] Additionally, the Global Antimicrobial Resistance Surveillance System, operated by the WHO, collects data on pathogen resistance to identify global trends in antibiotic resistance. Surveillance of new viruses like COVID-19, SARS, and MERS is rapidly carried out through laboratory-based surveillance systems.[41]

While laboratory-based surveillance is highly accurate, it requires specialized technology, equipment, and trained personnel, making it costly and difficult to implement in rural or resource-limited areas. Furthermore, laboratory surveillance often requires additional time for pathogen identification, limiting its ability to provide real-time outbreak detection.[42-44]

Joint surveillance of zoonotic infectious diseases

Zoonotic diseases, which can spread between humans and animals, require comprehensive management through collaboration among the health, agriculture, livestock, environment, and marine sectors under the 'One Health' approach.[45] Examples of zoonotic diseases include anthrax and rabies, while bacterial zoonoses include tuberculosis, brucellosis, and salmonellosis.

In Korea, the Animal and Plant Quarantine Agency, the Ministry of Oceans and Fisheries, the Ministry of Environment, and the KDCA collaborate to operate a joint surveillance system for zoonotic diseases. This system integrates animal, the environmental, and human health data to improve infectious disease monitoring and response. To enhance zoonotic surveillance, an One Health information platform is being developed to facilitate real-time data sharing among institutions. This platform will standardize data formats for compatibility and incorporate big data analytics and artificial intelligence to predict infectious disease outbreak patterns.[46,47]

THE KOREAN NATIONAL NOTIFIABLE DISEASE SURVEILLANCE SYSTEM

Group 1 infectious diseases require stringent isolation measures, such as negative pressure isolation rooms, as they include bioterrorism-related pathogens. Due to their high fatality rates or significant risk of outbreaks, they must be reported immediately upon detection or during an epidemic. Group 2 infectious diseases require isolation and must be reported within 24 hours of detection due to their potential for transmission. Group 3 infectious diseases necessitate continuous monitoring and must be reported within 24 hours of detection.[20]

Doctors, dentists, and practitioners of Korean medicine are required to report cases to the head of their medical institution, who then reports them to the local public health center. If an employee discovers an infectious disease case through laboratory testing, they must notify the laboratory head, who then reports the case to the local health center via fax or

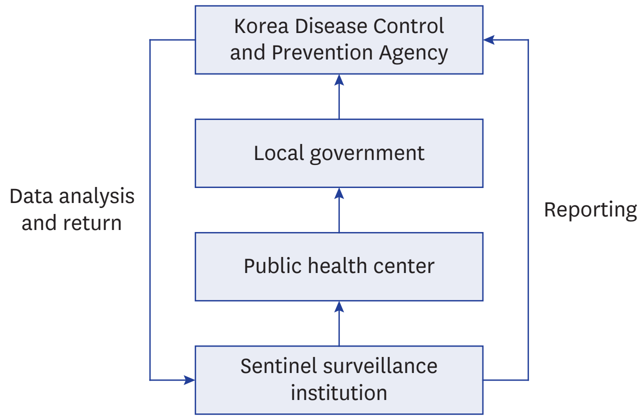

Fig. 2. Sentinel surveillance system reporting flowchart.

through the KDCA's online reporting system (https://eid.kdca.go.kr).[48] In case of the sentinel surveillance system process, the local public health center then forwards the report to the provincial or municipal authorities, which in turn verify the information and submit it to the KDCA (**Fig. 2**).[19] For infectious diseases requiring specimen-based surveillance, cases must be reported within seven days if a diagnosis, suspected case, or pathogen carrier is identified, or if an autopsy confirms infection.[20]

ROLES OF THE SURVEILLANCE SYSTEMS

During the initial spread of COVID-19, the surveillance system enabled early recognition of the outbreak in China, prompting enhanced screening measures for individuals entering Korea.[49] The surveillance system, designed to mitigate the social and economic impact of infectious diseases, strengthens national health capacity in several key ways.[50]

First, the system quickly identifies the occurrence and spread of infectious diseases, allowing for timely intervention. It continuously monitors disease trends, detects abnormal patterns, assesses outbreak risks, and issues alerts to prevent regional or international transmission. Over the past five years, the KDCA's Central Disease Control Headquarters has issued crisis warnings for MERS, Ebola, bioterrorism-related diseases, and emerging infections (**Fig. 3**).[51] The crisis situations at each stage are outlined in **Supplementary Table 2**.

The second role of the surveillance system is the collection and analysis of key epidemiological data, such as incidence, prevalence, and mortality. The collected and analyzed data serve as a critical foundation for health policy decisions, including epidemic prediction modeling, the development of response strategies, the procurement of vaccines and drugs, and the allocation of medical resources such as hospital beds and medical personnel.[52] For instance, data from Korea's Epidemiological Investigation Support System plays a vital role in managing the spread of infectious diseases by efficiently tracing contacts of confirmed cases and analyzing contact patterns.[53]

The third role of the surveillance system is to support infectious disease prevention and management policies. The system aids in the design and implementation of preventive measures aimed at reducing disease transmission. It assesses the effectiveness of policies

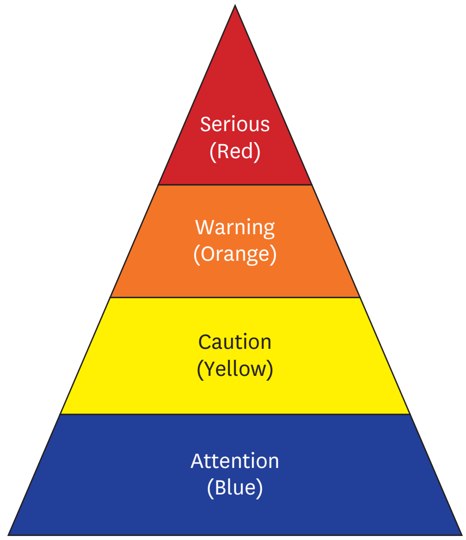

Fig. 3. National crisis alert level in Korea.

such as vaccination programs, the distribution of quarantine resources, and social distancing measures, providing necessary feedback for policy adjustments. For example, real-time influenza epidemic data collected through the system help determine optimal vaccination timing and prioritization.[54]

The final role of the surveillance system is raise public awareness and provide education through various media channels. By providing the public with accurate and timely information, it fosters trust in public health authorities and promotes proactive health behaviors to prevent the spread of infectious diseases. Additionally, the system offers targeted education and training on infectious disease control for healthcare workers and the broader community.[55] To reinforce public health practices, the KDCA conducts annual infectious disease prevention campaigns emphasizing personal hygiene measures such as handwashing and mask-wearing.[56]

LIMITATIONS AND CHALLENGES OF SURVEILLANCE SYSTEM OPERATION

Despite the legal requirement for infectious disease reporting, compliance with reporting deadlines has steadily declined, from 97.9% in 2020 to 96.8% in 2021 and 94.6% in 2022. The decline has been attributed to limited awareness regarding national notifiable infectious diseases, confusion about reporting deadlines, and the complexity of the reporting system.[56] Additionally, reporting may be omitted for patients with mild symptoms or in regions with insufficient monitoring capabilities, making it difficult to track transmission patterns and efficiently implement prevention and quarantine plans.[57,58]

Another major challenge is regional disparities in medical infrastructure. In rural, underprivileged, or developing regions, surveillance capacity is limited due to insufficient healthcare budgets and a shortage of trained personnel. Consequently, reporting rates vary between medical institutions, quarantine enforcement differs across regions, and initial outbreak responses may be delayed, compromising overall disease containment efforts.[59-62]

Although the Infectious Disease Prevention and Control Act provides a foundational legal framework, it lacks specific guidelines for large-scale pandemics.[63] Concerns remain regarding the balance between mandatory measures, such as quarantine enforcement, and issues of personal freedom and privacy rights. Additionally, the use of mobile applications and big data for real-time location tracking has raised ethical and legal debates regarding individual privacy protections.[64-66]

COMPARISON OF INFECTIOUS DISEASE SURVEILLANCE SYSTEMS

The U.S. CDC, European Center for Disease Prevention and Control (ECDC), and WHO operate infectious disease surveillance systems targeting different regions, facilitating the prevention and control of outbreaks through information sharing and cooperation. These organizations play key roles in data collection, analysis, and policy recommendations, serving as central hubs for international collaboration, particularly during global health crises (**Table 2**).[41]

The U.S. CDC, through the National Center for Emerging and Zoonotic Infectious Diseases collaborates with state and local public health agencies to collect and share infectious disease data. Key surveillance networks include the National Notifiable Diseases Surveillance System (NNDSS) and BioSense.[67,68] NNDSS collects and analyzes infectious disease data from state and local health departments. BioSense monitors real-time hospital emergency visits to detect potential outbreaks early.[69-70] The CDC also conducts population-based surveillance for specific diseases such as the influenza surveillance network (FluSurv-Net), foodborne diseases surveillance (FoodNet), and passive surveillance for insect vector diseases (ArboNet).[70,71] Hospitals, healthcare providers, and laboratories must report cases to local health departments, which in turn report to the CDC through both formal and informal channels.[67]

The ECDC works with 27 European Union member states to integrate infectious disease data and coordinate surveillance efforts.[72] The European Infectious Disease Surveillance System (TESSy) collects and analyzes outbreak data from national health authorities, providing real-time insights into infectious disease trends. The European Early Warning and Response System (EWRS) detects and shares outbreak alerts among member states, enhancing regional preparedness and response coordination.[73,74] ECDC contributes to the response to global infectious diseases by coordinating and sharing information between member states, providing policy recommendations and quarantine guidelines, and collaborating with the WHO.[75]

Table 2. Comparison of global infectious disease surveillance systems

Institutions	Region and scope	Surveillance system	Activities
U.S. CDC	United States and International	NNDSS, BioSense	- Focuses on domestic data collection and analysis - Collaborates with state governments - Develops an early warning system
ECDC	EU and EU member states	TESSy, EWRS	- Integrates data and facilitates information sharing among EU member states - Coordinates surveillance and response measures between countries
WHO	Global	GISRS, EIOS, IHR	- Conducts global infectious disease surveillance - Operates under the framework of the IHR - Develops early warning systems for global health threats

CDC = Centers for Disease Control and Prevention, NNDSS = National Notifiable Diseases Surveillance System, ECDC = European Centre for Disease Prevention and Control, TESSy = The European Surveillance System, EWRS = European Early Warning and Response System, WHO = World Health Organization, GISRS = Global Influenza Surveillance and Response System, EIOS = Epidemic Intelligence from Open Sources, IHR = International Health Regulations.

The WHO conducts global surveillance activities and collaborates with the health departments of its member countries. The GISRS collects and analyzes influenza data from over 150 public laboratories in 125 countries.[76] The International Health Regulations (IHR) mandate member states to report outbreaks that could pose a public health emergency.[77] Meanwhile the Pandemic Influenza Preparedness Framework facilitates virus data sharing and vaccine distribution.[78] The Epidemic Intelligence from Open Sources (EIOS) supports public health decision-making by gathering information from member states, international organizations, expert networks, and research institutes. Additionally, global initiatives such as the Early Alerting and Reporting System and the Hazard Detection and Risk Assessment System — projects of the Global Health Security Initiative — along with ProMED, the Global Public Health Intelligence Network, HealthMap, and the Europe Media Monitor, further strengthen global disease tracking.[79]

Singapore utilizes advanced digital surveillance and smart technology for efficient contact tracing and quarantine enforcement. The TraceTogether app records Bluetooth signals between users and securely stores contact data, which is then shared with disease control authorities when a confirmed case is detected. This system balances privacy protection with effective disease tracking.[80] Taiwan's entry quarantine system integrates health status reports with travel records, allowing authorities to identify and monitor high-risk individuals.[81] The National Health Insurance Administration links COVID-19 infection status to individual health records, enabling effective tracking and intervention.[82] Japan's Health Center Real-time Information-sharing System on COVID-19, enables real-time tracking of infectious disease cases, patient status, and hospital bed availability. The Contact-Confirming Application notifies users of potential exposure to confirmed cases, enhancing digital contact tracing efforts.[83,84]

Since 2023, Korea has implemented the Korea Wastewater Surveillance program, a national sewage-based surveillance system covering 17 cities or provinces. This initiative enhances early detection capabilities by tracking viral loads in wastewater samples, expanding the scope of epidemiological surveillance.[85] Compared to international practices, Korea's health-related surveillance systems operate independently, lacking strong interagency coordination. In contrast, the WHO, ECDC, and U.S. CDC utilize integrated surveillance systems that promote data-sharing, policy coordination, and global collaboration.[75] To strengthen infectious disease prevention, detection, and response, Korea should enhance national database integration and establish a centralized infectious disease data portal for streamlined access, fostering improved communication and cooperation among public health institutions.[86]

STRENGTHENING THE SURVEILLANCE SYSTEM

Improving reporting compliance requires reinforcing the obligation of medical institutions to report infectious diseases, offering appropriate incentives, and streamlining the reporting process. Additionally, education and outreach activities should be enhanced to provide clear and standardized guidance on reporting procedures.[87] Strengthening community participation is also essential, such as establishing a community-based surveillance system that actively involves local residents.[88]

Expanding financial and workforce support for public health centers and medical institutions in rural areas is critical. Integrating remote medical technology and digital surveillance tools will help ensure uniform surveillance capabilities across all regions.[89,90]

Legal and institutional measures for effectively responding to infectious diseases remain inadequate whenever a new outbreak occurs. To address this issue, pre-established regulations and guidelines must be developed to facilitate rapid and flexible responses. Additionally, a differentiated legal framework should be introduced to apply varying levels of quarantine measures based on the severity of the infectious disease.[58,91]

CONCLUSION

The surveillance of infectious diseases is a fundamental component of public health policy, ensuring the timely detection, monitoring, and response to outbreaks.[26] While Korea has implemented a robust surveillance system, challenges persist in data integration, interagency coordination, and response mechanisms.[92] To address these issues, a comprehensive strategy must be established to interconnect surveillance mechanisms while enhancing real-time data sharing and analysis.

Moving forward, infectious disease surveillance should not focus on specific diseases but rather adopt a One Health framework that integrates environmental, animal, and human health factors. The One Health approach is widely recognized as a fundamental principle for managing neglected tropical diseases and zoonoses, demonstrating that a collaborative approach across these sectors yields greater efficiency and synergy compared to independent sector operations.[93]

Furthermore, different types of infectious disease surveillance systems should be implemented in parallel to leverage their respective strengths and mitigate limitations. For example, combining mandatory surveillance with sentinel and laboratory surveillance can help reduce unreported cases. Integrating sentinel surveillance with syndromic surveillance enhances early warning capabilities and addresses potential underreporting. Similarly, syndromic surveillance, when paired with sentinel surveillance and event-based surveillance, facilitates the timely detection of unusual outbreaks. Moreover, linking event-based surveillance with syndromic surveillance improves the reliability of unstructured data.

In addition to domestic surveillance systems, international networks such as the WHO, ECDC, and the U.S. CDC should be leveraged to detect infectious diseases that spread across borders due to globalized trade and travel. For instance, a hepatitis A outbreak in the United Kingdom was identified through surveillance systems as originating from imported food. A notable example of a regional approach is the pan-European surveillance network, which currently monitors salmonella infections, legionnaires' disease, and viral infections.[94]

By leveraging the unique characteristics of each system within the One Health framework and integrating infectious disease surveillance systems as needed, enhanced collaboration with international networks will enable Korea's infectious disease surveillance system to advance further and strengthen its contribution to global public health security.

SUPPLEMENTARY MATERIALS

Supplementary Table 1

National notifiable infectious diseases classification

Supplementary Table 2

The crisis situations at each stage

REFERENCES

1. Reyes R, Ahn R, Thurber K, Burke TF. Urbanization and Infectious Diseases: General Principles, Historical Perspectives, and Contemporary Challenges. In: Fong IW, editor. *Challenges in Infectious Diseases*. New York, NY, USA: Springer New York; 2013, 123-46.
2. Baker RE, Mahmud AS, Miller IF, Rajeev M, Rasambainarivo F, Rice BL, et al. Infectious disease in an era of global change. *Nat Rev Microbiol* 2022;20(4):193-205. PUBMED | CROSSREF
3. Shrivastava SR, Shrivastava PS. 2019-nCoV outbreak declared as public health emergency of international concern: what next? *Int J Prev Med* 2020;11(1):65. PUBMED | CROSSREF
4. World Bank Group. Disease control priorities in developing countries, second edition (English). https://documents.worldbank.org/en/publication/documents-reports/documentdetail/632721468313531105/disease-control-priorities-in-developing-countries-second-edition. Updated 2006. Accessed January 21, 2025.
5. World Bank Group. Republic of Korea's COVID-19 preparedness and response (English). https://documents.worldbank.org/en/publication/documents-reports/documentdetail/534981606291035033/republic-of-korea-s-covid-19-preparedness-and-response. Updated 2020. Accessed January 20, 2025.
6. Lee S, Lee SY, Yeo SG. National surveillance and response to possible and suspected Middle east respiratory syndrome cases in the Republic of Korea, 2022. *Public Health Wkly Rep* 2023;17(8):295-314.
7. Sihn KH. Concealment and disclosure: the cholera crisis of 1969-70 in Korea. *Uisahak* 2021;30(2):355-92. PUBMED | CROSSREF
8. Korea Development Institute. 2013 Modularization of Koreas development experience: establishment of Korea's infectious disease surveillance system. https://www.kdi.re.kr/eng/research/reportView?pub_no=13672. Updated 2014. Accessed January 20, 2025.
9. Park O. Surveillance system for communicable disease in Korea. *Korean J Epidemiol* 2006;28(1):22-7.
10. Kang YJ, Myong JP, Eom H, Choi B, Park JH, L Kim EA. The current condition of the workers' general health examination in South Korea: a retrospective study. *Ann Occup Environ Med* 2017;29:6. CROSSREF
11. Lee DH. The disease management division infectious disease surveillance system. *HIRA Policy Brief* 2016;10(5):7-12.
12. Yoo HS, Park O, Park HK, Lee EG, Jeong EK, Lee JK, et al. Timeliness of national notifiable diseases surveillance system in Korea: a cross-sectional study. *BMC Public Health* 2009;9(1):93. PUBMED | CROSSREF
13. Kang H, Kwon S, Kim E. *COVID-19 Health System Response Monitor: Republic of Korea*. New Delhi, India: Asia Pacific Observatory on Health Systems and Policies; 2020.
14. Ministry of Security and Public Administration. Upgrade of the Korea Centers for Disease Control and Prevention to an agency; introduction of multiple vice ministers in the Ministry of Health and Welfare. https://www.korea.kr/news/policyNewsView.do?newsId=148873066. Updated 2020. Accessed January 20, 2025.
15. Korea Disease Control and Prevention Agency. Reorganization of the disease management agency ... in a new crisis quickly and firmly at risk in everyday life. https://kdca.go.kr/board/board.es?mid=a20501030000&bid=0015&list_no=725161&cg_code=&act=view&nPage=4&newsField=202405. Updated 2024. Accessed January 22, 2025.
16. The Korea Times. Chief of new disease control agency appointed in special ceremony. https://www.koreatimes.co.kr/www/nation/2024/10/113_295903.html. Updated 2020. Accessed January 20, 2025.
17. Korea Disease Control and Prevention Agency. First anniversary of the Korea Disease Control and Prevention Agency. https://www.kdca.go.kr/board/board.es?mid=a20501000000&bid=0015&list_no=716945&cg_code=&act=view&nPage=5&newsField=202109. Updated 2021. Accessed January 20, 2025.
18. Chun BC. Public policy and laws on infectious disease control in Korea: past, present and prospective. *Infect Chemother* 2011;43(6):474. CROSSREF
19. Korea Disease Control and Prevention Agency. Infectious Disease Surveillance System. https://www.kdca.go.kr/contents.es?mid=a20301110100. Accessed January 20, 2025.
20. Korea Legislation Research Institute. Infectious Disease Control and Prevention Act. https://elaw.klri.re.kr/eng_service/lawView.do?hseq=67634&lang=ENG. Updated 2024. Accessed January 21, 2025.
21. Korea Legislation Research Institute. Quarantine Act. https://elaw.klri.re.kr/eng_service/lawView.do?hseq=60127&lang=ENG. Updated 2021. Accessed January 21, 2025.

22. Korea Legislation Research Institute. Framework Act on the Management of Disasters and Safety. https://elaw.klri.re.kr/eng_service/lawView.do?hseq=64709&lang=ENG. Updated 2023. Accessed January 21, 2025.
23. Ministry of the Interior and Safety. Crisis management manual. https://www.mois.go.kr/frt/sub/a06/b11/crisisManual/screen.do. Updated 2024. Accessed January 21, 2025.
24. Choi H, Cha J, Seo Y, Hyun J, Kim I, Yang J. Introduction of respiratory infectious disease sentinel surveillance systems and assessment results. *Public Health Wkly Rep* 2024;17:1611-24.
25. U.S. Centers for Disease Control and Prevention. Mandatory reporting of infectious diseases by clinicians. https://www.cdc.gov/mmwr/preview/mmwrhtml/00001665.htm. Updated 2024. Accessed January 20, 2025.
26. Babu Rajendran N, Mutters NT, Marasca G, Conti M, Sifakis F, Vuong C, et al. Mandatory surveillance and outbreaks reporting of the WHO priority pathogens for research & discovery of new antibiotics in European countries. *Clin Microbiol Infect* 2020;26(7):943.e1-6. PUBMED | CROSSREF
27. Henning KJ. What is syndromic surveillance? *MMWR Suppl* 2004;53:5-11. PUBMED
28. California Department of Public Health. What is syndromic surveillance? https://www.cdph.ca.gov/Programs/CID/OIDPR/Pages/Syndromic-Surveillance/What-is-Syndromic-Surveillance.aspx#:~:text=Syndromic%20surveillance%20provides%20public%20health,%2C%20and%20opioid%2Drelated%20overdoses. Updated 2024. Accessed January 20, 2025.
29. Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, et al. Disease Control Priorities in Developing Countries. 2nd ed. Washington. D.C., USA: World Bank and Oxford University Press; 2006.
30. Elliot AJ, Hughes HE, Harcourt SE, Morbey RA, Smith S, Smith GE. Real-time syndromic surveillance. In: WHO Guidance on Research Methods for Health Emergency and Disaster Risk Management; Geneva, Switzerland: World Health Organization; 2020.
31. Tokars JI, English R, McMurray P, Rhodes B. Summary of data reported to CDC's national automated biosurveillance system, 2008. *BMC Med Inform Decis Mak* 2010;10(1):30. PUBMED | CROSSREF
32. Cai O, Sousa-Pinto B. United States influenza search patterns since the emergence of COVID-19: infodemiology study. *JMIR Public Health Surveill* 2022;8(3):e32364. PUBMED | CROSSREF
33. Hope K, Durrheim DN, d'Espaignet ET, Dalton C. Syndromic Surveillance: is it a useful tool for local outbreak detection? *J Epidemiol Community Health* 2006;60(5):374-5. PUBMED | CROSSREF
34. Ganser I, Thiébaut R, Buckeridge DL. Global variations in event-based surveillance for disease outbreak detection: time series analysis. *JMIR Public Health Surveill* 2022;8(10):e36211. PUBMED | CROSSREF
35. Balajee SA, Stephanie J. The practice of event-based surveillance: concept and methods. *Glob Secur (Abingdon)* 2021;6(1):1-9. CROSSREF
36. Keller M, Blench M, Tolentino H, Freifeld CC, Mandl KD, Mawudeku A, et al. Use of unstructured event-based reports for global infectious disease surveillance. *Emerg Infect Dis* 2009;15(5):689-95. PUBMED | CROSSREF
37. Hong SH, Hwang JH, An MS, Kim YH, Park JG. Event-based surveillance systems in the Republic of Korea by the emergency operations center. *Public Health Wkly Rep* 2020;13(48):3400-7.
38. Ministry of Health of Malaysia. Event-based surveillance protocol. https://www2.moh.gov.my/moh/resources/Penerbitan/Garis%20Panduan/Garis%20panduan%20Umum%20(Awam)/Buku_Event-Based_Surveillance.pdf. Updated 2018. Accessed January 20, 2025.
39. Lee BK. Laboratory based surveillance system of communicable disease in Korea. *Korean J Epidemiol* 1997;19(1):22-8.
40. Hay AJ, McCauley JW. The WHO global influenza surveillance and response system (GISRS)-A future perspective. *Influenza Other Respi Viruses* 2018;12(5):551-7. PUBMED | CROSSREF
41. Liu J, Xie W, Wang Y, Xiong Y, Chen S, Han J, et al. A comparative overview of COVID-19, MERS and SARS: review article. *Int J Surg* 2020;81:1-8. PUBMED | CROSSREF
42. World Health Organization. Surveillance of health care-associated infections at national and facility levels. https://www.who.int/publications/i/item/9789240101456. Updated 2024. Accessed January 20, 2025.
43. Aggarwal D, Ramachandran A. One health approach to address zoonotic diseases. *Indian J Community Med* 2020;45(5 Suppl 1):S6-8. PUBMED | CROSSREF
44. Jayatilleke K. Challenges in implementing surveillance tools of high-income countries (HICs) in low middle income countries (LMICs). *Curr Treat Options Infect Dis* 2020;12(3):191-201. PUBMED | CROSSREF
45. Horefti E. The importance of the one health concept in combating zoonoses. *Pathogens* 2023;12(8):977. PUBMED | CROSSREF
46. George J, Häsler B, Mremi I, Sindato C, Mboera L, Rweyemamu M, et al. A systematic review on integration mechanisms in human and animal health surveillance systems with a view to addressing global health security threats. *One Health Outlook* 2020;2(1):11. PUBMED | CROSSREF

47. Global Health Security Index. Country score justifications and references. https://ghsindex.org/wp-content/uploads/2021/12/South-Korea.pdf. Updated 2021. Accessed January 20, 2025.

48. Korea Disease Control and Prevention Agency. Case definitions for national notifiable infectious diseases. https://www.kdca.go.kr/board/board.es?mid=a20507020000&bid=0019. Accessed January 21, 2025.

49. Chang MC, Baek JH, Park D. Lessons from South Korea regarding the early stage of the COVID-19 outbreak. *Healthcare (Basel)* 2020;8(3):229. PUBMED | CROSSREF

50. Baker MG, Easther S, Wilson N. A surveillance sector review applied to infectious diseases at a country level. *BMC Public Health* 2010;10(1):332. PUBMED | CROSSREF

51. Korea Disease Control and Prevention Agency. Infectious disease crisis management. https://www.kdca.go.kr/contents.es?mid=a20301020300. Updated 2024. Accessed January 21, 2025.

52. Nsubuga P, White ME, Thacker SB, Anderson MA, Blount SB, Broome CV, et al. Chapter 53. Public health surveillance: a tool for targeting and monitoring interventions. In: Jamison DT, Breman JG, Measham AR, Alleyne G, Claeson M, Evans DB, et al, editors. *Disease Control Priorities in Developing Countries*. 2nd ed. New York, NY, USA: Oxford University Press; 2006.

53. Park YJ, Cho SY, Lee J, Lee I, Park WH, Jeong S, et al. Development and utilization of a rapid and accurate epidemic investigation support system for COVID-19. *Osong Public Health Res Perspect* 2020;11(3):118-27. PUBMED | CROSSREF

54. Suh KD, Choi JI, Choi PA. A study on healthcare policy response to risks of future infectious diseases: focused on infectious disease surveillance systems. *J Ind Converg* 2020;18(3):109-16. CROSSREF

55. Lars Samuelsson NL. Online surveillance and education for digital competence. *Athens J Educ* 2022;9(4):545-58. CROSSREF

56. Korea Disease Control and Prevention Agency. Cooperation between the Korea Disease Control and Prevention Agency and the Health Insurance Review and Assessment Service to ensure infectious disease reports are not missed in medical institutions. https://www.kdca.go.kr/board/board.es?mid=a20501020000&bid=0015&list_no=722973&cg_code=C01&act=view&nPage=4&newsField=202307. Updated 2023. Accessed January 21, 2025.

57. Meadows AJ, Oppenheim B, Guerrero J, Ash B, Badker R, Lam CK, et al. Infectious disease underreporting is predicted by country-level preparedness, politics, and pathogen severity. *Health Secur* 2022;20(4):331-8. PUBMED | CROSSREF

58. Downey A, Brown L, Calonge N. *Evidence-Based Practice for Public Health Emergency Preparedness and Response*. Washington, D.C., USA: National Academies Press; 2020.

59. Tan HF, Yeh CY, Chang HW, Chang CK, Tseng HF. Private doctors' practices, knowledge, and attitude to reporting of communicable diseases: a national survey in Taiwan. *BMC Infect Dis* 2009;9(1):11. PUBMED | CROSSREF

60. Korea Institute for Health and Social Affairs. A study on restructuring of the regional health systems for coping with public health crises: centering on Health Centers. https://repository.kihasa.re.kr/handle/201002/41538. Accessed January 25, 2025.

61. Aborode AT, Hasan MM, Jain S, Okereke M, Adedeji OJ, Karra-Aly A, et al. Impact of poor disease surveillance system on COVID-19 response in Africa: time to rethink and rebuilt. *Clin Epidemiol Glob Health* 2021;12:100841. PUBMED | CROSSREF

62. Tsai FJJ, Chen B, Yang HWU, Huang S. *Sustainability and Resilience in the Taiwanese Health System*. Taipei, Taiwan: Center for Asia-Pacific Resilience and Innovation (CAPRI); 2024.

63. Cohen CL, Walker KH, Hsiang M, Sonenthal PD, Riviello ED, Rouhani SA, et al. Combating information chaos: a case for collaborative clinical guidelines in a pandemic. *Cell Rep Med* 2021;2(8):100375. PUBMED | CROSSREF

64. Anom BY. The ethical dilemma of mobile phone data monitoring during COVID-19: the case for South Korea and the United States. *J Public Health Res* 2022;11(3):22799036221102491. PUBMED | CROSSREF

65. Kim H. COVID-19 apps as a digital intervention policy: a longitudinal panel data analysis in South Korea. *Health Policy* 2021;125(11):1430-40. PUBMED | CROSSREF

66. Lowe H, Woodd S, Lange IL, Janjanin S, Barnet J, Graham W. Challenges and opportunities for infection prevention and control in hospitals in conflict-affected settings: a qualitative study. *Confl Health* 2021;15(1):94. PUBMED | CROSSREF

67. U.S. Centers for Disease Control and Prevention. How we conduct case surveillance. https://www.cdc.gov/nndss/what-is-case-surveillance/conducting.html. Updated 2024. Accessed January 29, 2025.

68. Rha B, Burrer S, Park S, Trivedi T, Parashar UD, Lopman BA. Emergency department visit data for rapid detection and monitoring of norovirus activity, United States. *Emerg Infect Dis* 2013;19(8):1214-21. PUBMED | CROSSREF

69. Khabbaz RF, Moseley RR, Steiner RJ, Levitt AM, Bell BP. Challenges of infectious diseases in the USA. *Lancet* 2014;384(9937):53-63. PUBMED | CROSSREF

70. Lindsey NP, Brown JA, Kightlinger L, Rosenberg L, Fischer M; ArboNET Evaluation Working Group. State health department perceived utility of and satisfaction with ArboNET, the U.S. National Arboviral Surveillance System. *Public Health Rep* 2012;127(4):383-90. PUBMED | CROSSREF

71. U.S. Centers for Disease Control and Prevention. EIP network activities. https://www.cdc.gov/emerging-infections-program/php/network-activities/index.html. Updated 2024. Accessed January 20, 2025.

72. European Centre for Disease Prevention and Control. Our main areas of work. https://www.ecdc.europa.eu/en/about-ecdc/what-we-do. Accessed January 29, 2025.

73. European Commission. Surveillance and early warning. https://health.ec.europa.eu/health-security-and-infectious-diseases/surveillance-and-early-warning_en. Accessed January 20, 2025.

74. Faculty of Public Health. The UK and the European Centre for Disease Prevention and Control (ECDC). https://www.fph.org.uk/media/1778/brexit-booklet-digital-2.pdf. Updated 2018. Accessed January 20, 2025.

75. European Centre for Disease Prevention and Control. International cooperation. https://www.ecdc.europa.eu/en/about-us/who-we-work/international-activities#collaboration-with-non-eu-countries-and-international-partners. Updated 2024. Accessed January 21, 2025.

76. World Health Organization. Operational considerations for COVID-19 surveillance using GISRS. https://iris.who.int/bitstream/handle/10665/331589/WHO-2019-nCoV-Leveraging_GISRS-2020.1-eng.pdf. Updated 2020. Accessed January 20, 2025.

77. U.S. Centers for Disease Control and Prevention. International Health Regulations. https://www.cdc.gov/global-health/topics-programs/ihr.html. Updated 2024. Accessed January 28, 2025.

78. World Health Organization. Pandemic influenza preparedness (PIP) framework. https://www.who.int/europe/groups/pandemic-influenza-preparedness-(pip)-framework. Accessed January 20, 2025.

79. European Commission. Supporting policy with scientific evidence. https://knowledge4policy.ec.europa.eu/disaster-risk/eios_en. Updated 2020. Accessed January 20, 2025.

80. Qin H, Guo T, Han Y. Locating infectious sources using Bluetooth system of smart devices. *Appl Sci (Basel)* 2023;13(12):7218. CROSSREF

81. Kim J, Moon J, Jung TY, Kim W, Yoo HC. Why have the Republic of Korea, Taiwan, and Singapore coped well with COVID-19 and what are the lessons learned from their experiences? *Yonsei Med J* 2022;63(3):296-303. PUBMED | CROSSREF

82. Lo WC, Wang FC, Lin LY, Jyan HW, Wu HC, Huang YL, et al. Enhancing data linkage to break the chain of COVID-19 spread: the Taiwan experience. *J Med Internet Res* 2021;23(5):e24294. PUBMED | CROSSREF

83. Takeshita K, Takao H, Imoto S, Murayama Y. Improvement of the Japanese healthcare data system for the effective management of patients with COVID-19: a national survey. *Int J Med Inform* 2022;162:104752. PUBMED | CROSSREF

84. Ishimaru T, Ibayashi K, Nagata M, Tateishi S, Hino A, Tsuji M, et al. Factors associated with acceptance of a digital contact tracing application for COVID-19 in the Japanese working-age population. *Nagoya J Med Sci* 2023;85(1):59-69. PUBMED | CROSSREF

85. Jang J, Park SY, Kim SS, Kim A, Choi YJ, Kim SH, et al. Establishment and operation of national wastewater-based surveillance system on infectious diseases. *Public Health Wkly Rep* 2023;16(14):424-38.

86. World Health Organization, Regional Office for the Western Pacific. Republic of Korea health system review. *Health Syst Transit* 2015;5(4).

87. Institute of Medicine (US) Forum on Emerging Infections; Davis JR. *Managed Care Systems and Emerging Infections: Challenges and Opportunities for Strengthening Surveillance, Research, and Prevention*. Washington, D.C., USA: National Academies Press; 2000.

88. Haldane V, Chuah FLH, Srivastava A, Singh SR, Koh GCH, Seng CK, et al. Community participation in health services development, implementation, and evaluation: a systematic review of empowerment, health, community, and process outcomes. *PLoS One* 2019;14(5):e0216112. PUBMED | CROSSREF

89. Worsley-Tonks KEL, Bender JB, Deem SL, Ferguson AW, Fèvre EM, Martins DJ, et al. Strengthening global health security by improving disease surveillance in remote rural areas of low-income and middle-income countries. *Lancet Glob Health* 2022;10(4):e579-84. PUBMED | CROSSREF

90. Runkle JD, Sugg MM, Graham G, Hodge B, March T, Mullendore J, et al. Participatory COVID-19 surveillance tool in rural appalachia: real-time disease monitoring and regional response. *Public Health Rep* 2021;136(3):327-37. PUBMED | CROSSREF

91. Yang C, Li X. How should the law respond to emerging infectious diseases: China's experience and considerations in containing COVID-19. *J Glob Health* 2024;14:03028. PUBMED | CROSSREF

92. Ha J, Choi M, Yoo J. The 3rd master plan for the prevention and control of infectious disease, 2023-2027. *Public Health Wkly Rep* 2023;16:1668-81. CROSSREF

93. Zinsstag J, Utzinger J, Probst-Hensch N, Shan L, Zhou XN. Towards integrated surveillance-response systems for the prevention of future pandemics. *Infect Dis Poverty* 2020;9(1):140. PUBMED | CROSSREF

94. Noah N. Surveillance of Infectious Diseases. In: Bamford DH, Zuckerman MA, editors. *Encyclopedia of Virology*. 4th ed. Amsterdam, The Netherlands: Elsevier/Academic Press; 2021, 247-55.