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Editorial

What are the strategies for national health security in preparation for the next pandemic?

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Reflecting on the past 4 years of the response to coronavirus disease 2019 (COVID-19), there has been considerable discussion about the importance of public health measures before vaccines and treatments become available during a new outbreak. Additionally, there has been a focus on transforming the patient-centered healthcare system to reduce mortality caused by the paralysis of medical services during a pandemic, as well as on protecting vulnerable populations affected by social inequality. It is widely recognized that improving governance is essential for these 3 strategies to be effectively implemented, and that ensuring human dignity as a fundamental human right is critical in the measures taken to respond to infectious diseases. However, medical interventions constitute the cornerstone of the response. The evolution of viruses has outpaced our predictions, reducing the effectiveness of treatments and vaccines by half or more. As a result, our response has been constrained to temporary and short-term solutions, constantly trying to catch up with the evolving threat. What, then, are the strategies for a more effective response in the face of the next outbreak? Discussions within the biomedical science community are particularly important, underscoring the need for concerted efforts to establish robust national health security governance.

Firstly, to reduce unexpected uncertainties, the "prototype pathogen approach" is crucial. This strategy involves preemptively predicting which diseases might reach epidemic levels, conducting preliminary research, and then swiftly developing a "medical countermeasure" strategy through further research as the situation evolves. This approach is in line with the World Health Organization's "A scientific framework for epidemic and pandemic research preparedness" consultation on the vaccine research response to pathogen X [1], as well as the United States National Institutes of Health's Workshop on Pandemic Preparedness: The Prototype Pathogen Approach to Accelerate Medical Countermeasures—Vaccines and Monoclonal Antibodies [2]. Both initiatives emphasize compiling a list of diseases with the potential to cause future pandemics, particularly as a strategy for vaccine and treatment development. For instance, directing research efforts toward prototype viruses within certain virus families that could spawn new pandemic pathogens (such as Coronaviridae, including severe acute respiratory syndrome coronavirus-1 [SARS-CoV-1], Middle East respiratory syndrome [MERS] coronavirus, and SARS-CoV-2; Orthomyxoviridae, including influenza; and Paramyxoviridae, including Nipah and respiratory syncytial virus) is a strategy that would necessitate the establishment of research centers focused on approximately 10 virus families currently under discussion.

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Secondly, this research center-focused approach requires a multidisciplinary effort as a complementary strategy to the "prototype pathogen approach," which can be broadly applied to various viruses within a classification group, including those that are yet to be discovered. Furthermore, the development of medical countermeasures (MCMs) based on prototype pathogens requires a robust collaborative network of scientists to advance promising candidates into clinical trials, drawing on foundational research in virus biology, pathogenesis, and immunity. This opens up opportunities for researchers from diverse disciplines or those with specialized technical skills to collaborate in innovative ways. Progress in developing MCMs for one prototype pathogen can be accelerated by leveraging insights and discoveries from research on other prototype pathogens.

Thirdly, research outcomes must be translated into MCMs that facilitate product development. This involves enabling technologies such as mRNA vaccines, recombinant virus vaccines, new adjuvants, or novel drug delivery systems. Additionally, innovations in vaccine storage and cold chain logistics necessitate the alignment of materials, components, and equipment to scale up production. Falling behind in foundational technology development could lead to a loss of market dominance, similar to the situation with semiconductors. Thus, there is a need for intensive investment in mRNA technology, which can be used for essential immunization vaccines, other therapeutic vaccines, and cancer treatments, because the market is expected to reach 230 trillion dollars by 2035 [3]. Our failure to produce significant results during this outbreak can largely be attributed to insufficient investment in foundational technologies, workforce development, university startups, and the cultivation of industry clusters related to materials, components, and equipment, which has left us trailing behind other nations.

In conclusion, the preparation for pandemics should not only focus on purpose-driven science in priority areas but also on fostering scientific and organizational capabilities to accelerate the development of products from MCM candidates, potentially putting us ahead of other countries in developing our response strategies. In essence, a robust and consistent management system—or governance—is essential for a swift medical response within the framework of "National Health Security." Establishing and steering a coherent health security governance agenda is vital. This includes: (1) monitoring diseases, including those imported from abroad; (2) strengthened surveillance and proactive case identification; (3) investigations in response to outbreaks; (4) clinical research and diagnostic laboratory tests; (5) evaluations of non-medical and medical interventions; (6) clinical trials of treatments and vaccines as part of an always-ready "research and development scenario." The WHO has incorporated lessons from its experiences with SARS-CoV-1 and MERS into its field response research strategies for the COVID-19 pandemic. Following the MERS outbreak in 2015, the Republic of Korea undertook a Joint External Evaluation (JEE) with the WHO and the Global Health Security Agenda (GHSA) to identify 19 areas of preparedness and response under the revised International Health Regulations (IHR 2005), thereby strengthening public health measures related to MCMs [4]. Although a multi-ministerial forum and a government-wide Research and Development Fund for Infectious Disease Research (GFID) were established, strategies directly connected to product development fell short. Despite commitments to develop an mRNA vaccine domestically, progress has been sluggish, and even with some production, these vaccines have not been fully integrated into clinical practice. Reflecting on the historical trajectory of vaccine development, including both triumphs and setbacks as seen with COVID-19 [5], it is imperative to identify bottlenecks preventing vaccines from reaching the field in order to better prepare for future outbreaks and national health security threats.

Notes

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Conflicts of Interest
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