EDITORIAL

The next pandemic catastrophe: can we avert the inevitable?

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Keywords: COVID-19, Mpox, Pandemic, Vaccinations, Public health, Education

Original Submission: 1 March 2023; **Accepted:** 6 March 2023

Article published online: 10 March 2023

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The world faced an unprecedented health crisis due to the spread of the coronavirus pandemic. Over 756 million confirmed cases and over 6.8 million fatalities had been reported globally as of February 18, 2023. While the pandemic has been devastating, it has also been a wake-up call to the world about the need for better preparedness and response to future health crises [1]. The ability to predict future pandemics using current scientific knowledge and the aid of specialists is one of the essential concerns in global health owing to pandemics being one of the primary forces driving the globalization of science and following those specialists are seeking a pathogen and a solution to control it. The why only some of the pathogens are mentioned as having an actual or potential pandemic should also be addressed simultaneously [2].

The history of pandemics has shown that humans and pathogens coevolved. Environmental changes also accelerate this process, meaning immunization is only part of the process. That is where the idea of "emerging and reemerging infectious diseases" begins. The majority of pandemics have been spread among species by spillover and zoonosis. For instance, the most recent COVID-19, mpox, poliovirus, and respiratory syncytial virus (RSV) outbreaks have all provided additional evidence. It is difficult to say whether or not we can stop or predict the next pandemic disaster. Because preparing for the future aims to increase awareness of the vulnerabilities existing in the present rather than to forecast what will happen in the future [3].

The increased migration of animals and animal products has also contributed to the threat of developing illnesses. Every year, new strains of avian influenza circulate among wild birds around the globe. In addition, intensive poultry farming techniques enhance the likelihood that domestic birds will be infected by wild birds, which might then be transmitted to poultry workers.

Invasion of virgin forests for lumber and mining can expose humans to pandemic-prone diseases like Ebola. Other potential viruses that might spillover from the zoonotic reservoir and

https://doi.org/10.1016/j.nmni.2023.101110

possibly be capable of person-to-person transmission are the Chapare Hemorrhagic Fever virus, Lassa virus, Crimean-Congo Hemorrhagic Fever virus, Rift Valley Fever virus, Alkhurma Hemorrhagic Fever virus, Kyasanur Forest Disease virus, and Omsk Hemorrhagic Fever virus [4]. Other sources include the amplification of diseases in healthcare settings at the onset of a pandemic where infection prevention and control measures are inadequate, the increased spread in dense, overpopulated cities, and the accidental release of high-risk pathogens due to inadequate biosecurity measures in laboratories researching these pathogens. Rising temperatures allow mosquitoes, ticks, and other disease-carrying insects to grow, adapt to changing seasons, and invade new territory, which increases the likelihood of a pandemic. For instance, flooding caused by harsh weather provides additional mosquito breeding grounds, increasing the probability of spreading dengue and other arboviral diseases. Melting permafrost can cause the discharge of diseases from animal corpses, such as the 2016 anthrax epidemic on the Yamal Peninsula in Siberia.

Understanding how new viral agents emerge, behave, and use is one of the most accessible factors in predicting future epidemics that must be considered to create and implement efficient policy measures to reduce socioeconomic repercussions. It also is imperative to see whether the environmental factor or human invasion is responsible for some critical mutations in organisms that made them pathogenic, which otherwise were non-pathogenic. An example is Zika which was found to cause mild disease symptoms at the time of detection but later gained pathogenicity leading to microcephaly and Guillain-Barre syndrome, and subsequently gained 12 amino acids substitutions and displayed enhanced neurovirulence [5]. Governments rely mainly on prior epidemiological models in this situation. To navigate a challenging future, human society requires a stable vision. So, to reduce the emergence of future epidemics and other health emergencies, human society must be guided towards sustainable communities that respect wildlife, the environment, and their natural resources. Human curiosity leads him to discover new things, but his attitude may also be harmful.

Global warming is breaking the ice sheets, permafrost, and glaciers that contain many viruses and other pathogens in the dormant stage. Genetic analysis of soil and lake sediments of Arctic freshwater lake Lake Hazenm revealed molecular signatures closer to existing viruses with risks of virus spillover. Breaking the permafrost layer just for adventure and curiosity and exposing the ice layer encompassing various dormant pathogens could be a recipe for disaster. Hence, in thinking about and preparing for future pandemics, Health organizations and governments should have documented programs for choosing to adopt, adapt, and improve their methods of operation in advance [6]. The key to averting the next pandemic catastrophe is to be prepared. That means strengthening public health systems and investing in research and development to create new treatments and vaccines. It also means increasing access to education and resources in vulnerable communities, so people can better understand and take preventive measures [7]. One approach to avoiding and controlling future pandemics could be developing a global One-Health program. The World Health Organization (WHO) has identified six critical areas for pandemic preparedness: risk assessment, surveillance, laboratory capacity, clinical management, public health interventions, and risk communication [8].

Existing plans in advance are required. This plan should include strategies for prevention, mitigation, and response. Prevention strategies should focus on risk assessment and risk reduction, while mitigation strategies should focus on creating protective measures and evacuation plans. Response strategies should focus on providing timely and effective aid to those affected by the disaster. Creating a communication plan and developing partnerships with local and international organizations can also help ensure a coordinated response [9]. Predictions and projections of weather and climate changes in the eco-epidemiological contexts favouring the spillover events might help understand future pandemics. The spillover risk can be minimized by reducing human encroachment on wildlife and interrupting animal-to-human transmission chains. Measures are needed to prevent endemics from becoming pandemic by effectively monitoring disease and real-time tracking through enhancing international collaboration to obtain better preparedness. Machine learning and artificial intelligence may help in developing a mechanistic and dynamics spatiotemporal disease spread model [10], the status of infection in vaccine recipients [11] and vaccine adverse effects through a natural language processing approach [12].

Risk assessment is an understanding of the possible risks caused by a virus or other infection. That includes monitoring the spread of the virus, tracking its mutations, and analyzing the risk factors associated with infection. Surveillance involves collecting and analyzing data to identify and monitor disease trends and inform public health interventions. It is essential to address the limitations and challenges of the existing infectious disease surveillance programs and warning systems to alert in case of pandemics. Blockchain technology, the pool of structurally and functionally different databases, may be used to trace infectious diseases for information management [13]. Blockchain technology rapidly detects infection data from individuals.

Furthermore, it can ameliorate data processing to make it worthwhile for scientific research and applicable to government and political implications. Blockchain technology ensures data immutability, transparency, and traceability, which are essential

during possible outbreaks. Using blockchain technology, patient movement, real-time data of affected areas, and implicated strategies to fight disease may be tracked. Potentially infected index cases may be monitored at each stage with reliability and accuracy in the form of blocks, where each block stores the outbreak update at a particular point, and a combination of blockchain with artificial intelligence and geographical information system will be more robust in surveillance programs [14]. In addition, the technology will help track and determine the correct allocation and distribution of vaccines [15].

Laboratory capacity is essential for diagnosing and testing for the virus, as well as for developing treatments and vaccines. Clinical management includes giving affected people health care, medicines, and vaccinations. Public health interventions, such as contact tracing, quarantining, and social seclusion, are actions used to stop the virus from spreading. Risk communication involves educating the public about the virus, its risks, and how to stay safe. Investing in international cooperation, public health systems, and research and development are essential for pandemic preparedness and response [16]. It is critical to improving vulnerable groups' access to resources and education. That includes giving access to medical care and treatment, information about the infection, and how to protect oneself. In addition, it's critical to offer financial assistance to people affected by the pandemic, such as those who have lost their jobs or are ill and unable to work [17].

PANDEM-2 is one of the leading programs. PANDEM-2 aims to discover, map, and integrate data from numerous sources into a cohesive pandemic-management database and provide a comprehensive dashboard for pandemic preparedness training and response. The dashboard gathers sources of information on the social, economic, and health-related effects of a pandemic. The PANDEM-2 project will include the lessons learned from the current COVID-19 pandemic and implement worldwide best practices in modelling, simulations, pandemic messaging, contact tracking, and training [18]. PANDEM-2 will assist public health agency pandemic managers, first responders, laboratory workers, and hospital administrators. Advances in visual and data analytics will aid pandemic managers in making crucial decisions, thereby decreasing the impact of future pandemics on EU residents.

State and federal leaders must demonstrate national leadership and unity to combat the next health hazard. Despite its evident threat to world health, economics, and security, the COVID-19 pandemic has, with a few exceptions, been characterized by excessive rhetoric and insufficient action. The worldwide COVID-19 meetings have resulted in commendable financial promises, and leaders have addressed WHO conferences, but action has not been sustained [19]. Preparedness in the vaccine development program should be state of the art, where a vaccine can be prepared immediately after diagnosing the infecting agent. An mRNA-based vaccine may be readily developed against virtually almost all viral pathogens with information of only genomic sequence in hand. Robust animal models are required to identify the vaccine efficacy reliably. The number of biocontainment labs should be increased to receive samples for diagnosis from nearby outbreak sites immediately. An adequate number of such facilities will reduce the workload and associated human errors in existing labs. Horizontal and vertical transfer of pathogens with the involvement of new potential hosts is also essential to determine. Apart from biosafety, biosecurity is also an important measure to be taken when encountering new pathogens having the potential to reason a pandemic. It is the shared responsibility of scientists and the government to ensure the swift implementation of related laws to minimize the possibilities of laboratory escape or misuse of these pathogens [20].

Therefore, a global council of leaders must identify gaps in readiness and reaction, mobilize funds, keep public and private actors responsible, and give leadership at the first sign of a threat. This council should be constituted by a political statement made by the General Assembly of the United Nations.

In conclusion, being prepared is the key to preventing the next pandemic disaster. Public health services must be strengthened, and money must be spent on research and development to produce new medications and vaccinations. For people to understand prevention better and take preventive action, expanding access to education and resources in vulnerable communities also entails increasing access to education and resources. Additionally, it is crucial to invest in international cooperation to help countries at risk of outbreaks and provide economic support to those affected by the pandemic. Unfortunately, past crises have demonstrated that governments and donors typically shift their focus to more critical issues after an outbreak is under control. This "panic-then-forget" loop has hampered the global development of efficient health emergency preparedness. This vicious loop must be broken once and for all.

Ethical approval

This article does not require any human/animal subjects to acquire such approval.

Funding

This study received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

CRediT authorship contribution statement

Maryam Shafaati: Conceptualization, Data Curation, Visualization, Writing - Original Draft, Writing - review & editing. **Hitesh Chopra:** Conceptualization, Data Curation, Visualization, Writing - Original Draft, Writing - review & editing. **Priyanka:** Conceptualization, Data Curation, Visualization, Writing - Original Draft, Writing - review & editing. **Rekha Khandia:** Data Curation, Visualization, Writing - Original Draft, Writing - review & editing. **Om Prakash Choudhary:** Conceptualization, Software, Resources, Supervision, Visualization, Writing - Original Draft, Writing - review & editing. **Alfonso J. Rodriguez-Morales:** Supervision, Writing - Original Draft, Writing - review & editing.

Declaration of competing interest

All authors report no conflicts of interest relevant to this article.

Acknowledgements

The authors thank their respective institutions/universities for completing this work.

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