Disaster preparedness to exotic and emerging infections

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Abstract. **Exotic and emerging infectious diseases are emerging more frequently, and impacting more profoundly, all of humanity. Disasters risk reduction efforts over the preceding decades, culminating in the Hyogo and Sendai frameworks, have provided a roadmap for all countries to address emerging disaster related risks. Sudden onset or surprise epidemics of exotic or emerging diseases have the potential to exceed the adaptive capacity of countries and international efforts and lead to widespread unmitigated pandemics with severe flow on impacts. In this article pandemic preparedness is viewed through the lens of international disaster risk reduction and preparedness efforts. Preparing for the unknown or unexpected infectious disease crisis requires different approaches than the traditional approaches to disaster related epidemic events. Countries must be able to position themselves optimally through deliberate planning and preparation to a position where future exotic or emerging infections can be managed without overwhelming public health, and other societal resources.**

Introduction

Disaster preparedness has been a key focus of national and international efforts to reduce risks to vulnerable populations and improve resilience. International frameworks such as the Hyogo and now Sendai frameworks for disaster risk reduction provide all nations with a roadmap to protect development gains from disaster risks. The all-encompassing breadth of the Sendai Framework, covering all types of disasters at the strategic policy level, on its own is insufficient to provide the detailed information required to specifically address risks and improve capacity to manage emerging or exotic pathogens. Challenging even for the most advantaged, many countries are unable to properly evaluate or respond to these requirements in a way that guarantees an effective response to a major epidemic crisis[1,2].

Since the late 1990s the world has been subjected to repeated epidemics of significance caused by exotic and emerging pathogens[3–6], and with increasing frequency even when accounting for increased surveillance and better detection technologies. It is proposed this is being driven by overpopulation, urbanisation, globalisation of trade and travel, climate change, resource depletion, and new habitat encroachment and exploitation[4,5,7–9]. Equally, and interlinked, are increased vulnerabilities to emerging and exotic pathogens due to overcrowding, aging related immune senescence, immunosuppression, antimicrobial resistance, poor nutrition and rising levels of chronic disease[3,10,11].

Understanding how to achieve disaster risk reduction and disaster preparedness for exotic and emerging pathogens requires a detailed understanding of not only the traditional approaches to disaster preparedness, but also a detailed understanding of how population vulnerabilities, behaviour, resilience and patterns or life interact to influence disease dynamics[7]. By their very nature as emerging and exotic infections, such diseases are characterised by limited data, disease dynamics uncertainties, and assumptions regarding the most effective public health interventions. In this article the disaster preparedness frameworks relevant to exotic and emerging infections are outlined, and the challenges in achieving optimal pandemic preparedness in the face of uncertainty due to novelty and limited understanding of the pathogen are discussed.

Epidemics caused by disasters

Numerous examples are available that outline the causal relationship between simple and complex disasters, and the emergence of epidemics in the post-disaster phase. A prominent example of this was the emergence of cholera in Haiti following the major earthquake of 2010. The epidemic of cholera disease in Haiti occurred at a time where the population was least prepared, with a highly compromised health system[12,13] and widespread population vulnerabilities. A more recent example is the emergence of

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diphtheria in the Rohingya refugee camp on the border of Bangladesh[14], and other many others. The frequent linkage of disasters with outbreaks of infectious disease is fundamentally important to disaster and humanitarian response planners[15,16]. In humanitarian response it is assumed at least one major epidemic will occur in a major event, thus significant resources are allocated to prepare and prevent it. Estimations of the most likely types of outbreaks that could occur following particular disasters are based on historical data and experience contextualised into the crisis at hand during the operational planning process. The standard medical and logistic planning tools available in the World Health Organization (WHO) and UN Disaster Aid Coordination (UNDAC) approaches support post-disaster epidemic preparedness and planning in this way.

Epidemics as disasters

Epidemics do not always occur secondarily to disasters. Such events, possibly due to a zoonotic cross-over event, an accident involving the mishandling a pathogen, or a deliberate release of one, occur at an unpredictable time and location. Significant uncertainties about pathogen specific virulence factors, transmissibility, behaviour within human and zoonotic populations, and the impact on populations and societies are usually present. There is also a paucity of evidence during the early phases of an epidemic about what therapeutic, social, and non-pharmaceutical interventions might be effective[3,17]. It is well recognised that the quality and quantity of available information to support decision-making increases over time. In humanitarian responses the Multi-sector Initial Rapid Assessment (MIRA) framework is designed to rapidly and systematically address this information gap, but the novel aspect of the epidemic makes this gap all the more impactful and dangerous.

Two of the three most recent major coronavirus epidemics (SARS-1 and MERS-CoV) emerged outside of the context of disasters, all believed to have emerged as a consequence of cross-over events from a zoonotic reservoir[3]. The emergence of H1N1 pandemic influenza equally occurred in the absence of a deliberate triggering event but as the result of a cross-over event[18]. In each of these examples, initial uncertainties and unknowns were gradually replaced with greater and greater information allowing for more effective epidemic control. Modest morbidity and mortality, the nature of the infectious diseases themselves, and appropriate initial epidemic response, provided decision-makers time to collect sufficient information and bring systems to bear. In contrast, uncertainties associated with SARS-CoV-2 (COVID-19) coupled with the unexpected rapidity of spread within communities and various modes of transmission have possibly contributed to the relative ineffectiveness of public health authorities and governments to prevent COVID-19 becoming a pandemic[2,19].

The critical difference between epidemic disasters and other forms of disasters is the transmissible and spreading nature of the hazard within the vulnerable population. Epidemics of emerging or exotic pathogens occurring *de novo* in a population are unlikely to be well aligned with even the most carefully devised pandemic preparedness activities and plans, in contrast with opportunistic epidemics triggered by disasters that are more likely to correlate well with existing preparedness activities[17].

Preparedness frameworks

Pandemic influenza, particularly a novel avian influenza, has historically been identified as the most likely emerging pathogen with pandemic potential[19]. The WHO has therefore utilised Influenza as the exemplar pathogen around which pandemic preparedness is framed. This has led to a number of key preparedness activities that are outlined in Table 1[20]. However, it is equally recognised that influenza may not be the pathogen responsible for the next major pandemic. While influenza preparedness is a focus, a key assumption within each plan is the ability to readily and rapidly adapt existing influenza preparedness plans to suit any other respiratory pathogen. A key issue with this approach is the assumption that preparedness plans for all respiratory pathogens of pandemic potential conform to the model influenza framework, and that adaptation is possible within the timeframes available in the early part of an emergent pandemic when preparedness efforts are likely to have most effect.

Equally, at the country level significantly more detail is needed in order to translate what is broad intent, agreement and strategic guidance at the international level into concrete preparedness and planning actions. This is often a very difficult problem for individual countries, particularly low- and middle-income countries. In this case regional collaborations to share resources and jointly build capacity have been recommended as a possible solution[8,16]. Some of the key pitfalls associated with the current exemplar system of pandemic preparedness and response, as embodied in the plans for pandemic influenza, are:

- A failure to follow through on strategic commitment with the necessary resources and changes required to deliver a cohesive and effective epidemic response
- Disconnection between senior political and health leadership, and middle level health system professionals and managers, leading to inaccurate understanding of health system flexibility and adaptability to pandemic challenges.

Table 1. Core areas of international global influenza pandemic preparedness activities.

Component	Type of activity	Purpose and function
Pandemic Influenza Preparedness (PIP) framework[A]	International agreement	Share specific resources for influenza pandemic response, such as: – virus samples – countermeasures – surveillance data – information on key activities such as laboratory capacity building, regulatory capacity building, community engagement, risk communication, and planning for deployment
International Health Regulations (IHR)[B]	International treaty	Framework for building consensus and aligning global health stakeholders on questions of disease prevention, detection and response
Joint External Evaluation (JEE)[C]	Assurance and capacity assessment program (voluntary)	Encourage IHR signatories to develop core public health capacities in order to prevent, detect and respond to disease outbreaks. Identify gaps and trigger signatories to address them
National Pandemic Influenza Preparedness Plans	Operational plan at the national level	Provide detailed guidance on how preparedness and planning requirements from IHR and other agreements are implemented at the national and sub-national level
WHO 2019–2030 Global Influenza Strategy[D]	Strategic Plan specifically focused towards a disease (in this case Influenza)	Strategic objectives and plans for realising key priorities for the management of a single disease (in this case influenza). Aligns influenza pandemic preparedness activities with other preparedness activities and requirements (e.g. vulnerable groups)
Partnership for Influenza Vaccine Introduction (PIVI)[E]	Partnership agreement for collaborative capacity building	Aims to improve capacity and capability of partners by targeting specific areas of concern to influenza pandemic operational response such as vaccine supply, distribution and delivery
Global Influenza Surveillance and Response System (GISRS)[F]	Global monitoring, surveillance, and response system for influenza	Acts as a global alert for exotic and emerging influenza viruses. Comprises National Influenza Centers, WHO collaborating centres, Regulatory laboratories and reference laboratories
WHO specialist advisory committees[G]	Advisory functions	Provides advice to senior leadership and partner nations Conducts specific analyses and develops advice to support future direction of preparedness activities
Global Action Plan (GAP) for Influenza Vaccines[H]	Capacity building	Provides a mechanism for improving vaccine access across partner countries, and coordination of research and development activities

[A]https://www.who.int/influenza/resources/pip_framework/en/.
[B]https://www.who.int/ihr/publications/9789241580496/en/.
[C]https://www.who.int/ihr/publications/WHO_HSE_GCR_2018_2/en/.
[D]https://www.who.int/influenza/global_influenza_strategy_2019_2030/en/.
[E]https://pivipartners.org/.
[F]https://www.who.int/influenza/gisrs_laboratory/en/.
[G]https://www.who.int/influenza/pip/advisory_group/members/en/.
[H]https://www.who.int/influenza_vaccines_plan/objectives/en/.

– Inaccurate self-reporting of national capacity through various evaluation mechanisms
– Barriers to ensuring that gaps and identified problems in national response capacity are addressed or improved.

How to improve preparedness for future exotic or emerging pandemics

Improving preparedness for future exotic or emerging pandemics at both the country and international level requires strong political and health leadership at all levels[19,20]. Without a commitment to improving preparedness the necessary resources will not be made available and efforts cannot be coordinated and supported.

Beyond strong leadership, a flexible and agile health care system able to respond to the unexpected demands and realities of an outbreak of an emerging or exotic pathogen is important, allowing adaptation during any epidemic crisis from a baseline that allows the system to flex to a posture of sufficient and effective response. This is shown diagrammatically in Figure 1.

A recent report commissioned by the WHO identified 10 points that are necessary to best prepare for future exotic or emerging infectious disease epidemics[20]. They are:

(1) Improving core public health capacities
(2) Improving national and global surveillance capacities
(3) Developing systems for sharing resources and information relevant to disease preparedness and response

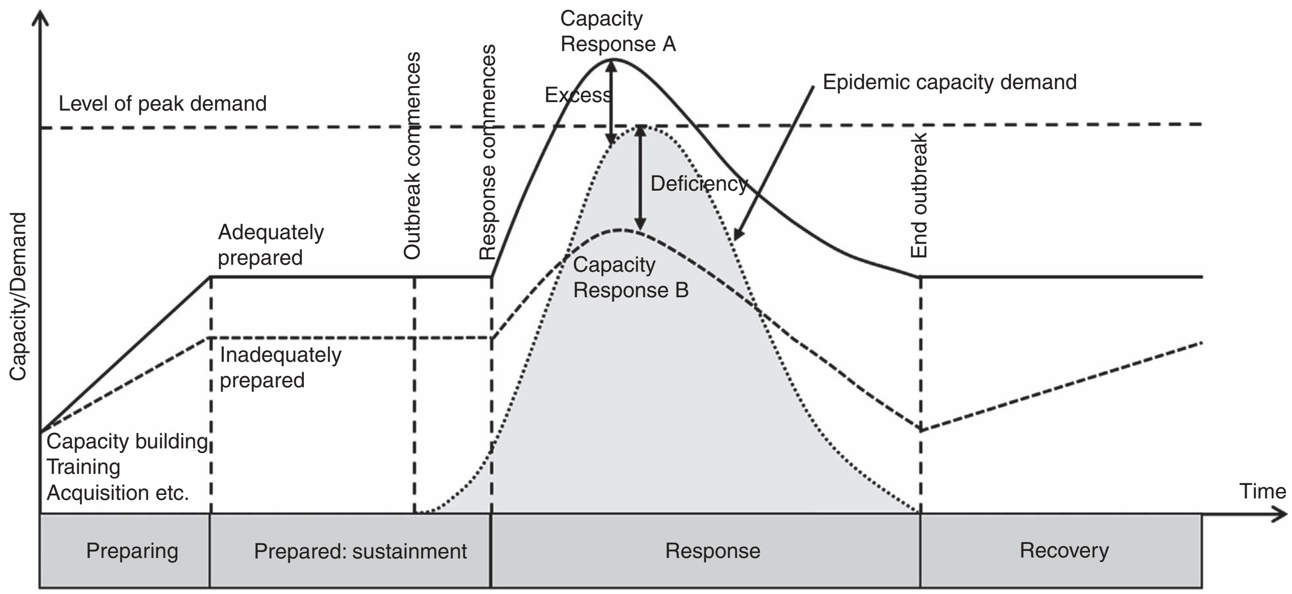

Figure 1. Relationship between pre-pandemic preparedness and response capacity. For a hypothetical outbreak with an adequately prepared jurisdiction, Capacity Response A results in consistent exceedance of epidemic capacity demand. In contrast, a lower baseline preparedness level results in deficiency at high demand periods during the epidemic. Incorporating sufficient flexibility in preparedness activities (Response A) to handle unknown factors in emerging and novel pathogens is important.

(4) Improving operational readiness to respond to infectious disease emergencies
(5) Using social science and community engagement to optimise pandemic response
(6) Individual countries and global organisations developing and exercising plans for risk communication
(7) Research effort directed towards rapid vaccine development and surge manufacturing capacity
(8) The evidence and role of non-pharmaceutical interventions clearly articulated to decision-makers
(9) Improving biosafety around high impact pathogens
(10) Accepting the possibility of surprise and the need to prepare for it.

While all of these areas have already been the focus of intense efforts over many years to improve pandemic preparedness, concerns such as increased activities in Dual Use Research of Concern (DURC) areas, reductions in barriers to accessing technologies enabling the development of emerging biological pathogens of pandemic potential, increasing opportunities for zoonotic cross-over, and many other factors are continually undermining these efforts. Addressing both the positive and negative influences on preparedness is important to optimising flexibility, resilience and reducing system vulnerability.

Conclusion

Preparedness for exotic and emerging pathogens is a challenging area of public and health policy. Traditionally preparedness for infectious disease disasters has been driven by historical data and examples – an approach that is the mainstay of the health and humanitarian response to disasters. Exotic and emerging pathogens introduce uncertainties and unknown factors that require a modified approach to preparedness. This is most commonly managed through the development of agile preparedness systems that are able to support system wide adaptation to the emergence of an exotic or emerging pathogen in a population. Recently numerous factors, particularly those associated with the risk of deliberate or accidental release of a novel pathogen, work against achieving an adequate level of agility and responsiveness to a novel infectious disease event. Addressing factors that improve preparedness to respond, while simultaneously addressing factors that threaten to undermine preparedness in general, are equally important to the overall pandemic preparedness effort.

Conflicts of interest

The author declares no conflicts of interest.

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Biography

Dr David Heslop is an Associate Professor at the School of Public Health and Community Medicine at UNSW Sydney. He retains military responsibilities as SO1 Public Health and Occupational Medicine at Army Headquarters. He is a clinically active vocationally registered General Practitioner, registered Occupational and Environmental Medicine Physician with the Royal Australasian College of Physicians, and a fellowship candidate for the Academy of Wilderness Medicine. During a military career of over 15 years he has deployed into a variety of complex and austere combat environments, and has advanced training in Chemical, Biological, Radiological, Nuclear and Explosive (CBRNE) Medicine. His research interests lie in health and medical systems innovation and research. He is a chief investigator on the NHMRC Centre for Research Excellence Integrated Systems for Epidemic Response (ISER), and undertakes collaborative research exploring evaluation of the medical aspects of high risk and high consequence environments through a novel computational modelling and simulation effort with DST Group, and various emergency response and CBRNE related teaching and research activities with Industry and Government organisations. Throughout the COVID-19 crisis he has been providing specialist Public Health and Occ and Env Medicine advice to a range of government and private organisations, the most notable as the biosecurity operational and policy adviser to the NRL Project Apollo initiative.

Border wars or considered containment?

On 30 January 1919 the NSW government, without any warning, closed its border with Victoria, Queensland and South Australia. No trains, cars, or pedestrians were allowed to cross the Murray River. Police were stationed at all of the 56 border crossings the length of the Murray river. Desperate to be reunited with family and friends, soldiers returning from fighting in the First World War tried to cross but were caught by police, and subsequently faced seven days in quarantine camps. The reason? The federal government had declared NSW to be a state infected with the Spanish flu.

Victoria was also infected but had refused to acknowledge it. Wodonga was without the benefit of a hospital to match the newly constructed one in Albury. So, a tent hospital and isolation camp were constructed on the Wodonga racecourse. Church services were held outside and schools, public buildings and hotels were closed. People within 10 miles of the border were required to wear masks and stay six feet (1.8 m) apart. Farmers avoided making trips to town leading to food shortages: the egg supply was particularly disrupted. The death toll in Australia, with a population of 5 million at the time, was finally estimated at 12 000.

This was not the first time NSW had seen fit to close their borders. In 1903 the state had tried to pass legislation to prevent convicted criminals from other states entering NSW. However, the other states invoked Section 92 of the recently written Constitution of the Commonwealth of Australia that stated, Trade, Commerce and Intercourse among the states, whether by means of internal carriage or ocean navigation, shall be absolutely free. The High Court subsequently ruled that the NSW legislation was unconstitutional.

However, there was no challenge to closure in 1919 as subsequent re-interpretation of the Constitution had accepted that states should retain a degree of latitude to limit border crossings to protect public health. Although it has taken a century and another virus for states to exercise this right, hopefully the initial historical accord that replaced old feelings of self-interest between the various states will prevail and the move will be seen for what it is – an attempt to contain a highly infectious virus and not a move to pain or suffering in particular by depriving sports lovers of their weekly dose of pleasure.