Exploring Lessons Learned from a Century of Outbreaks: Readiness for 2030: Proceedings of a Workshop (2019)

DETAILS

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Appendix A

Commissioned Paper

Readiness for Microbial Threats 2030: Exploring Lessons Learned Since the 1918 Influenza Pandemic

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ACRONYMS AND ABBREVIATIONS

DG	Director-General
DON	disease outbreak news
DORS	disease outbreak response system
ED	executive director
EIS	epidemic intelligence service
EOC	emergency operations centers
ERF	emergency response framework
FAO	Food and Agriculture Organization of the United Nations
GHSA	Global Health Security Agenda
GOARN	Global Outbreak Alert and Response Network
HSS	health systems strengthening
IHR	International Health Regulations
ILAR	Institute for Laboratory Animal Research
IMF	International Monetary Fund
MERS-CoV	Middle East respiratory syndrome coronavirus
MOH	Ministry of Health
OIE	World Organisation for Animal Health
PHEIC	public health emergency of international concern
R&D	research and development
SARS	severe acute respiratory syndrome
SDG	Sustainable Development Goal
UHC	universal health coverage
UN	United Nations
UNGA	United Nations General Assembly
UNSG	United Nations Secretary-General
WHA	World Health Assembly
WHO	World Health Organization
WTO	World Trade Organization

BACKGROUND

The world has made dramatic strides in tackling infectious diseases over the past century, including smallpox eradication, significant progress on polio eradication, and widespread vaccination. However, new threats have emerged—including 30 new zoonotic diseases in the past two decades alone. This uptick in new diseases may be the result of many factors, including economic growth, global travel, the proximity of humans to animals, or climate change, and the trend does not appear to be slowing. One hundred years after the 1918 pandemic influenza, we remain at risk of pandemic spread—perhaps more so than ever before. This continued risk highlights the need to be globally prepared. While many lessons on preparedness were gleaned following the 2014 Ebola outbreak in West Africa, we still lack a more comprehensive summary of lessons from different outbreak and pandemic events over the course of the past century.

To address this gap, we reviewed reports outlining recommendations and lessons from major epidemics that have occurred since the 1918 influenza pandemic. Six major types of outbreaks were chosen by the Forum on Microbial Threats (FMT) to survey.[1] We conducted a unique review of the literature for each outbreak to capture reports or studies published during, or in the years following, that pandemic (see reference list at the end of the commissioned paper). The subject of the review was *what needs to be accomplished to make progress in epidemic and pandemic preparedness moving forward*—or globally relevant lessons learned from each event. Where possible, we focused on global lessons (for more than one country) from each specific outbreak. This ultimately included global lessons abstracted from 16 peer-reviewed papers or reports. The process was not meant to be exhaustive but rather representative of different periods, disease types, and authorship (e.g., academic, practitioner, multilateral).

We found significant overlap in content across the reports. This finding was consistent with themes summarized by both Gostin (2016) and Moon et al. (2017) in *Toward a Common Secure Future: Four Global Commissions in the Wake of Ebola* and *Post-Ebola Reforms: Ample Analysis, Inadequate Action*, respectively. Moon et al. (2017) categorized recommendations from the 2014 Ebola outbreak in West Africa as follows:

1. Bolster country-level core capacities and compliance with the International Health Regulations (IHR).

[1] The following outbreaks were selected: (1) the 1957 and 1968 influenza pandemics, (2) the 2003 emergence of influenza A (H5N1) and severe acute respiratory syndrome (SARS), (3) the 2009 H1N1 influenza A pandemic, (4) the 2013 emergence of influenza A (H7N9), (5) the 2014–2016 Ebola outbreak in West Africa, and (6) the 2012–2015 Middle East respiratory syndrome coronavirus (MERS-CoV) outbreak in Saudi Arabia and in Korea.

2. Improve knowledge sharing and research.
3. Strengthen the World Health Organization (WHO), the United Nations (UN), and broader global health or humanitarian systems.

Below, we summarize highlights from the review using an adaptation of this same framework. Additionally, for each category, we provide summaries of recommendations and lessons (see Boxes A-1 to A-5), which are outlined in more detail in Tables A-1 to A-5.

CATEGORY 1: COUNTRY-LEVEL CORE CAPACITIES

Robust and sustainable health systems are a prerequisite for preventing, detecting, and responding to pandemics and to pandemic threats. The IHR are the current framework for country preparedness for infectious disease outbreaks and require 196 State Parties to develop and maintain core health system capacities in the face of acute public health risks such as infectious disease threats of international concern. Core capacities in this framework are organized into three categories related to prevention, detection, and response, which include subdomains (e.g., health workforce, laboratories, data systems, and risk communication), in order to identify and to contain threats before they cross national borders. While this review includes studies that were released prior to the development of the IHR, we use the IHR framework to organize recommendations and lessons from reviewed content (see Box A-1). Additional content was also reviewed on trade and travel, accountability mechanisms, and other suggestions to support countries as they work to achieve adequate core capacities.

BOX A-1
Recommendations and Lessons for Bolstering Country-Level Core Capacities

Strengthening Capacity to PREVENT

1. Response frameworks should include better scenario planning and less rigidity, considering variation that occurs among diseases. Ministries of health should be familiar with different suites of measures so that they can deploy them flexibly. (H1N1)
2. Effective primary care can help alleviate the overloading of emergency departments. (H1N1)
3. Prevention goals within the International Health Regulations (IHR) should align with those in the universal health coverage (UHC) agenda, and accountability should be built into both frameworks. (Ebola)

BOX A-1 Continued

Strengthening Capacity to DETECT

1. "Wide net" surveillance often makes sense in situations when there are nonspecific symptoms (H1N1), and nonhealth entities can support screening in places such as schools, businesses, and transportation sites. (SARS, H1N1)
2. National surveillance needs to be paired with rapid international verification, especially when a pandemic occurs in low-resource contexts with limited lab capacity. (H5N1)
3. Web-based search patterns can be used to identify potential risks early. (H1N1)
4. Surveillance efforts must be tied to animal health and focused on rural areas. (H1N1, H5N1)
5. "Timeliness of data management and risk assessment is essential for identifying unusual clusters (e.g., high death rates) and initiating appropriate responses" (Fisher et al., 2011). (H1N1)
6. When the disease is not fully understood, detection systems should include feedback loops on spread, so clinicians and other people who treat the disease can understand viral transmission and treatment effectiveness. (H1N1)

Strengthening Capacity to RESPOND

1. Strong health systems are key: "Underresourced, understaffed, and fragmented health services are unable to contain outbreaks of serious infectious diseases or to adequately respond to health emergencies" (Save the Children, 2015). (Ebola)
2. "Health care workers must be given priority for protection and treatment to enable them to perform their duties" (Lee et al., 2008). (H1N1)
3. Lack of epidemiological information on the disease hampers effective treatment. (H1N1)
4. Response plans, even those created for prior diseases, are effective and provide a blueprint for countries. However, there is need for practical testing of these plans at both hospital and above hospital levels. (H1N1)
5. Containment, as a strategy, is highly dependent on the disease. When containment efforts do not work, the importance of communicating risk to the public increases. (H1N1)
6. Risk communication and engagement with communities throughout outbreak events were noted as critical for each outbreak. Specific efforts featured included dedicated government websites and use of social media. (Multiple)

In this review, we found that 16 out of 16 papers included content on core national capacities on outbreak reporting (if not specifically those outlined in the IHR). Some of this content was presented in the form of lessons for future outbreaks while other content was framed as reflections (often made by practitioners or policy makers who actively addressed an outbreak event).

Recommendations and lessons regarding how the broader global health system could support countries' efforts to develop core capacities were also mentioned throughout the reviewed papers but were less common than lessons aimed at countries themselves. Suggestions for WHO included content on supporting country preparedness in the absence of a current pandemic and on what WHO's role should be during an actual outbreak (see Box A-2).

BOX A-2
Recommendations and Lessons for Bolstering the Global System Support for Country-Level Core Capacities

Role of the World Health Organization (WHO) in Supporting Country Capacity

1. WHO should prepare a template pandemic preparedness plan for countries. (H5N1)
2. WHO should develop benchmarks for core capabilities and support countries' efforts to achieve them. (Ebola)
3. WHO needs to "establish a more extensive public health reserve workforce" (WHO, 2005). (H5N1)
4. WHO is mandated to serve as the guardian of the International Health Regulations, and it may require involvement from multiple levels of the organization to accomplish this mandate (e.g., national country offices, regional offices, and headquarters). (H7N9)
5. WHO needs to "work with existing regional and sub-regional networks to strengthen linkages and coordination; the ultimate goal is to enhance mutual support and trust" (Sands et al., 2016). (Ebola)
6. WHO and other international guidelines cannot adapt as fast as local knowledge and should not eclipse clinical judgment. Adequate feedback loops are required so that guidelines are dynamic and respond to on-the-ground realities. (MERS-CoV)

BOX A-2 Continued

Roles of Other Global Actors in Supporting Country Capacity

1. The UN Secretary-General should ensure a minimum level of health-system functionality in fragile and failed states. (H7N9)
2. "The International Monetary Fund (IMF) should include pandemic preparedness in countries' economic and policy assessments" (Sands et al., 2016). (Ebola)
3. All development assistance for health should be contingent on pandemic preparedness at the national level. (Ebola)

Public Health Emergency of International Concern (PHEIC)[a] Reporting

1. The PHEIC reporting mechanisms should be used for the duration of a pandemic to communicate updates throughout the event. (H7N9)
2. An intermediate level prior to a formal PHEIC would incentivize countries to express risk at earlier stages—without the risks associated with communicating a full PHEIC. (Ebola)

[a]"A PHEIC is an extraordinary event that constitutes a public health risk to other State Parties through the international spread of disease and that potentially requires a coordinated international response" (WHO, 2016a).

CATEGORY 2: RESEARCH, DEVELOPMENT, AND KNOWLEDGE SHARING

There has been a persistent failure of timely vaccine deployment and lack of global knowledge/data sharing over time. The papers reviewed, consistent with prior work, recognize that for both effectively preventing and mitigating outbreaks timely sharing of information of research and health technology efforts is critical. While this topic was less well explored than national core capacities or global governance, several papers have outlined problems with vaccine readiness, sample sharing, and other issues related to the handling of epidemiological, genomic, or clinical data both during as well as after pandemics.

In this review, we found that 8 out of the 16 papers contained content that addressed pharmaceutical research and development (R&D) or sample sharing and information sharing (see Box A-3).

BOX A-3
Recommendations and Lessons for Improving Research, Development, and Knowledge Sharing

Vaccine, Diagnostic, and Therapeutic Readiness

1. "Public health measures such as antivirals, vaccination, and nonpharmaceutical interventions must be performed in concert to reduce the impact of a future pandemic" (Lee et al., 2008). (H1N1 1957–1968)
2. Very rapid and highly sensitive tests, which "substantially reduce the number of individuals that need to be quarantined without decreasing the effectiveness of the measure, need to be developed" (Tan, 2006). (SARS)
3. The development of a pandemic vaccine should be expedited: "Shorten the time between the emergence of a pandemic virus and the start of commercial production" (Behrens et al., 2006). (H5N1)
4. Scientific understanding and technical capacity need to be improved, because both are currently fundamental constraints on pandemic preparedness. (H1N1)
5. A comprehensive influenza research and evaluation program should be pursued. (H1N1)
6. "Investment in medical research and development (R&D) for diseases that largely affect the poor is deeply inadequate. Of the $214 billion invested in health R&D globally in 2010, less than 2 percent was allocated to neglected diseases" (UN High-level Panel on the Global Response to Health Crises, 2016). (Ebola)
7. Research and development (R&D) should not be left to market forces: The Ebola outbreak exemplified "how ill-suited the medical research and development model is for addressing the world's health priorities" (Heymann et al., 2015). (Ebola)
8. Drug quality issues should be addressed: They pose "social, economic, and political challenges to health security by undermining capabilities to curb both infectious and noncommunicable diseases while eroding public confidence in governments and international institutions" (Heymann et al., 2015). (Ebola)
9. R&D "armory" should be built. It currently has "many gaps, which Ebola and other outbreaks have revealed, that span vaccine development and capacity, diagnostic tools, therapeutics, protective equipment, and anthropological research" (Sands et al., 2016). (Ebola)
10. Resources should be dedicated to "R&D on prioritized pathogens to ensure the greater availability of critical vaccines and treatments when they are most needed" (UN, 2016). (Ebola)

Delivery Capacity for Pharmaceutical and Medical Goods

1. An outbreak should be contained or delayed at the source. An international stockpile of antiviral drugs should be established, and mass delivery mechanisms for antiviral drugs should be developed. (H5N1)
2. There is a worldwide need for greater production capacity and for faster throughput. (H1N1)
3. Advanced agreements for vaccine distribution and delivery should be encouraged. (H1N1)
4. Significantly greater resources for medical products should be prioritized, mobilized, and deployed, and development and regulatory approval processes should be harmonized. (Ebola)

Sample and Knowledge Sharing

1. "The exchange of epidemiological information on infectious diseases, especially the emergence of new infections, should be strengthened between the health authorities in Mainland China and Hong Kong" (Hung, 2003). (SARS)
2. It is important to reach an agreement on the sharing of viruses. (H1N1, Ebola)

Synergies with One Health

1. Feedback loops should be developed between human and animal health. (Multiple)
2. "Most of the affected countries could not adequately compensate farmers for culled poultry, thus discouraging the reporting of outbreaks in rural areas where the vast majority of human cases have occurred" (WHO, 2005). (H5N1)
3. "Domestic ducks were able to excrete large quantities of a highly pathogenic virus without showing signs of illness. Their silent role in maintaining transmission further complicated control in poultry and made human avoidance of risky behaviors more difficult" (WHO Communicable Disease Surveillance and Response Global Influenza Programme, 2005). (H5N1)
4. More investment in "One Health research should be requested to enhance understanding of the emergence, prevention, detection, and control of pandemic influenza viruses" (Monath et al., 2010). (H1N1)

CATEGORY 3: WHO AND THE GLOBAL SYSTEM

Following the 2014 Ebola outbreak in West Africa, seven major reports agreed that reforms needed to be put in place to improve the global governance mechanisms within WHO and the broader UN and humanitarian systems to strengthen the global response capacity to these type of events. While the reports also agreed on maintaining the global preparedness and response functions for global disease outbreaks within WHO, they did not agree on how best to do this. Since Ebola, WHO has undergone a number of reforms—which we do not fully cover here. Rather, in this review, we look at what postpandemic reports have suggested as necessary changes. In line with prior work on this topic, we use sub-themes—for example, WHO's specific role in outbreaks, as well as internal suggestions regarding leadership and human resources (see Box A-4). This includes issues related to WHO's operational capacity to respond to disease outbreaks on the ground as well as broader institutional reforms to all multilateral organizations, such as financing, that may not be limited to emergencies or outbreaks (see Box A-5). There is some overlap with the category on national core capacities, but in that category we had focused on the role of WHO in supporting countries, while in this category, we take a systems view of the global governance mechanisms in place.

We found that 7 of the 16 papers addressed broader issues of the global governance system (items that might be addressed by cross-national bodies, such as WHO or the UN). The inclusion of this topic, recommendations related to the global system (UN, WHO, or other multilateral organizations), increased during and after the 2014 Ebola outbreak. Therefore, the majority of recommendations are from reports on, or following, the 2014 Ebola outbreak. Prior to this time, many reports were produced by agencies themselves with minimal inward-looking recommendations or critiques of the global health system, however defined.

BOX A-4
Recommendations and Lessons for Strengthening World Health Organization's (WHO's) Capacity

WHO Actions and Internal Capacity for Future Outbreaks

1. WHO needs to develop operational capacity. (Ebola)
2. WHO should build capacity to support low- and middle-income countries in the development of their own vaccine manufacturing capacity, and national pandemics preparedness plans. (H5N1)
3. Greater resources are needed to be able to improve WHO capacities, and this would require a profound organizational transformation. (Ebola)
4. WHO should establish a Program/Center for Health Emergency Preparedness and Response that is governed by an independent technical governing board. (H5N1, Ebola)
5. The role of WHO as a broker of knowledge—with the ability to respond more effectively when at odds with local, quickly developing knowledge—should be reinforced. (Ebola)
6. WHO should enhance cooperation with non-state actors while recalibrating relationships with member states and recognizing the distinct roles that each actor plays. (Ebola)

WHO Leadership and Human Resources

1. The new Director-General's critical role should be to refocus WHO's purpose and structure, and remain accountable for incident management within WHO. (Ebola)
2. WHO should revise how elections are conducted for WHO officials and should specifically improve transparency and the democratic nature of elections. (Ebola)
3. WHO should invest in training health professionals, especially community health workers. (Ebola)
4. WHO staff need to be qualified to manage outbreaks and emergencies. Health workforces should include a broad range of actors from multiple sectors working at different levels, rather than a single global workforce of "white helmets." (Ebola)
5. WHO should increase its staff. (Ebola)

BOX A-5
Recommendations and Lessons for Strengthening System-Wide Capacity

Operations (Internal and External to World Health Organization [WHO])

1. Existing institutions should be leveraged rather than creating new ones. (Ebola)
2. Actors need to coordinate more effectively with each other and to establish clear lines of command. (Ebola)
3. During health crises, humanitarian actors should have access to guidelines and standard operating procedures. (Ebola)
4. Health cluster capacities and integration need to be developed along with the overall humanitarian system. (Ebola)

Accountability

1. Regular independent assessments should be commissioned. (Ebola)
2. Sustainable Development Goals (SDGs) should be used to target indicators as a baseline for accountability. (Ebola)
3. WHO should be required to use existing resources more efficiently, report against specific outcomes, develop indicators to assess progress, and rigorously track expenditures. (Ebola)

Financing and Aid

1. Investments need to increase for building robust health systems. (Ebola)
2. WHO should mobilize international financial support for IHR core capacities strengthening. (Ebola)
3. Contributions should increase for WHO, and WHO should establish a contingency fund for these type of emergencies. (Ebola)
4. Funding for WHO's Emergency Program's baseline capacity should be secured through predictable and reliable financing streams, including assessed contribution and different from funding for specific responses. (Ebola)
5. Effective mechanisms are needed to help countries in need through institutions like the IMF and World Bank. Initiatives need to provide budgetary support and rapid credit availability. (Ebola)
6. The creation of World Bank's Pandemic Emergency Finance Facility should be supported. (Ebola)

CONCLUSION

We found that country-level core capacities were the most common subject covered by the reports in this review. In earlier reports, recommendations on core capacities were more thoroughly explored, and targeted advice was provided at the country level. Later reports, particularly those following the 2005 IHR, focused on the effective implementation of IHR as opposed to its component parts. However, domains across the reports were similar (e.g., preparedness, detection, and response), which may reflect the incorporation of earlier recommendations into the IHR in 2005. Another notable difference in later reports was a shift toward taking a wider lens view (e.g., recommendations to strengthen capacities across countries) and examining the need to tie together global health agendas, such as the IHR and universal health coverage (UHC), as a primary component of the SDGs. This trend aligns with an increase in the number of global health actors over time, which, in turn, likely increases the relevance of dialogue on global coordination and accountability for country preparedness.

While some reports covered issues such as health technologies, pharmaceutical readiness, deployment, or knowledge sharing (e.g., biological samples or results from trials), several others provided recommendations focused primarily on vaccine readiness. Specifically, many of the reports discussed the persistent failure of timely vaccine deployment and the lack of global knowledge-sharing norms around vaccines. Unlike their suggestions around country-level core capacities, recommendations on vaccine readiness resulting from outbreaks over time were generally consistent, which suggests broader challenges have yet to be addressed in this domain. There have, however, been notable efforts to address these recommendations more recently (e.g., the Coalition for Epidemic Preparedness Innovations, the WHO's R&D "Blueprint," and other efforts summarized by Leigh et al. [2018]). Additionally, across reports, systems for the delivery of pharmaceuticals and other medical technologies were noted as impediments to effective response. However, authors offered few recommendations to improve delivery capacity or to engage other actors, such as the private sector or military, in doing so. Content on R&D differed among reports depending on disease context. For example, following influenza outbreaks, discussions included a focus on One Health and on the need to better align human and animal R&D strategies. This was not true for Ebola reports, where the zoonotic nature of the disease was less well understood. In line with country-level capacity recommendations, this category may benefit from a more dynamic approach to readiness given the diversity of medical technologies needed. Such an approach could include familiarizing ministries of health and other key actors with multiple scenarios so that outbreak responses are adaptive to disease types.

For reports following the 2014 Ebola outbreak, there was a notable increase in discussion of and recommendations regarding global governance mechanisms for health. As noted above, this may stem from diversification of the global health landscape over time and from the empowerment of additional global actors, such as those in academia, civil society, and the private sector, to assess and to comment on global performance—including WHO's performance. This category, which addresses accountability at a multinational level, is particularly relevant given the current Ebola outbreak in the Democratic Republic of the Congo. When faced with fragile or failed states, a focus on national core capacities alone becomes starkly inadequate. The global system should help countries as they develop and maintain core capacities on the ground but also should oversee global accountability, ensure clear and accurate knowledge transfer, and assume other roles that a single country cannot fill. This can be a delicate balance, and report recommendations highlighted the importance of ensuring that global guidelines do not eclipse local, real-time understandings of disease. This has been a consistent challenge to effective global and local response. Common recommendations included the need to better delineate roles and responsibilities, improve coordination, ensure accountability mechanisms, and consider drivers of trust in the relevant institutions.

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TABLE A-1 Category 1a: Country-Level Core Capacities—National Core Capacities

				National Core Capacities		
Publication	Disease	Year of Outbreak	Outlet	Prevent/Prepare	Detect	Respond (Treat and Control)
Twentieth Century Influenza Pandemics in Singapore	H1N1	1957–1968	*Annals Academy of Medicine Singapore*		(R) Identify the onset of the pandemic for early intervention (however, influenza remains a difficult surveillance target because it manifests in a variety of non-specific symptoms) (R) Collect viral samples in a routine way. If a pandemic originates in less developed regions with high baseline mortality rates, the signal may be missed (R) Focus global surveillance efforts on frontline efforts in East Asian farms	(R) Give protection and treatment priority to health care workers to enable them to perform their duties
The SARS Epidemic in Hong Kong: What Lessons Have We Learned?	SARS	2003	*Journal of the Royal Society of Medicine*			(B) Inadequate epidemiological information about the disease hampered the prompt application of effective control measures (B) Lack of specified infectious disease hospitals led to difficulties in designating hospitals for the isolation and treatment of SARS patients (B) Deficient communication between the secretary (ministry) level responsible for health policy and the management level responsible for operation of hospitals
SARS in Singapore—Key Lessons from an Epidemic	SARS	2003	*Annals Academy of Medicine Singapore*		(F) MOH adopted wide-net surveillance, isolation, and quarantine policy to detect all suspicious cases as early as possible and to isolate them (F) Temperature screening in hospitals and in the community (e.g., preventing the importation and exportation of SARS through temperature screening at the airport and sea ports)	(F) Major containment efforts were concentrated on hospitals (SARS was predominantly a nosocomial infection) (F) Early separation of potentially infectious patients (F) Enforced use of personal protective equipment for all hospital staff and the adoption of strict infection-control measures, including temperature monitoring of all hospital staff (F) Designation of one SARS hospital allowed the clinicians at that site to develop strong clinical expertise

						(R) Contain public anxiety and re-direct this energy into positive community bonding and action (R) Enact a strong and effective command, control, and coordination of responses
Responding to the Avian Influenza Pandemic Threat	H5N1	2003	*WHO Communicable Disease Surveillance and Response Global Influenza Programme*		(R) Use WHO, FAO, and OIE jointly established Global Early Warning and Response System for trans-boundary animal diseases (R) Develop infrastructure to complement national testing with rapid international verification in WHO-certified laboratories, especially as each confirmed human case yields information essential to risk assessment	(R) Prioritize interventions in the backyard rural farming system "wet markets" where live poultry are sold in overcrowded and often unsanitary conditions (R) Strengthen risk communication to rural residents (R) Generate better knowledge on animal and human disease through WHO, in collaboration with FAO and OIE, to make risk communication more precise and better able to prevent risky behavior (R) Identify risk groups to guide preventive measures and early interventions (R) Health authorities should start a continuous process of risk communication to the public as soon as pandemic is declared (R) Monitor the effectiveness of health and nonhealth interventions in real time
Pandemic Preparedness and Response—Lessons from the H1N1 Influenza of 2009	H1N1	2009	*New England Journal of Medicine*	(R) Accelerate the implementation of the IHR (2005) core capacities	(F) Web-based search patterns can yield valuable intelligence that can give the world a head start on the next emerging pandemic	

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Influenza A (H1N1-2009) Pandemic in Singapore—Public Health Control Measures Implemented and Lessons Learnt	H1N1	2009	*Annals Academy of Medicine Singapore*	(F) When previous DORS framework was not applicable to H1N1-2009, both MOH and its stakeholders had to reframe and relearn the context of public health control measures mid-response (F) Stakeholders benefited from the flexibility to assess and take appropriate measures locally (R) Ensure better planning for multiple scenarios and less rigidity in plans (R) MOHs should familiarize themselves with different suites of measures, which could be implemented in a modular fashion (R) Invest in an effective primary care response, which can prevent the overloading of emergency departments in times of acute need	(F) Local disease surveillance systems are critically important to informing pandemic situations (e.g., monitoring the progression of the pandemic in the community, identifying the start of sustained community transmission, and guiding the step-down of containment measures) (F) At-home learning or work-from-home options helped decrease risk when transmission was high (R) Work with clinics and community, not only large hospitals, to assess true prevalence of disease (R) Nonhealth care establishments (e.g., schools and businesses) should be involved in temperature and symptom screenings	(F) National Influenza Pandemic Readiness and Response Plan developed for SARS was useful in responding to H1N1 (F) Framework for organizing/coordinating "whole of government" strategy and creation of crisis management groups (F) Dedicated ambulance service created for suspected patients (F) A dedicated government website on influenza also facilitated the public's easy access to information (R) Consider DORS as a guide for increasing or scaling down response (R) Have a core group of clinicians (comprising public health, infectious disease, microbiology, and respiratory medicine specialists) meet regularly to review epidemiological and clinical information to make decisions (R) Develop real-time, targeted public health "operational" research to determine the effectiveness of specific public health policies and control measures (R) Work toward building trust among stakeholders, as well as a degree of system discipline. This must be developed and built in peacetime (R) Generate creative personnel strategies that will help to build and maintain health care surge capacity in peacetime
Lessons from Pandemic H1N1 2009 to Improve Prevention, Detection, and Response to Influenza Pandemics from a One Health Perspective	H1N1	2009	*ILAR Journal*		(R) Develop an effective global, strategic, integrated surveillance and response system (which requires human, animal, and environmental health professionals to work together for earlier detection and disease control) (R) Establish more comprehensive surveillance for infection and disease in occupational groups that work most closely with animals (i.e., poultry and swine workers, live market workers	(B) Misunderstandings of the relationship between pigs and H1N1 led to unnecessary confusion and policy action, such as trade bans on the sale of meat (R) Move away from naming flu strains based on potential animal hosts

					and vendors, abattoir workers, veterinarians, and animal health technicians)	
Pandemic Response Lessons from Influenza H1N1 2009 in Asia	H1N1	2009	*Respirology*	(R) Develop integrated analyses that combine microbiological/virological, immunological, clinical, epidemiological, and genetic data for comprehensive assessment of host–emerging pathogen interactions	(R) Strengthen timeliness of data management and risk assessments for identifying unusual clusters (e.g., high death rates) and initiating appropriate responses	(B) Planning and hierarchy of intensive care and high dependency units across Asia were inadequate and slowed the response (R) Need for practical and tested hospital and inter-hospital level response plans for public health emergencies and mass casualty events (R) Need for systems above the hospital level that allow for coordinated management of beds and other finite resources including equipment and manpower (R) Focus on risk communication when containment measures do not work (R) Establish a two-way communication system between administration and clinical providers to coordinate protocol dissemination and resources (R) Improve preexisting infection control practices
Early Response to the Emergence of Influenza A (H7N9) Virus in Humans in China: The Central Role of Prompt Information Sharing and Public Communication	H7N9	2013	*Bulletin of the World Health Organization*	(R) Strengthen coordination between public health and veterinary services during an emergency by engaging in joint preparedness planning beforehand	(R) Strengthen the relevant infrastructures, surveillance systems, and response capacity in preparation for future emergencies caused by emerging or existing disease threats	
Avian Influenza A (H7N9) Response: An Investment in Public Health Preparedness	H7N9	2013	WHO Publication	(F) Notable initiatives undertaken by China included enhancing public health emergency planning, establishing a Web-based reporting system, and strengthening the National Influenza Center as one of the six WHO collaborating centers	(R) Leverage surveillance capacity developed through previous events (e.g., SARS)	(F) Combined efforts of the human and animal health sectors through mutual sharing of information, close and timely communication, and coordinated response (F) Rumors spread faster than the virus itself, so a coordinated social media strategy was key to keeping the public up to date (R) Establish country–WHO partnerships, such as the China–WHO mission, to allow WHO to learn from people on the frontline and allow people on the frontline to communicate information quickly to regional actors

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Global Health Security: The Wider Lessons from the West African Ebola Virus Disease Epidemic	Ebola	2014	*The Lancet*	(F) Enhanced pharmacovigilance and quality assurance composed two broad policy responses that were essential to coordinate across governments		
A Wake Up Call: Lessons from Ebola for the World's Health Systems	Ebola	2014	*Save the Children Publication*	(R) Make public commitments to building universal health coverage, with little or no direct payments at the point of use, and promote the accountability of government and of health service providers (R) Increase investment in comprehensive health services, starting with primary care, and prioritize essential services, such as infectious disease outbreaks, and maternal and child health (R) Increase public finances by raising fair taxation, and clamping down on tax avoidance and evasion (R) Strengthen and invest in national preparedness plans for possible outbreaks of infectious diseases. Plans should comprise public health surveillance, alert and referral systems, and supply chain systems that can rapidly procure and/or distribute medical equipment and drugs in emergencies		(F) Under-resourced, understaffed, and fragmented health services are unable to contain outbreaks of serious infectious diseases or adequately respond to health emergencies
Middle East Respiratory Syndrome Coronavirus (MERS-CoV): What Lessons Can We Learn?	MERS-CoV	2013	*Journal of Hospital Infection*	(B) Poor prognosis associated with MERS-CoV, especially in patients with multiple comorbidities, and the lack of effective antiviral therapy make appropriate infection prevention and diagnosis challenging	(R) Reinforce dynamics of continuous vigilance and perseverance with diagnostic investigation of undiagnosed infectious diseases	(R) Update guidelines regularly, and incorporate local knowledge from the ground (R) Facilitate the communication of epidemiological, medical, and scientific developments in addition to presenting the public with factual material, timely updates, and relevant advice

NOTES: DORS = disease outbreak response system; FAO = Food and Agriculture Organization of the United Nations; IHR = International Health Regulations; ILAR = Institute for Laboratory Animal Research; MERS-CoV = Middle East respiratory syndrome coronavirus; MOH = Ministry of Health; OIE = World Organisation for Animal Health; SARS = severe acute respiratory syndrome; WHO = World Health Organization.
13 of 16 publications had relevant findings for this category and were included.

Key:
(B) Barriers to pandemic preparedness and response.
(F) Facilitators to pandemic preparedness and response.
(R) Recommendations for implementation moving forward.

TABLE A-2 Category 1b: Country-Level Core Capacities—Core Capacity Enablers

Publication	Disease	Year of Outbreak	Outlet	Accountability and PHEIC Reporting	Role of WHO and HSS	Regional and Non-WHO Global Actors	Trade and Travel
SARS in Singapore—Key Lessons from an Epidemic	SARS	2003	*Annals Academy of Medicine Singapore*	(F) Regular audits by MOH teams, supplemented by internal audits by hospitals, helped ensure a high level of compliance			
Responding to the Avian Influenza Pandemic Threat	H5N1	2003	*WHO Communicable Disease Surveillance and Response Global Influenza Programme*	(R) Give risk-prone countries an incentive to collaborate internationally	(R) WHO to establish a surveillance program for antiviral susceptibility testing, modeled on a similar program for anti-tuberculosis drugs (R) WHO to monitor the unfolding epidemiological and clinical behavior of the new virus in real time (R) WHO to prepare a template pandemic plan, which will give many developing countries a head start in national pandemic preparedness planning		
Pandemic Preparedness and Response—Lessons from the H1N1 Influenza of 2009	H1N1	2009	*New England Journal of Medicine*		(R) WHO to ensure necessary authority and resources for all national focal points (R) WHO to revise and streamline the management of pandemic preparedness guidance (R) WHO to establish a more extensive public health reserve workforce globally		(R) Reinforce evidence-based decisions on international travel and trade
Influenza A (H1N1-2009) Pandemic in Singapore—Public Health Control Measures	H1N1	2009	*Annals Academy of Medicine Singapore*		(F) WHO created a model country plan with the goal of giving developing countries a framework to assess their status		(R) Push nonhealth government sectors involved in mounting a "whole of government" response to the H1N1-2009 pandemic to include border

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Implemented and Lessons Learnt					of preparedness and to identify priority needs (R) WHO to provide support to countries in rehearsing these plans during simulation exercises		control (temperature screening, health declaration cards, and health alert notices for travelers), trade, and industry
Early Response to the Emergence of Influenza A (H7N9) Virus in Humans in China: The Central Role of Prompt Information Sharing and Public Communication	H7N9	2013	*Bulletin of the World Health Organization*	(R) Release any results of risk assessments as well as other epidemic-related data promptly and publicly	(F) WHO and China's National Health and Family Planning Commission jointly coordinated the response mission by internationally recognized influenza experts (R) WHO to strengthen relevant infrastructures, surveillance systems, and response capacity in preparation for future emergencies		
Avian Influenza A (H7N9) Response: An Investment in Public Health Preparedness	H7N9	2013	WHO Publication	(R) Establish transparent and open channels of communication with the global community, including regular situation updates (R) Support the continued use of IHR (2005) reporting mechanisms throughout the event in order to provide timely updates for relevant stakeholders and the public (e.g., EIS and DON)	(F) WHO activated an organization-wide mechanism involving the three levels of WHO from the country to regional to headquarters offices (F) The ERF provided guidance in line with emergency management system and ensured adequate human resource surge capacity for monitoring and assessment (F) The EOC at the regional office was the common platform used to coordinate the response (R) As a guardian of IHR (2005) WHO to coordinate and support the H7N9 response	(F) The Western Pacific regional office developed a framework for action for national health authorities to highlight areas of public health emergency response that may need specific action for avian influenza A (H7N9)	
Global Health Security: The Wider Lessons from the West African Ebola	Ebola	2014	*The Lancet*	(R) Use GHSA to make rapid progress in strengthening collective health security through country and inter-country		(R) Address future threats to health security comprehensively based on deeper understanding of prevention and	

Virus Disease Epidemic				capacities to prevent, detect, and respond to infectious disease threats; independent evaluations are crucial to accelerate progress		remediation of human security (R) Broaden approach beyond the IHR (2005); simply taking the IHR (2005) to a next step is too weak and narrow as an approach (R) Develop an initiative to drive better health within corporations	
The Neglected Dimension of Global Security: A Framework for Countering Infectious Disease Crises	Ebola	2014	*New England Journal of Medicine*	(R) Make all development assistance for health system strengthening contingent on country agreement to assessment (R) Countries to develop and publish plans to achieve benchmarks by 2020 (R) Create an intermediate alert level before declaring a PHEIC (R) Develop a daily high-priority "watch list" of outbreaks with potential to become PHEIC, summary to be published weekly	(R) Develop benchmarks for core capabilities and support countries in achieving them (R) Work with existing regional and sub-regional networks to strengthen linkages and coordination enhancing mutual support and trust, sharing of information and laboratory resources, and joint outbreak investigations among neighboring countries	(R) World Bank to convene funders to support lower-middle and low-income countries to achieve IHR (2005) core capacities (these countries should also develop plans for eventual financial self-sufficiency) (R) IMF to include pandemic preparedness in countries' Economic and Policy Assessments (R) UNSG to ensure minimal health systems functioning in fragile and failed states	(R) The proposed WHO Emergency Centre should create protocols to dissuade member states and the private sector from implementing unnecessary restrictions on trade and travel; WHA to implement
A Wake Up Call: Lessons from Ebola for the World's Health Systems	Ebola	2014	*Save the Children Publication*	(R) Civil society should engage with tax processes and advocate for progressive tax reforms and increased transparency (R) Civil society should monitor domestic		(R) Ensure that aid and global support is increased and better aligned to help build suitable and comprehensive health services, and increase	

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			budgets to track resource flows and advocate for increased and more equitable revenue and health expenditure (R) The SDGs should commit the world to support UHC, alongside priorities such as ending preventable maternal, newborn, and child deaths (R) The SDGs should aim (via target indicators) for universal coverage of key health services and for financial risk protection and should ensure that targets apply to all social groups		public financing for health (R) Ensure the multilateral initiatives—such as the Gavi, the Vaccine Alliance, the Global Fund, and the new proposed Global Financing Facility for reproductive, maternal, and child health—are aligned to support comprehensive and universal health services and can demonstrate that they are doing this (R) Implement domestic and international reforms to curb illicit financial flows and tax avoidance (R) Strengthen and respect the IHR (2005) and support globally coordinated support for health emergencies	
Protecting Humanity from Future Health Crises: UNSG's High Level Panel on Global Response to Health Crises	Ebola	2014	*UNGA Publication*	(R) IHR Review Committee to develop mechanisms to rapidly address violations of PHEIC temporary recommendations (R) All countries to fulfill full IHR (2005) compliance by 2020 (R) WHO to perform periodic compliance review through an "independent field-based assessment"	(R) WHO to work with existing regional and sub-regional networks to strengthen linkages and coordination, and thus to enhance mutual support and trust, sharing of information and laboratory resources, and joint outbreak investigations among neighboring countries (R) WHO regional directors to answer to WHO Emergency Centre ED in emergencies (R) WHO to lead efforts to mobilize international financial	(R) World Bank should convene funders to support lower-middle and low-income countries to achieve IHR (2005) core capacities; these countries should develop plans for eventual financial self-sufficiency (R) Regional and sub-regional organizations to develop or strengthen standing capacities to monitor, prevent, and respond to health crises	(R) IHR Review Committee to develop mechanism to address undue adoption of trade and travel bans (R) WTO and WHO to establish a commission of experts to increase coherence between the IHR (2005) and the WTO legal regime regarding trade restrictions imposed for public health reasons

				(R) Global community to perform country reviews on rotating basis (R) Mobilize domestic and international funding to support IHR (2005) core capacity compliance	support for building IHR (2005) core capacities		

NOTES: DON = disease outbreak news; ED = executive director; EIS = epidemic intelligence service; EOC = emergency operations centers; ERF = emergency response framework; GHSA = Global Health Security Agenda; HSS = health systems strengthening; IHR = International Health Regulations; IMF = International Monetary Fund; MOH = Ministry of Health; PHEIC = public health emergency of international concern; SARS = severe acute respiratory syndrome; SDG = Sustainable Development Goal; UHC = universal health coverage; UNGA = United Nations General Assembly; UNSG = United Nations Secretary-General; WHA = World Health Assembly; WHO = World Health Organization; WTO = World Trade Organization.
10 of 16 publications had relevant findings for this category and were included.

Key:
(B) Barriers to pandemic preparedness and response.
(F) Facilitators to pandemic preparedness and response.
(R) Recommendations for implementation moving forward.

TABLE A-3 Category 2: Research and Development

Publication	Disease	Year of Outbreak	Outlet	Vaccine, Diagnostic, and Therapeutic Readiness	Delivery Capacity for Pharmaceutical and Medical Goods	Sample Sharing and Knowledge Sharing	Synergies with One Health
Twentieth Century Influenza Pandemics in Singapore	H1N1	1957–1968	*Annals Academy of Medicine Singapore*	(R) Use the increased knowledge of influenza, and the availability of antivirals (and possibly prepandemic vaccines), to further reduce the impact of a future pandemic by combining pharmaceutical and non-pharmaceutical interventions based on available evidence (R) Perform public health measures, such as antivirals, vaccination, and non-pharmaceutical interventions, to reduce the impact of a future pandemic (R) Develop vaccines that can improve heterotypic immunity, better techniques for vaccine production, and more effective antiviral therapies which may reduce the pandemic's spread			
The SARS Epidemic in Hong Kong: What Lessons Have We Learned?	SARS	2003	*Journal of the Royal Society of Medicine*		(R) Strengthen the exchange of epidemiological information on infectious diseases, especially the emergence of new infections, between the health authorities in Mainland China and Hong Kong		
SARS in Singapore—Key Lessons from an Epidemic	SARS	2003	*Annals Academy of Medicine Singapore*	(R) Develop very rapid and highly sensitive tests for SARS infection, which would substantially reduce the numbers of individuals that need to be quarantined without decreasing the effectiveness of the measure			

Responding to the Avian Influenza Pandemic Threat	H5N1	2003	*WHO Communicable Disease Surveillance and Response Global Influenza Programme*	(R) Expedite the development of a pandemic vaccine (shorten the time between emergence of a pandemic virus and the start of commercial production, and increase the supply of influenza vaccines) (R) Improve approaches to environmental detection of the virus (R) Assist developing countries that plan to manufacture their own vaccines	(R) Contain or delay spread at the source by establishing an international stockpile of antiviral drugs, developing mass delivery mechanisms for antiviral drugs, and conducting surveillance of antiviral susceptibility	(R) Compile and compare clinical data on human cases in order to elucidate modes of transmission, identify groups at risk, and find better treatments	(B) Most affected countries were not able to adequately compensate farmers for culled poultry. This discouraged reporting of outbreaks in rural areas where the majority of human cases occurred (B) Domestic ducks were able to excrete large quantities of pathogenic virus without showing signs of illness. Their silent role maintained transmission and further complicated control in humans and poultry
Pandemic Preparedness and Response—Lessons from the H1N1 Influenza of 2009	H1N1	2009	*New England Journal of Medicine*	(R) Ensure better antiviral agents and more effective influenza vaccines, greater production capacity, and faster throughput (R) Pursue a comprehensive influenza research and evaluation program (R) Improve scientific understanding and technical capacity (beyond institutional, political, and managerial difficulties)	(R) Develop better antiviral agents and more effective influenza vaccines, greater production capacity, and faster throughput (R) Recommend encouraging advance agreements for vaccine distribution and delivery	(R) Reach an agreement on the sharing of viruses, access to vaccines, and other benefits	
Influenza A (H1N1-2009) Pandemic in Singapore—Public Health Control Measures	H1N1	2009	*Annals Academy of Medicine Singapore*			(F) Frequent information reviews guided local decisions on the implementation	

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Implemented and Lessons Learnt						of public health control measures	
Lessons from Pandemic H1N1 2009 to Improve Prevention, Detection, and Response to Influenza Pandemics from a One Health Perspective	H1N1	2009	*ILAR Journal*				(R) Invest in One Health research to enhance understanding of the emergence, prevention, detection, and control of pandemic influenza viruses
Avian Influenza A (H7N9) Response: An Investment in Public Health Preparedness	H7N9	2013	WHO Publication			(R) Ensure that the timely release of data does not jeopardize future publication of the data in scientific journals	
Global Health Security: The Wider Lessons from the West African Ebola Virus Disease Epidemic	Ebola	2014	*The Lancet*	(R) Address issues of drug quality, which pose social, economic, and political challenges to health security by undermining ability to address diseases while eroding public confidence in governments and international institutions (R) Prevent market forces from being the only driver of medical research			
The Neglected Dimension of Global Security: A Framework for Countering Infectious Disease Crises	Ebola	2014	*New England Journal of Medicine*	(R) Need to address the many gaps in our R&D armory, as Ebola and other outbreaks have shown, which range from vaccine development and capacity, diagnostic tools, therapeutics, and protective equipment to anthropological research. Relying on the disparate efforts of the R&D community—academia, government, industry, and civil society—has not worked	(R) Enhance our scientific armory against infectious disease, including prioritization, mobilization, and deployment of significantly greater resources and harmonization of development and regulatory approval processes		

Protecting Humanity from Future Health Crises: UNSG's High Level Panel on Global Response to Health Crises	Ebola	2014	*UNGA Publication*	(B) Investment in medical R&D for diseases that largely affect the poor is deeply inadequate. Of the $214 billion invested in health R&D globally in 2010, less than 2 percent was allocated to neglected diseases (R) Dedicating resources to R&D on prioritized pathogens will ensure the greater availability of critical vaccines and treatments when they are most needed			

NOTES: ILAR = Institute for Laboratory Animal Research; R&D = research and development; SARS = severe acute respiratory syndrome; UNGA = United Nations General Assembly; UNSG = United Nations Secretary-General; WHO = World Health Organization.
11 of 16 publications had relevant findings for this category and were included.

Key:
(B) Barriers to pandemic preparedness and response.
(F) Facilitators to pandemic preparedness and response.
(R) Recommendations for implementation moving forward.

TABLE A-4 Category 3—Global Governance

				System Wide			WHO		
Publication	Disease	Year of Outbreak	Outlet	Cooperation and Operational Response	Accountability	Financing/Aid	New Bodies and Actions for Future Outbreaks	Function and Role	Leadership/Human Resources
Avian Influenza A (H7N9) Response: An Investment in Public Health Preparedness	H7N9	2013	WHO Publication				(F) The WHO Western Pacific regional office developed a framework for national health authorities to highlight areas of public health emergency response that may need specific action for avian influenza (the framework was based on the Asia Pacific Strategy for Emerging Diseases [2010], which covered the key technical areas [e.g., command and control, surveillance, risk assessment, etc.])		
The Neglected Dimension of Global Security: A Framework for Countering Infectious Disease Crises	Ebola	2014	*New England Journal of Medicine*	(R) WHO and UN to establish clear mechanisms for coordination and escalation in health crises (R) Use existing institutions rather than creating new bodies (e.g., United Nations Mission for Ebola Emergency Response)	(R) Commission an independent assessment in 2017 and then every 3 years following 2017	(R) IMF to develop capacity to provide budgetary support to governments that raise outbreak alerts through the existing Rapid Credit Facility (R) Develop a World Bank Pandemic Emergency Facility	(R) WHO to establish a WHO Centre for Health Emergency Preparedness and Response governed by independent technical governing board (R) WHO Emergency Centre to coordinate global health emergency workforce by strengthening and expanding GOARN	(R) WHO to take the lead in the global system to identify, prevent, and respond to potential pandemics (R) WHO to increase its capability and resources while demonstrating better leadership across actors (R) WHO to enhance means of cooperation with non-state actors, including local and	(R) Next DG should reenergize and refocus WHO on core priorities and on relationship building with other actors, such as other multilateral agencies and non-state actors; (R) Next DG needs stature and courage to engage with other global leaders, accept accountability, and hold countries accountable

								international civil society organizations, the private sector, and the media	
A Wake Up Call: Lessons from Ebola for the World's Health Systems	Ebola	2014	*Save the Children Publication*	(R) Develop disease surveillance systems with strong regional networks for better forecasting and control	(R) Use SDG target indicators to hold globe accountable to UHC (key health services) and for financial risk protection (R) Ensure that SDG targets apply to all social groups in a country and are not just reported as national averages (e.g., "no target met unless met for all") (R) Civil society to monitor domestic budgets to track resource flows and to advocate for increased and more equitable revenue in	(R) Ensure that aid and global support is increased and better aligned to help build suitable and comprehensive health services, and increase public financing for health (R) Ensure that multilateral initiatives are aligned to support comprehensive and universal health services and can demonstrate that they are doing this (R) Implement domestic and international reforms to curb illicit financial flows and tax avoidance			(R) WHO to revise how elections are conducted for WHO officials, specifically: improve transparency and democratic nature of elections

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					global health expenditure				
Protecting Humanity from Future Health Crises: UNSG's High Level Panel on Global Response to Health Crises	Ebola	2014	*UNGA Publication*	(R) Reinforce a clear line of command throughout the UN system (e.g., WHO DG reports to UNSG, WHO regional directors report to WHO Emergency Centre ED, ED to become UNSG's Emergency Coordinator) (R) Integrate UN health and humanitarian crisis trigger systems e.g., ERF Grade 2 or 3 heath crisis automatically triggers an interagency multisectoral assessment		(R) Increase assessed contributions to WHO by at least 10 percent with a share mandatorily directed to support the proposed Emergency Centre (R) Build a "Contingency Fund" of at least $300 million by 2016 that is financed according to assessment scale and managed by the proposed Emergency Centre (to be immediately replenished when depleted) (R) Guarantee that aid is disbursed according to Paris Declaration principles, especially alignment of support, harmonization, and mutual accountability (R) Support the creation of a World Bank Pandemic Emergency Financing Facility (national governments should decide how funds are spent in-country)	(R) WHO to establish a WHO Centre for Emergency Response with a multisectoral advisory board (R) WHO Emergency Centre and Inter-Agency Standing Committee to establish Standard Operating Procedures for humanitarian actors in health crises (R) WHO Emergency Centre to incorporate GOARN and foreign medical team programs in coordinating the global health emergency workforce	(R) WHO to serve as the single global health leader, determining and executing global health priorities (R) WHO to build unified and effective operational capacity (R) WHO to work closely with development actors to ensure complementarity between development programs and efforts to build health care systems and public health (R) WHO to establish a culture of emergency response and to develop the capacity and instinct to lead major operations	(R) WHO to increase investment in training health professionals at national level (especially community health workers)

Report 2: Advisory Group on Reform of WHO's Work in Outbreaks and Emergencies	Ebola	2014	*WHO*	(R) WHO to work with health cluster partners to build dedicated capacity for coordination, planning, information management, and communications (R) Integrate cluster partners' capacities in emergency operations (R) Articulate linkages between the Emergency Program, the Health Clusters, and overall humanitarian system		(R) Fund Emergency Program baseline capacity through predictable and reliable financing streams, including assessed contributions (this money should be different from emergency funds deployed in specific responses) (R) Maximize the use of existing funding mechanisms, such as the Central Emergency Response Fund, to support emergency operations (R) Seek full capitalization of the Contingency Fund	(R) WHO to develop the internal capacity to function as an operational organization (R) WHO to define and promote acceptance of common professional standards on health interventions, on sharing information and handling personal health data, and on building robust capacity for systematized information management and protocols for information sharing	(R) WHO to develop the capacity to function as and position itself as an operational organization since working in outbreaks and emergencies is part of WHO's core mandate (R) Reflect WHO's mandate (working in outbreaks and emergencies) in the focus of its governing bodies (R) Demonstrate that WHO is independent and impartial while reviving and improving relationships with member states and partners (R) Engage in a profound organizational transformation rather than piecemeal reform (i.e., a single merger of organizational units within WHO will not suffice; it will need new organizational	(R) Next DG should remain accountable for incident management within WHO (R) Ensure that WHO's mandate to work in outbreaks and emergencies is reflected in the capabilities of its staff (R) WHO to facilitate the diversification of the health workforce: engaging multiple actors from multiple sectors and at multiple levels, rather than a single global workforce of "white helmets" (R) WHO to increase its staff

continued

								structures and procedures)	
Middle East Respiratory Syndrome Coronavirus (MERS-CoV): What Lessons Can We Learn?	MERS-CoV	2013	*Journal of Hospital Infection*		(R) Global system to ensure adequate assessment of patients presenting with febrile illness prior to international air travel		(R) WHO to act as a knowledge broker: WHO guidelines should not prevail over clinical judgment during a pandemic because such guidelines are inevitably based on incomplete evidence		

NOTES: DG = director-general; ED = executive director; ERF = emergency response framework; GOARN = Global Outbreak Alert and Response Network; IMF = International Monetary Fund; MERs-CoV = Middle East respiratory syndrome coronavirus; SDG = Sustainable Development Goal; UHC = universal health coverage; UN = United Nations; UNGA = United Nations General Assembly; UNSG = United Nations Secretary-General; WHO = World Health Organization.
6 of 16 publications had relevant findings for this category and were included.

Key:
(B) Barriers to pandemic preparedness and response.
(F) Facilitators to pandemic preparedness and response.
(R) Recommendations for implementation moving forward.