REVIEW

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Policy and planning for large epidemics and pandemics – challenges and lessons learned from COVID-19

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Purpose of review
The COVID-19 pandemic is a global catastrophe that has led to untold suffering and death. Many previously identified policy challenges in planning for large epidemics and pandemics have been brought to the fore, and new ones have emerged. Here, we review key policy challenges and lessons learned from the COVID-19 pandemic in order to be better prepared for the future.

Recent findings
The most important challenges facing policymakers include financing outbreak preparedness and response in a complex political environment with limited resources, coordinating response efforts among a growing and diverse range of national and international actors, accurately assessing national outbreak preparedness, addressing the shortfall in the global health workforce, building surge capacity of both human and material resources, balancing investments in public health and curative services, building capacity for outbreak-related research and development, and reinforcing measures for infection prevention and control.

Summary
In recent years, numerous epidemics and pandemics have caused not only considerable loss of life, but billions of dollars of economic loss. The COVID-19 pandemic served as a wake-up call and led to the implementation of relevant policies and countermeasures. Nevertheless, many questions remain and much work to be done. Wise policies and approaches for outbreak control exist but will require the political will to implement them.

Keywords
COVID-19, epidemics, pandemics, planning, policy, SARS-CoV-2

INTRODUCTION

The COVID-19 pandemic is a global catastrophe that has led to untold suffering and death. Many previously identified policy challenges in planning for large epidemics and pandemics have been brought to the fore [1], and new ones have emerged. Here, we review key policy challenges and lessons learned from the COVID-19 pandemic in order to be better prepared for the future.

PANDEMICS, THE HUMAN RIGHT TO HEALTH AND EQUITABLE SHARING OF BENEFITS

Pandemic impacts extend far beyond individual health, touching every sector of life and society. The COVID-19 pandemic has threatened the human right to health [2], highlighted underlying inequities, and disproportionately impacted already disadvantaged groups who have a high prevalence of co-morbidities and those with limited access to testing and vaccines [3▪]. Uneven mortality rates

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KEY POINTS

- Pandemic preparedness requires us to take a broad view of global health security that incorporates universal health coverage, noncommunicable diseases, sustainable development and human rights, investing in up-stream interventions that address multiple societal aims.
- There is a need for a more stable funding commitment and financing mechanism for both efficient emergency response and long-term preparedness.
- Pandemic preparedness and response touch many ethical issues, including the relationship between the individual and the state, and there is no one-size-fits-all approach.
- The world needs to develop a rapid and comprehensive research ecosystem and strengthen mechanisms for evidence-based policy-making that can handle uncertainty, which will require stronger institutionalization of public health functions and strengthening of global cooperation and coordination mechanisms.

have often been driven by preexisting inequities, mainly social and economic, which have themselves been exacerbated by the pandemic response [4]. Societal stresses brought about by the pandemic have heightened racism around the world [5], especially toward Asians. Progress toward achievement of the sustainable development goals, themselves important for better pandemic preparedness, has been impeded [6,7]. Better pandemic preparedness is dependent on recognizing, committing to, and investing in health as a human right. In addition to the obvious moral imperative of such an investment, COVID-19 has made clear the strategic advantages with regard to ensuring economic and general societal health and the additional risks that result from poverty and the absence of social protection.

Rapid research and evidence generation has led to unprecedented achievements in the development of diagnostics, vaccines and, to a lesser extent, therapeutics for COVID-19. However, despite the rapidity of clinical trials demonstrating efficacy for numerous COVID-19 vaccines, their accelerated production, and establishment of the COVAX Facility – a collective procurement and distribution scheme designed to assure equitable access – to date only 1% of the population in low-income countries has been vaccinated, compared with 43% in high-income countries (Fig. 1) [8]. There remain many gaps in achieving an end-to-end research and development ecosystem that can ensure rapid development and equitable access to the benefits from research, especially with regard to countermeasure products [9▪].

Future pandemic preparedness will require greater global health equity, with more health and public health capacity in low- and middle-income countries (LMICs), reducing dependence on international stakeholders who, through the

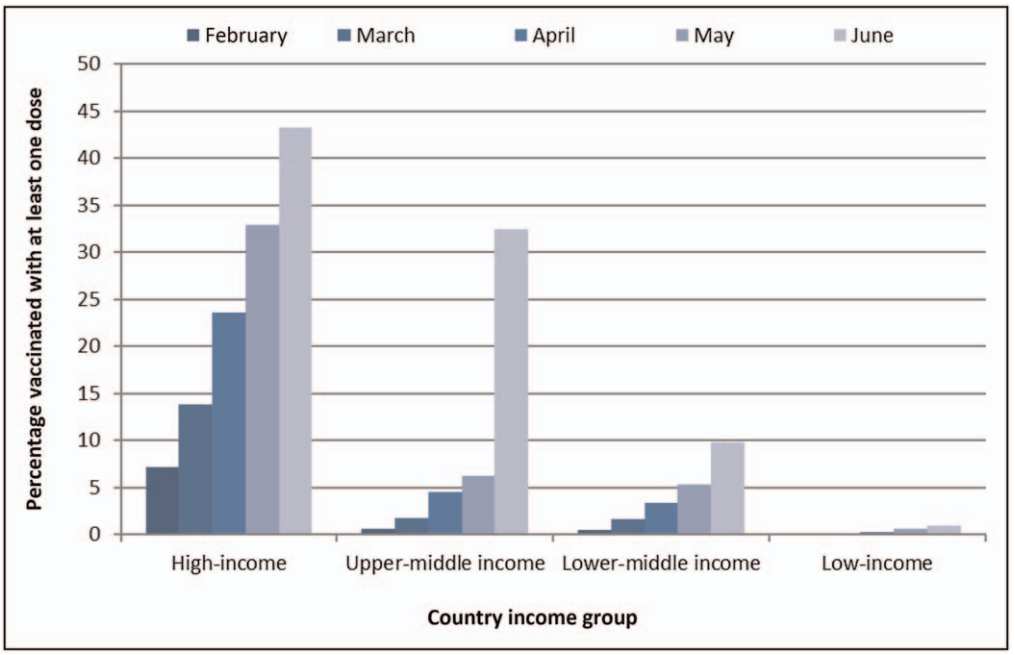

FIGURE 1. Cumulative proportion of the population vaccinated with at least one dose by income group, 2021.

colonial and postcolonial periods, have arguably established a response architecture perpetuating reliance on high-income countries and institutions. This entails strong national public health institutes [10,11] as well as regional public health and research organizations, such as the Africa Centres for Disease Control and Prevention (Africa CDC) and World Health Organization (WHO) Regional Offices, to provide expertise and coordination. Regional networks are essential for cross-border collaboration to assure equitable deployment of countermeasures, such as personal protective equipment and vaccines, at times of high global demand and protectionist trade policies. Strengthening support for LMIC academic institutions will also be essential to provide long-term leadership and expertise for preparedness efforts.

It will be important to strengthen LMIC private sector biotech capacity, not only to ensure adequate product pipelines, but also to foster innovation. In Sub-Saharan Africa, for example, there are very few vaccine manufacturers, with most providing only 'fill and finish' rather than full end-to-end production. The recent Africa CDC initiative to acquire and deliver COVID-19 vaccines across the African continent is a welcome development in this regard, as are initiatives to produce COVID-19 rapid tests and eventually vaccines at the Pasteur Institute of Dakar, Senegal. Lastly, as demonstrated by the present debate on waiving intellectual property rights regarding COVID-19 vaccines, considerable thought and negotiation will be needed to find the right balance of maximizing global access to products while not stifling private sector innovation.

GLOBAL HEALTH SECURITY REQUIRES A BROAD INVESTMENT IN HEALTH SYSTEM STRENGTHENING AND UNIVERSAL HEALTH COVERAGE

Global health security (GHS) has been defined as 'measures that are required to reduce the risk and impact of health events that endanger populations around the world' [12]. Over the past decade, discussions on GHS have broadened from a relatively narrow initial focus on infectious disease epidemiology to deeper integration with health systems strengthening, universal health coverage, and disaster risk reduction [13,14,15▪]. COVID-19 has made it clear that mitigating the impact of pandemics will require generally healthy populations with additional protection for the most vulnerable, which will require investments far beyond those related to a particular infectious disease threat. The pandemic has highlighted vulnerabilities due to comorbidities, with COVID-19 mortality rates more than ten times higher in countries where over half the population is overweight [16]. During the first transmission peak in the United Kingdom (UK), 96% of COVID-19 deaths were in persons with at least one preexisting medical condition, with many of these deaths clustered in more marginalized populations [17]. Preventing these conditions through addressing common risk factors like smoking, poor diet, obesity, lack of physical exercise and alcohol use will be essential to minimize the impact of future epidemics. Although noncommunicable diseases (NCDs) account for the majority of deaths globally, the implementation of WHO-recommended NCD policies varies across the world [18]. In the wake of the pandemic, the temptation to focus on narrow infectious disease-specific activities must be balanced against the continued need for progress in health promotion and the social determinants of health. The long-term health impacts of COVID-19, particularly in the least accessible, affordable, and well-resourced health systems, are yet to be seen. Deep inequities regarding access to care will also need to be addressed through a renewed push for universal health coverage. Building robust health systems is thus essential not only to detect and control infectious diseases, but to address complex population-wide issues like obesity and NCDs. Health systems must be sufficiently robust, with surge capacity to prevent disruption of essential services during outbreaks, which has unfortunately occurred even in many of the most economically developed countries in the world during COVID-19; during the first phase of the pandemic, the WHO found that 42% of 155 countries surveyed had disrupted services for cancer treatment [19].

FUNDING PANDEMIC PREPAREDNESS AND RESPONSE

Investment strategies and mindsets will need to change drastically if pandemic-resilient health systems are to be built. Health systems are inherently complex; require long-term multisectoral engagement; present formidable challenges with regard to design, implementation, and evaluation of interventions; and require a long lag time to deliver measurable benefits. Consequently, investments in them have traditionally been less attractive compared to vertical infectious disease programs or new technologies. For example, whereas there has been much focus recently on the need to establish global sequencing capacity and other high-tech surveillance tools for early warning and response, the world should not overly rely on such systems in

lieu of the long-term investments in basic care and services. It must be remembered, after all, that the COVID-19 pandemic is not primarily a result of insufficient surveillance, but rather capacity to contain. A primary challenge arises from constrained domestic public budgets in which the opportunity costs of investing in one area of health impinges upon others. Curative health services, including high-tech clinical interventions, are often prioritized over preventive ones, despite the latter often being more cost-effective in long term [20]. COVID-19 may be an opportunity for positive change; the pandemic response has been accompanied by a surge in both political and financial capital for public health, with potential impact far beyond the control of epidemic-prone diseases. COVID-19 has prompted several countries to review their organization of public health systems, including Canada, China, and UK, who are each redesigning systems in response to lessons learned.

Although such structural and political changes may be replicable globally, providing the required financial resources may be challenging, particularly in countries that currently spend less than the WHO benchmark of 5% of GDP on health, many of which also risk being saddled with debt from the pandemic response. Wealthy countries also generally have low-interest rates that make servicing debt more manageable.

It may be possible to increase domestic fiscal space for health in LMICs through increasing efficiency of collection of tax revenues and, to a lesser extent, reprioritizing public sector budgets and improving the technical efficiency of programs [21]. Such measures will be essential to increase public sector investment in health, creating the conditions required for a more expansive whole-of-health approach to GHS. Countries must also develop the decision-making processes needed to channel additional financial impetus into areas that serve the multiple objectives of improving public health at local and regional levels, including universal health coverage, while strengthening broader GHS.

At the international level, COVID-19 has unmasked important gaps in global financing for pandemic preparedness, so much so that the G20 has now established a high-level independent panel on this issue. In addition to assuring sufficient magnitude, funds must not be overly 'earmarked' or funneled through fragmented bureaucratic systems that impede the required flexibility to address inherently unpredictable emerging diseases. At present, several overlapping financial mechanisms exist for pandemic preparedness, with funds variably contributed, often through intermediaries, from governments, charities, philanthropists, and the private sector [22]. Perhaps the most well-known is the WHO Contingency Fund for Emergencies, operating in parallel to, and to some extent competing with, other funds, such as the United Nations Central Emergency Response Fund.

With an increase in global health investment in response to the COVID-19 pandemic, financial flows may further increase in complexity. Mitigating the potential diseconomies of scale arising from overlapping and inefficient financing mechanisms will be key to maintaining sustainable political and financial commitment to pandemic preparedness. Strengthening coordination across agencies will be essential, such as the new COVID-19 Solidarity Response Fund that brings UNICEF, WHO, and donors together into a single financial platform to serve a unified goal, with similar principles applying to the COVAX Facility. Lastly, significant questions remain regarding the optimal approach to harnessing private sector funds for the public good, including pandemic preparedness.

GOVERNMENT REGULATIONS, INDIVIDUAL FREEDOMS, AND PUBLIC TRUST

The pandemic has brought to the fore the role of government in the lives of citizens, and the trade-offs individuals are willing to make between their personal freedoms and government-issued public health mandates. Isolation and quarantine; social distancing; mask wearing; and agreement to testing, contact tracing, and vaccination are essential control measures for COVID-19. However, they are largely dependent upon individual adherence. Myriad economic, technological, legislative, cultural, ethical, and political factors dictate the extent to which individuals adhere to, and governments can enforce, disease control measures (Fig. 2).

Changes in the law have been used as a way of strengthening COVID-19 control measures, prompting WHO to establish a COVID-19 Law Lab to gather and share legal documents from throughout the world to help States to implement strong legal frameworks to manage the pandemic. This kind of action is often limited by a lack of capacity or desire for local enforcement and fails to address the root causes of mistrust and non-adherence. Nevertheless, legal instruments can still be effective, even without wholesale popular support. In the United States (US), a nation historically and politically centered on libertarian ideals and individual freedoms, face mask mandates have been enforced and supported in many States, with evidence suggesting that States where masks were legally mandated had significantly fewer cases than those where they were not [23].

FIGURE 2. The Sturgis Motorcycle Rally, pictured here in 2018, is held every year in Sturgis, South Dakota (population 6,958). The August 2020 rally was the biggest gathering of people during the pandemic in the US to date, and possibly globally, and was held at a time when the US was reporting approximately 50,000 new COVID-19 cases a day. Although the majority of Sturgis residents did not support the event, with commercial interests at play, local leaders gave the go-ahead. Masks and social distancing were recommended, but not required, and were subsequently ignored by many attendees. Subsequent epidemiologic analysis revealed that at least 649 COVID-19 cases and one death in 10 US states could be connected to the rally, although the actual figures were probably higher, since many attendees refused to cooperate with health authorities [38]. Cell phone data showed that 61% of US counties had been visited by a Sturgis Rally attendee, creating a travel hub comparable to a major US city, with analyses estimating that the rally generated public health costs of approximately $12.2 billion [39], although the study's methodology have been questioned. South Dakota governor Kristi Noem deemed the analysis 'fiction' and an 'attack on those who exercised their personal freedom to attend Sturgis'. The rally serves as an example of how deep-rooted social, cultural, economic, political and ethical influences can affect disease control in the absence of robust legal safeguards to protect public health. Photo credit: 125509667/Motorcycle Rally © Phillip Lowe | Dreamstime.com.

Since the law itself is a product of context-specific societal values, understanding how to effectively balance competing risks will be a major future challenge for all governments, laying the foundation for pandemic-resilient legal frameworks. Varied cultural, political, and legal norms across the world are at play. For example, while the use of face masks is generally easily accepted and widespread in many parts of Asia, there has been significant resistance to their use in many parts of North America and Europe. In South Korea, quarantine was enforced through mobile technology and the imposition of heavy fines, with an estimated 36,561 individuals quarantined daily, with only 6 violations per day [24]. Large fines were similarly implemented in the UK but were largely unenforced, with adherence to self-isolation over the course of the pandemic estimated at just 42.5% [25].

With broad public awareness of the risk and impacts of epidemics, mounting evidence on the importance of ensuring widespread adherence, and increased public engagement with the scientific evidence, there is an opportunity to discover new ways to increase community resilience and self-

reliance, for example by creating platforms for communities to develop and share their local adaptations of policies.

INTERNATIONAL HEALTH REGULATIONS

In recent decades, the 2005 International Health Regulations (IHR), based on annual self-reporting and periodic peer-review assessments through a joint external evaluation (JEE) process, have served as the legal and conceptual framework for GHS. In principle, disease data are reported to the WHO, who assesses national, regional, and global risk. However, the COVID-19 pandemic, along with the 2013–2016 epidemic of Ebola virus disease in West Africa, has engendered considerable debate on whether the IHR are fit-for-purpose [26▪]. One specific often cited concern is the process of declaring a Public Health Event of International Concern, which detractors argue offers a difficult and unwieldy 'all or none' choice. Many attribute this to a perceived delayed declaration and response by WHO to the West Africa Ebola virus disease in 2014 and, conversely, a premature declaration with regard to N1H1 influenza virus in 2009.

Accountability and the consequence of noncompliance are central issues. Despite undoubted political overtones, the controversy over the timeliness of China's reporting of the first cases of COVID-19 in Wuhan Province in 2019 is one example. Less debatable has been the government of Tanzania stopping reporting cases of COVID-19 in May 2020, eventually claiming that the country was COVID-19-free despite overwhelming evidence to the contrary. Other than theoretically being required to write a letter to WHO, there is no definitive consequence to countries that fail to report, or to follow other WHO recommendations. For example, despite early recommendations from WHO that there should be no travel restrictions due to COVID-19, most WHO member states indeed posed restrictions, creating a confusing patchwork of policies across the world, and one that has only enhanced in complexity as countries have grappled with varied policies on testing and vaccination required for travel.

Another issue is the assessment and development of IHR core capacities. Correlations between JEE scores and the success of countries' responses to COVID-19 have not always been strong [27]. Given the complexity of pandemic preparedness, which includes hard-to-predict societal factors and real-time political decision-making, the JEE may not be well suited to assess pandemic preparedness, as distinguished from preparedness for more local or regional epidemics. Nor is there a clear funding mechanism to help countries address shortcomings identified on JEE. There is scope for taking a more multisectoral approach to assessment and reporting, including One Health integration, synergizing human and animal health capacity assessment frameworks and tools [28–30] to address health threats at the human-animal–ecosystem interface [31].

A number of evaluations of the IHR have been done [32▪,33,34]; no doubt the issues are complex, and opinions range from mild tweaks to completely scrapping the IHR. One proposed approach is to upgrade to a more binding treaty, with consequences for lack of reporting [26▪] The precise mechanism and balance of 'carrot and stick' remains to be seen.

RAPID EVIDENCE GENERATION, EVIDENCE QUALITY, AND TRANSLATION TO POLICY

A major challenge for decision-makers dealing with COVID-19 has been a dearth of evidence on critical matters such as modes of transmission (e.g. respiratory, fomites, and/or aerosol), transmission risk in schools and workplaces, and effectiveness of countermeasures including face masks, lockdowns, and travel bans. Consequently, politicians and health authorities were forced to rapidly set public policy in the absence of sufficient evidence (which was sometimes contradictory), often in a highly politically charged environment. The frequent result was conflicting public policy and confusing public health messaging.

Rapidly identifying, triaging, and digesting the massive daily volume of COVID-19 data to translate it into clear policy has been a major challenge. Although ubiquitous internet access, use of social media, and other advanced technologies offer rapid sharing of data and innovative solutions, such as digital contact tracing [35], they have also led to an 'info-demic' – an overabundance of rapidly spreading information of variable reliability that may make a solution more difficult to achieve [36].

The source of misinformation often comes from the general public or press, sometimes intentionally, such as falsehoods of COVID-19 vaccines causing sterility or autism. Arguably, the scientific community itself may also at times be culpable, for example, when prematurely recommending the use of hydroxychloroquine as a COVID-19 treatment, despite a lack of evidence. The pressure for rapid data sharing, whereas often well-intentioned, also adds complexity, with study results being released through pharmaceutical company press releases or open-access journal preprints that have yet to undergo peer-review [37].

Misinformation has at times stemmed from the highest political levels, either through active promotion of falsehoods, or from sidelining data and

informed opinions from bonafide scientific experts. It is well established that the US Centers for Disease Control and Prevention, considered one of the world's leading public health agencies, was largely sidelined as part of the US response to COVID-19. Similarly in Brazil, which, like the US, has one of the highest rates of COVID-19 cases and deaths, political leaders ignored national institutions and experts, leading to conflicts between the policies of state and federal government and, consequently, poorly controlled local outbreaks.

One key lesson from COVID-19 in translating evidence into policy is the necessity of considering broad expertise. Early responses often over-relied on traditional epidemiological data and public health responses to curtail transmission, failing to integrate and balance economic, social, and political considerations. Biases and incorrect extrapolations from experience with previous similar diseases could also play a role, such as assuming that, since there was no asymptomatic transmission of Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-1), the same was true with SARS-CoV-2. Informed complex multifaceted policy decisions will rely on transparent, explicit, preplanned, and institutionally led processes to create, evaluate and communicate evidence, while managing political or commercial interests. Regardless of whether institutions undergo internal organizational reform, modify external structures to alter lines of reporting and accountability, or establish formal legal protections, converting evidence into policy will be a critical function.

CONCLUSION

The world was not prepared for the COVID-19 pandemic and must do better [3▪]. For future pandemic preparedness, we will need to take a broad view of GHS that incorporates universal health coverage, NCDs, sustainable development and human rights, investing in up-stream interventions that address multiple societal aims. We need a more stable funding commitment and financing mechanism for both efficient emergency response and long-term preparedness. Pandemic preparedness and response touch many ethical issues, including the relationship between the individual and the state, and there is no one-size-fits-all approach, however, the central issue of trust remains. The world needs to develop a rapid and comprehensive research ecosystem and strengthen mechanisms for evidence-based policy-making that can handle uncertainty. This will require stronger institutionalization of public health functions and strengthening of global cooperation and coordination mechanisms. Solutions must be cross-cutting. It is not an overstatement to say that the planet is at a crossroads. As eloquently stated by Christina Figueres, former Executive Secretary of the UN Framework Convention on Climate Change, 'We did not ask for the COVID-19 crisis to converge with the climate, biodiversity, and inequality crises, but all have converged in 2020. We have no other option but to make the solutions converge' [40].

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- ▪ of special interest
- ▪▪ of outstanding interest

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