Many initiatives, limited governance: Is global capacity to manage outbreaks improving?

Journal:	*BMJ*
Manuscript ID	BMJ.2018.043816
Article Type:	Analysis
BMJ Journal:	BMJ
Date Submitted by the Author:	21-Feb-2018
Complete List of Authors:	Leigh, Jennifer; Harvard T. H. Chan School of Public Health, Fitzgerald, Gabrielle; Panorama Global Garcia, Elvia; Harvard T. H. Chan School of Public Health Moon, Suerie; The Graduate Institute of Geneva
Keywords:	outbreak management, pandemic preparedness, IHR, epidemic response

Many initiatives, limited governance: Is global capacity to manage outbreaks improving?

Jennifer Leigh, MPH *(Corresponding Author)*
DrPH candidate
Harvard T. H. Chan School of Public Health
jleigh@hsph.harvard.edu

Gabrielle Fitzgerald, MPA
Chief executive Officer
Panorama Global
gabrielle.fitzgerald@panoramaglobal.org

Elvis Garcia, MEng, MArch, MPA, MPH
DrPH candidate
Harvard T. H. Chan School of Public Health
elvisgarcia@mail.harvard.edu

Suerie Moon, MPA, PhD
Director of Research at the Global Health Centre
The Graduate Institute of Geneva
suerie.moon@graduateinstitute.ch

Keywords: Outbreak management; pandemic preparedness; IHR; epidemic response

Jennifer Leigh, is the Corresponding Author and Guarantor of this article.

She affirms that the manuscript is an honest, accurate, and transparent account of the analysis being reported; that no important aspects of the analysis have been omitted; and that any discrepancies from the analysis as planned have been explained.

JL, GF, and SM contributed to the conception of the analysis. JL, GF, EG, and SM contributed to research. JL wrote the manuscript. GF, EG, and SM reviewed and edited the manuscript. JL and EG prepared the table. GF led and coordinated the project. All authors approved the final manuscript.

All authors have completed the Unified Competing Interest form (available on request from the corresponding author) and declare that Wellcome Trust funded the research for this paper, and the preparation of a related paper. Wellcome Trust commented on an earlier version of the related paper, but did not review or comment on this manuscript. They made no input into its findings or conclusions, which are the authors' own. There are no other competing interests.

No ethical approval was required for this analysis as it did not involve any human subjects.

Many initiatives, limited governance: Is global capacity to manage outbreaks improving?

Jennifer Leigh, Gabrielle Fitzgerald, Elvis Garcia, and Suerie Moon

This month marks four years since the first Ebola cases were confirmed in Guinea, and this year, a century since the Spanish flu pandemic that killed more people than the First World War. Over the past few decades, we have seen a cycle of urgency, then neglect, following major disease outbreaks. After each, panels and commissions make recommendations to ensure the world is better prepared. The aftermath of the 2013-2016 West Africa Ebola epidemic resulted in more than 40 reports reviewing what went wrong and how outbreaks could be better managed.[1] In January 2017, we offered an analysis of seven major post-Ebola reports,[2-10] identified areas of consensus, assessed what progress had been made, and highlighted gaps, concluding that the world remained unprepared for major outbreaks.[11]

Given the steady stream of disease events, increasing outbreak management capacity remains an important goal. In 2017 alone, there were outbreaks of plague, diphtheria, yellow fever, Marburg, dengue, chikungunya, cholera, H7N9 flu, MERS, Ebola, Lassa, Zika, hepatitis E, and meningitis.[12] Most of these were nationally contained. While this may suggest solid response capacity, we have not yet seen a major stress test of the global system. Here, we assess progress made in each of the gap areas identified in 2017. We based our analysis on a review of published documents and were informed by informal conversations with key experts; the conclusions remain our own.

National health systems capacity

National capacity to manage outbreaks was reiterated as a priority following Ebola. As an important first step, by the end of 2017 66 countries completed a Joint External Evaluation (JEE), an assessment of country capacity to prevent, detect, and respond to public health risks.[13] The World Health Organization's (WHO) Health Emergencies Programme (WHE) has supported 39 countries to improve their preparedness, prioritizing fragile states.[14] The Global Health Security Agenda (GHSA), with 61 participating countries, has been an important driver for building national preparedness, including a $1 billion US government investment.[15] In addition to several regional initiatives, the World Bank committed to support at least 25 countries to develop and implement pandemic preparedness plans.[16]

Surveillance initiatives are working to increase capacity to detect and report outbreaks and promote information exchange.[17-25] There have been advancements in risk-mapping and modeling, which can help pinpoint priorities for capacity building.[26-28] Several new initiatives focus on ensuring that communities partner closely with response efforts, in accordance with widespread recognition that community engagement played a major role in containing Ebola.[29-31]

Despite these efforts, and the development of several tools to calculate the cost of building country capacities,[32,33] inadequate funding remains a major barrier to increasing national preparedness. Few full-scale national action plans have been developed, funded, or implemented. Questions also remain on whether and how outbreak capacity building efforts and universal health coverage can concretely complement each other.

World Health Organization

WHO seems much better prepared for outbreaks after heavy criticism of its Ebola response. Significant emphasis has been put on strengthening its operational capacity through the WHE, whose leadership is highly regarded. The WHE has re-built the organization's technical capacities and investigates 30 events each month.[14] However, the WHE is seen as an operational island within a non-operational organization.

WHO's new Director-General as of 2017, Dr. Tedros Ghebreyesus, has brought high-level political engagement to WHO's outbreak response, which also features centrally in the organization's next five-year plan.[34] Dr. Tedros has stated an intent to transform the WHO, focusing on impact and accountability, and overhauling core business processes.[35]

However, the sustainability of reform efforts is at risk due to unstable and inadequate funding for both outbreaks and WHO more broadly. Perennial questions persist about the working relationship between headquarters and regional and country offices, coordination with other United Nations (UN) agencies, and managing sensitive political relationships with outbreak-affected Member States. Given the recent leadership transition and nascency of the WHE, the jury is still out on whether WHO's progress to date is adequate for a major global outbreak.

Research & development of health technologies

Research and development (R&D) of technologies for outbreaks has received extensive attention. WHO's R&D Blueprint is the main source of global guidance for epidemic R&D, including ten prioritized pathogens, with roadmaps and target product profiles for each.[36] The Global Research Collaboration for Infectious Disease Preparedness (GloPID-R) is working to set a research agenda and address scientific, legal, ethical, and financial challenges, to facilitate an effective research response within 48 hours of an outbreak.[37]

Vaccine development has emerged as a clear priority. The new Coalition for Epidemic Preparedness Innovations (CEPI) began funding vaccine projects in 2017.[38] While many are enthusiastic about the rapid pace with which CEPI was developed and launched, concerns persist about what will be required to keep major vaccine producers engaged and the appropriateness of CEPI's priorities (MERS, Lassa, and Nipah viruses[39]).

Four years on, momentum has been lost on Ebola vaccines. Despite several promising candidates,[40-42] decreasing private sector interest and infeasability of Phase III trials raises doubts regarding regulatory approval, and whether Ebola vaccines will be manufactured, affordable, or stockpiled,

and ultimately used by directly-affected populations. Similar questions arise regarding a Zika vaccine.

Therapeutics, diagnostics, and non-biomedical interventions have received far less attention and public financing. In June 2017, CEPI and the Foundation for Innovative New Diagnostics launched CEPIdx to address barriers to the development and uptake of diagnostics for outbreaks.[43] Despite this start, more action and funding are needed for these critical technologies.

Knowledge sharing

Sharing knowledge and data on outbreaks is critical, yet there are no overarching frameworks for knowledge sharing across priority pathogens. Nevertheless, there has been a proliferation of pathogen-specific platforms to facilitate the free exchange of epidemiological and research data.[44-49] It is too early, however, to assess how widely these platforms are being used, their impact, or whether they are sufficient. WHO[50] and GloPID-R[51] are working to address the many inherent challenges, including a lack of incentives and inadequate infrastructure. Complex regulatory, legal, and ethical questions also remain. Despite significant political attention to influenza virus-sharing, ensuring that all relevant pathogen samples (or genomic sequencing data) and resulting benefits are shared between countries also remains challenging. There are no clear governing frameworks to facilitate such sharing (beyond influenza), and limited information on actual sharing practices.

Travel & trade restrictions

Restrictions on travel and trade can deepen and lengthen outbreak-related crises.[52] Minimizing such restrictions is critical for public health, humanitarian, political and economic reasons. However, there is no governing framework covering the wide range of relevant public and private stakeholders. Norms and reasonable expectations for private firms during outbreaks remain undefined.

The WHO has strengthened monitoring of trade and travel restrictions, and Chatham House and the Graduate Institute developed a set of indicators to monitor travel and tourism reactions.[52] The World Economic Forum's Epidemics Readiness Accelerator is working to improve coordination and communications between the public and private sectors to minimize disruptions to travel and trade.[53] However, further research is still needed to better understand their causes and impacts, as well as greater political engagement to strengthen accountability for their negative consequences.

The humanitarian aid system

When outbreaks overwhelm the capacities of health actors or develop into complex emergencies, the broader humanitarian aid system becomes critical. Post-Ebola reviews highlighted the importance of strengthening the humanitarian sector's outbreak response capacity and coordination.

Efforts to improve coordination include the WHO's revised Emergency Response Framework to improve processes for coordination on health threats.[54] The UN's main humanitarian coordination body, the Inter-Agency Standing Committee, released and tested a new protocol for serious outbreaks.[55] Several other preparedness and response simulations were also conducted in 2017 by the World Economic Forum, the G20 and the World Bank/IMF.[30,56-58] However, addressing outbreaks in conflict settings remains a major political and operational challenge due to security concerns, restricted access, and a limited number of actors with capacity to do so. Furthermore, the international aid system is already under heavy strain, with multiple ongoing complex emergencies that require resources that might otherwise go to reform.

Financing

International financing for outbreak management has started to flow. The World Bank has several channels for financing health crises response, including loans, insurance, and cash disbursements.[59,60] The philanthropic sector has been an important contributor to new initiatives including CEPI. The WHO's new Contingency Fund for Emergencies (CFE) has made 44 emergency allocations totaling $34m, with more than 80% released within 24 hours.[61] However, the CFE received less than half its $100 million goal and is quickly being spent down. GHSA, another important hub of funding, was recently renewed through 2024,[62] but the US, its largest funder, has not made any financial commitments beyond 2019. The announcement of deep cuts to the US Centers for Disease Control and Prevention's global outbreak prevention work raises doubts about future US financial support.[63] The fate of the G7's 2016 capacity building funding pledge to 76 countries remains unclear, as no follow-up has been announced.[64]

Despite significant investments, only a fraction of required funding seems to have been mobilized. An estimated $4.5 billion is needed annually.[7] In addition, detailed tracking of financing is extremely difficult. No aggregate estimates are available of global investment in outbreak management, and data on national investments is especially difficult to find. Without such information, it is impossible to track whether global financing is increasing or decreasing over time, or to estimate the financing gap.

Leadership & Monitoring

While political attention to outbreaks skyrocketed immediately following the West Africa Ebola crisis, the past year has seen a comparative decline. Despite this drop, many actors demonstrated leadership by taking the initiative to strengthen various aspects of global outbreak capacity – these include governments, multilateral organizations, foundations, NGOs, companies, and researchers. As a result, many global initiatives are being implemented. However, amidst a proliferation of activities, there is no governing framework to ensure that efforts sum up to a functional, adequate global system.

Post-Ebola reviews emphasized the importance of system-wide leadership extending beyond the health sector. With a new UN Secretary General (UNSG) having taken the helm in 2017, however, it remains unclear what kind of leadership the UN will provide. Since the UNSG's Global Health Crises

Task Force concluded in mid-2017, the UN has not announced any follow-up entities.[30] There is no global monitoring mechanism, and an inability to meaningfully assess the state of global capacity.

Conclusions

Many new initiatives have been undertaken to improve global capacity to manage outbreaks. The multiplicity of projects is encouraging, but raises broader questions about fragmentation, coordination, and adequate financing.

We believe that attention is needed in three priority areas:

Funding - Significant investments are needed to strengthen outbreak management capacity, but thus far only a small fraction of required funding seems to have been committed at national or international levels. The large number of initiatives, the scope of funding required, and decreasing political attention have all contributed to this gap. In order to achieve adequate progress, more funding, and better tracking and coordination of those funds are required.

Monitoring - It is difficult to meaningfully assess the overall level of global capacity to manage outbreaks. Doing so requires in-depth investigation of implementation efforts and specialized expertise. An independent global monitoring mechanism is needed to conduct regular in-depth, system-wide tracking and assessment of efforts. Multilateral discussions regarding such a mechanism have been ongoing for over two years, but thus far no such entity has been created.

Leadership – Leadership and a clear governing framework are needed to ensure that efforts are coherent and sum up to a functional, adequate global system. In the absence of overarching stewardship, efforts are being made initiative by initiative and pathogen by pathogen. While the WHO can govern some areas, the overall system requires broader stewardship as the actors and issues extend beyond the health sector. We believe this role is best played by the UN. Without adequate leadership, momentum cannot be sustained, and the world will fall short of what is required to manage a major outbreak.

Overall, it is unclear how much better prepared the global system is today for a major outbreak than it was a few years ago. The evidence suggests that efforts have not progressed far enough, fast enough, or with enough financing.

Table 1: An overview of major initiatives to increase global capacity to manage outbreaks

Initiatives are presented in alphabetical order, by sector. While we tried to identify key activities in each area, the surge of new initiatives means that we cannot guarantee that all were included.

Sector	Initiative
National health systems capacity	▪ Africa Center for Disease Control Launched in 2017, to strengthen surveillance systems, laboratory systems, emergency preparedness and response, and public health research.[65] ▪ Global Health Security Agenda (GHSA) 61 participant countries, extended through 2024, funding unclear after 2019.[15,62] ▪ IHR Costing Tool, Georgetown University Help countries calculate the cost of developing the required health capacities.[32] ▪ Joint External Evaluations (JEE) Incubated by GHSA, now led by WHO; 66 completed, 27 scheduled for 2018.[13] ▪ Resolve To Prevent Epidemics Aims to catalyze technical assistance and funding to help health capacity planning.[66] ▪ World Bank Health Security Financing Assessment Tool Assists countries in understanding current expenditure and estimate financing gaps.[33] ▪ The World Bank Group Through IDA provides loans and grants to develop pandemic preparedness, governance mechanisms, and implementation.[16] ▪ World Health Organzation Health Emergencies Programme (WHE) Provides support for national level risk assessment, epidemic prevention and control, IHR assessment and capacities strengthening, and health systems strengthening.[14] ▪ SURVEILLANCE ○ Child Health And Mortality Prevention Surveillance Network (CHAMPS): By The Gates Foundation, collects and shares data on under five morbidity and mortality from sites in Africa and South Asia.[17] ○ Connecting Organizations For Global Disease Surveillance (CORDS): Information exchange between surveillance systems globally.[18] ○ DiSARM, by UCSF's Global Health Group: A spatial intelligence tool, built to enable disease prediction and control programs to deliver more effective field campaigns.[19] ○ Doctor Me App: Thai app uses digital volunteerism to identify potential outbreaks[20] ○ eBarometer: Buliding off of Dengue Track, Harvard Medical School, Boston Children's Hospital, and The Synergist are developing a tool to bundle data from public and private sources, including crowd surveillance.[21] ○ Ending Pandemics: Started by Skoll Global Threats Fund, a group of companies and philanthropies aiming to detect, verify and report outbreaks more rapidly.[22] ○ EpiHacK: Tool to bring together professionals to improve surveillance through existing or prototype technologies.[23]

	○ Global Virome Project: Aims to detect and sequence DNA for viruses present in wildlife[24] ○ PREDICT: Surveils zoonotic viruses to identify potential outbreaks[25] ▪ RISK MAPPING AND MODELING ○ Corporate Infectious Disease Risk Dashboard: On development by the WEF to enable visualization estimates of cost associated with infectious disease outbreaks.[26] ○ IHME: Conducted a study to aid in identifying priorities for outbreak mitigation and prevention.[27] ○ Models Of Infectious Disease Agent Study (MIDAS): Proposes advanced predictive modeling for infectious disease threats.[28] ▪ NON-CLINICAL OUTBREAK RESPONSE TECHNOLOGIES ○ Communication And Community Engagement Initiative: lead by UNICEF, addresses the need for more systematic approaches in this area.[29] ○ Good Community Engagement Practices, by the WHO R&D Blueprint guide for conducting clinical research in emergencies.[31] ○ Grand Challenge Competition to identify a better Personal Protective Equipment (PPE) resulted in new prototype by Johns Hopkins University.[67]
World Health Organization	▪ 2019-2023 General Programme of Work Identifies health emergencies, including outbreaks, as one of three strategic priorities.[34] ▪ Contingency Fund for Emergencies (CFE) Has made 44 emergency allocations totaling $34m, more than 80% of allocations released within 24 hours. Budget depleting rapidly; only $44.5m received of $100m target.[61] ▪ Emergency Response Framework 2nd edition released in April 2017; processes for coordinating information on health threats.[54] ▪ Health Emergencies Programme (WHE) Established in 2016, investigates 30 events per month.[14] ▪ Joint External Evaluations (JEE) Incubated by GHSA, now led by WHO; 66 completed, 27 scheduled for 2018.[13] ▪ Outbreak Crisis Response Had 27% gap at end of 2017, $780m out of the $1,073m proposed budget.[68] ▪ Research & Development Blueprint Main source of global guidance for epidemic preparedness R&D.[36] ▪ Simulation Exercise Manual Provide guidance on planning, conducting and evaluating simulation exercises for outbreaks and public health emergency preparedness and response.[56] ▪ ZIKA Open Space within the Bulletin of the World Health Organization, where experts can share their data, which is freely available for unrestricted use.[49]

Research & development of health technologies	▪ Global Coordination Mechanism (GCM) Under the Blueprint, builds a framework to address global R&D challenges during epidemics. Held first meeting in March 2017.[69] ▪ Global Research Collaboration For Infectious Disease Preparedness (GIoPID-R) Facilitates effective research response within 48h of an outbreak.[37] ▪ WHO R&D Blueprint Main source of global guidance for epidemic preparedness and R&D.[36] ▪ VACCINES ○ CEPI: Began funding projects in 2017. Initially targeting MERS-CoV, Lassa, and Nipah viruses.[38,39] ○ EBOLA: Merck's Ebola Zaire candidate successful, but unlikely to receive FDA approval.[40] GlaxoSmithKline also has Ebola Zaire candidate and is researching candidates for Marburg and Ebola Sudan.[41] Johnson & Johnson/Janssen Vaccine's candidate yields durable immune response.[42] China and Russia have licensed Ebola vaccines although little data has been shared.[70] ○ ZIKA: Sanofi Pasteur pulled out in september 2017 due to limited funding, low market prospects, and complications in development.[70] USG funding went to Takeda candidate.[71] ▪ DIAGNOSTICS ○ CEPIdx: partnership between CEPI and the Foundation for Innovative New Diagnostics (FIND) to strengthen global diagnostic preparedness.[43] ○ More than a dozen diagnostic tools available to detect Ebola.[36] ○ New affordable and simple blood test to distinguish between Zika and Dengue.[72]
Knowledge sharing	▪ Chatham House Created online guide to facilitate data sharing.[73] ▪ Data Sharing Working Group, GLoPID-R System for data sharing during public health emergencies.[51] ▪ PLATFORMS ○ FluID: Global platform managed by WHO for influenza data sharing[44] ○ The Infectious Disease Data Observatory (IDDO): Based at the University of Oxford, offers and online platform for Ebola, malaria and visceral leishmaniasis.[45] ○ MICROREACT: Epidemic visualization and tracking by Wellcome Sanger Institute and Imperial College London[46] ○ Nuffield Department of Obstetrics & Gynaecology's online platform for Zika[47] ○ System for Enteric Diseases response by CDC[48] ○ ZIKA OPEN by WHO[49] ▪ PATHOGEN (SAMPLE) SHARING ○ Material Transfer Agreement: Capacity building tool by WHO to facilitate sharing between research entities and countries.[74]

	▪ CLINICAL TRIALS ○ The U.S. National Academy of Medicine assessed clinical trials conducted during the Ebola response and made recommendations for future research during emergencies.[75] ○ WHO R&D Blueprint includes a work stream on designs for clinical trials in emergencies.[36]
Trade & travel restrictions	▪ CHATHAM HOUSE/GRADUATE INSTITUTE Proposed a set of indicators and areas to monitor.[52] ▪ UNSG TASK FORCE In final report in mid 2017, proposed posting travel and trade measures and their rationale on a WHO website, to promote greater transparency and accountability.[30] ▪ WORLD ECONOMIC FORUM TRAVEL AND TRADE WORKSTREAM Works to improve coordination and communications between the public and private sectors to minimize disruptions to travel and trade.[53]
The humanitarian aid system	▪ Level 3 Activation Procedures For Infectious Disease Events Protocol developed and tested by the Inter Agency Standing Committee (IASC) to ensure effective mobilization.[55] ▪ SIMULATIONS Performed by the WEF in Davos,[30] by the G20 in Berlin,[57] and selected ministers of finance during the WB/IMF annual meeting.[58] WHO published a Simulation Exercise Manual.[56] ▪ WHO Emergency Response Framework To improve processes for coordinating information on health threats.[54]
Financing	▪ GHSA Started in 2014. Extended through 2024, but no financial commitments from largest funder (US) after 2019.[15,62] ▪ WHO ○ Contingency Fund for Emergencies (CFE): $44.5m received out of $100m target.[61] ○ Outbreak Crisis Response (OCR): $780m out of the $1,073m proposed budget.[68] ▪ WORLD BANK ○ Pandemic Emergency Financing Facility (PEF) - $500m commitment over the next five years. To be activated only after WHO's CFE.[60] ○ Crisis Response Window (CRW) – expanded eligibility to include public health emergencies and epidemics.[76] ○ Disaster Risk Financing and Insurance Program (DRFIP) - provides funding and expertise to countries to implement financial protection strategies.[77] ○ International Working Group on Financing Preparedness - from 2016 proposes ways to ensure adequate financing for outbreaks to governments.[33] ▪ CEPI $625m committed by several countries and foundations.[78]

	▪ Ending Pandemics Collective (EPC) A group of companies and philantropies collaborating to more rapidly detect, verify and report outbreaks.[22] ▪ Global Health Security Funding Tracking Dashboard Georgetown University Center for Global Health Science and Security and Talus Analytics, maps the flow of committed and disbursed international funds for global health security.[79]
Leadership & Monitoring	▪ Global Health Security Agenda (GHSA) In May 2017 proposed an accountability mechanism to coordinate commitments made by each country and track progress and outcomes.[80] ▪ IHR Core Capacity Monitoring Framework Proposed by the WHO to monitor national governments' outbreak preparedness.[81] ▪ Global Health Security Index Being developed by Johns Hopkins Center for Health Security, the Nuclear Threat Initiative, and the Economist Intelligence Unit to assess national capacities.[82] ▪ Shared Monitoring Framework Developed by the Harvard Global Health Institute (HGHI) and the US National Academy of Medicine (NAM) together with more than 50 health security experts.[83] ▪ Global Health Security Conference A new research-oriented conference that will be held in Sydney, Australia, in June 2019.[84] ▪ Reporting Mechanism on World's Preparedness In its final report in mid-2017, the UNSG's Global Health Crises Task Force recommended a new independent mechanism for reporting on the status of global preparedness.[30] *Examples of disease specific frameworks:* ▪ Ending Cholera - Road Map to 2030 Adopted by partners and WHO Member States in October 2017.[85] ▪ Eliminating Yellow Fever Epidemics (EYE) Adopted by WHO's AFRO regional committee in August 2017.[86] ▪ The Global Influenza Strategy Updated in September 2016.[87] ▪ The Meningitis Vaccine Project (MVP) Road Map The project, started by PATH, WHO and The Gates Foundation in 2001, will develop a follow up document in 2018.[88] ▪ MERS Strategic Overview Discussed at a multi-stakeholder meeting in September 2017.[89] ▪ Zika Global Strategy Under development, may include alignment with other Arbovirosis (chikungunya, dengue).[90]

Citations

1. World Health Organization. Extended list of Ebola reviews. 2016. http://www.who.int/about/evaluation/extended-list-of-ebola-reviews-may2016.pdf?ua=1
2. World Health Organization. Report of the Ebola Interim Assessment Panel A68/25. 2015. http://apps.who.int/gb/ebwha/pdf_files/WHA68/A68_25-en.pdf
3. Moon S, Sridhar D, Pate MA, et al. Will Ebola change the game? Ten essential reforms before the next pandemic. The report of the Harvard-LSHTM Independent Panel on the Global Response to Ebola. Lancet 2015;356:2204-21. doi:10.1016/S0140-6736(15)00946- 0 pmid:26615326.
4. World Health Organization. Advisory Group on Reform of WHO's Work in Outbreaks and Emergencies; first report. 2015. http://www.who.int/about/who_reform/emergency-capacities/advisory-group/first-report.pdf?ua=1
5. World Health Organization. Second report of the Advisory Group on Reform of WHO's Work in Outbreaks and Emergencies. 2016. http://www.who.int/about/who_reform/ emergency-capacities/advisory-group/second-report.pdf?ua=1
6. High-Level Panel on the Global Response to Health Crises. Protecting humanity from future health crises. 2016. Report No.: A/70/723. http://www.un.org/News/dh/infocus/HLP/ 2016-02-05_Final_Report_Global_Response_to_Health_Crises.pdf
7. Commission on a Global Health Risk Framework for the Future; National Academy of Medicine Secretariat. The Neglected Dimension of Global Security: A Framework to Counter Infectious Disease Crises. National Academies Press, 2016.
8. Checchi F, Waldman RJ, Roberts LF, et al. World Health Organization and emergency health: if not now, when? BMJ 2016;356:i469. doi:10.1136/bmj.i469 pmid:26821569.
9. World Health Organization. Implementation of the International Health Regulations (2005). Report of the Review Committee on the Role of the International Health Regulations (2005) in the Ebola outbreak and response A69/21. 2016. http://apps.who.int/gb/ebwha/ pdf_files/WHA69/A69_21-en.pdf?ua=1
10. United Nations General Assembly. Strengthening the global health architecture: implementation of the recommendations of the High-level Panel on the Global Response to Health Crises.; 2016. http://www.un.org/ga/search/view_doc.asp?symbol=A/70/824.
11. Moon, S., Leigh, J., Woskie, L., Checchi, F., Dzau, V., Fallah, M., ... & Katz, R. (2017). Post-Ebola reforms: ample analysis, inadequate action. *Bmj*, *356*, j280. Available: http://www.bmj.com/content/356/bmj.j280
12. Emergencies preparedness, response | 2017 [Internet]. WHO. [cited 2018 Jan 16]. Available from: http://www.who.int/csr/don/archive/year/2017/en/
13. JEE Dashboard [Internet]. World Health Organization | Strategic Partnership Portal. [cited 2018 Jan 17]. Available from: https://extranet.who.int/spp/jee-dashboard
14. Key results for WHO's work on emergencies in 2017 [Internet]. World Health Organization. [cited 2018 Jan 17]. Available from: http://www.who.int/emergencies/achievements/2017-in-figures/en/

15. Advancing the Global Health Security Agenda: Progress and Early Impact from U.S. Investment [Internet]. Global Health Security Agenda; 2016. Available from: https://www.ghsagenda.org/docs/default-source/default-document-library/ghsa-legacy-report.pdf?sfvrsn=12

16. Report from the Executive Directors of the International Development Association to the Board of Governors : Additions to IDA Resources - Eighteenth Replenishment [Internet]. The World Bank; 2017 Jan [cited 2018 Jan 17] p. 1–171. Report No.: 112728. Available from: http://documents.worldbank.org/curated/en/348661486654455091/Report-from-the-Executive-Directors-of-the-International-Development-Association-to-the-Board-of-Governors-Additions-to-IDA-Resources-Eighteenth-Replenishment

17. Bill and Melinda Gates Foundation. Disease Surveillance Network in Africa and Asia [Internet]. Bill & Melinda Gates Foundation. [cited 2018 Jan 18] Available from: https://www.gatesfoundation.org/Media-Center/Press-Releases/2015/05/Child-Health-and-Mortality-Prevention-Surveillance-Network

18. Welcome to CORDS [Internet]. Connecting Organizations for Regional Disease Surveillance. [cited 2018 Feb 19]. Available from: https://www.cordsnetwork.org/about-cords/

19. DiSARM [Internet]. DiSARM. 2017 [cited 2018 Feb 11]. Available from: http://www.disarm.io/

20. Susumpow P, Pansuwan P, Sajda N, Crawley A. Participatory disease detection through digital volunteerism: how the doctorme application aims to capture data for faster disease detection in Thailand. In 2014. p. 663–6.

21. Global Observatory for eHealth. Global diffusion of eHealth: Making universal health coverage achievable [Internet]. World Health Organization; 2016. Available from: http://apps.who.int/iris/bitstream/10665/252529/1/9789241511780-eng.pdf?ua=1

22. Ending Pandemics Working to detect, verify, and report outbreaks faster around the world [Internet]. Ending Pandemics. [cited 2018 Feb 19]. Available from: http://endingpandemics.org/

23. Epihack. What is EpiHack™ [Internet]. [cited 2018 Jan 18]. Available from: https://epihack.org/what-is-epihack

24. GVP. About the Global Virome Project [Internet]. Global Virome Project. [cited 2018 Jan 18]. Available from: http://www.globalviromeproject.org/about-1/

25. USAID. Emerging Pandemic Threats | Fact Sheet [Internet]. U.S. Agency for International Development. 2016.[cited 2018 Jan 18]. Available from: https://www.usaid.gov/news-information/fact-sheets/emerging-pandemic-threats-program

26. Infectious Disease Outbreaks and Business Risk [Internet]. World Economic Forum.[cited 2018 Jan 18]. Available from: https://www.weforum.org/projects/infectious-disease-outbreaks-and-business-risk/

27. Pigott DM, Deshpande A, Letourneau I, Morozoff C, Reiner RC, Kraemer MUG, et al. Local, national, and regional viral haemorrhagic fever pandemic potential in Africa: a multistage analysis. The Lancet. 2017 Dec 16;390(10113):2662–72.

28. MIDAS. Models of Infectious Disease Agent Study (MIDAS) - National Institute of General Medical Sciences [Internet]. National Institute of General Medical Sciences. [cited 2018 Jan 18]. Available from: https://www.nigms.nih.gov/Research/specificareas/MIDAS/Pages/default.aspx

29. The Communication & Community Engagement Initiative: Towards a collective service for more effective humanitarian responses [Internet]. ReliefWeb. 2017 [cited 2018 Jan 18]. Available from: https://reliefweb.int/report/world/communication-community-engagement-initiative-towards-collective-service-more-effective

30. Global Health Crises Task Force Final Report [Internet]. Global Health Crises Task Force, United Nations; 2017 Jun. Available from: http://www.un.org/en/pdfs/Final%20Report.Global%20Health%20Crises%20Task%20Force.pdf

31. Catherine Hankins. Good participatory practice guidelines for trials of emerging (and re-emerging) pathogens that are likely to cause severe outbreaks in the near future and for which few or no medical countermeasures exist - Outcome document of the consultative process [Internet]. World Health Organization; 2016. Available from: http://www.who.int/blueprint/what/norms-standards/GPP-EPP-December2016.pdf?ua=1

32. Welcome to the IHR Costing Tool [Internet]. IHR Costing Tool. [cited 2018 Feb 9]. Available from: http://ghscosting.org/

33. International Working Group on Financing Preparedness. From Panic and Neglect to Investing in Health Security: Financing Preparedness at a National Level [Internet]. The World Bank; 2017 May. Available from: http://documents.worldbank.org/curated/en/979591495652724770/pdf/115271-REVISED-PUBLIC-IWG-Report-Conference-Edition-8-10-2017-low-res.pdf

34. Draft thirteenth general programme of work 2019–2023 | Promote health, keep the world safe, serve the vulnerable [Internet]. World Health Organization; 2018 Jan. Report No.: EB142/3. Available from: http://apps.who.int/gb/ebwha/pdf_files/EB142/B142_3-en.pdf?ua=1

35. Ambassador John E. Lange. A New WHO: The Ambitious Transformation of the World Health Organization [Internet]. United Nations Foundation. 2018 [cited 2018 Feb 10]. Available from: http://unfoundationblog.org/new-ambitious-transformation-world-health-organization/

36. An R&D Blueprint for Action to Prevent Epidemics - Accelerating R&D and Saving Lives Update 2017 [Internet]. World Health Organization; 2017. Available from: http://www.who.int/blueprint/about/brochure-2017.pdf?ua=1

37. Find out about our work – GloPID-R [Internet]. Global Research Collaboration for Infectious Disease Preparedness. [cited 2018 Jan 18]. Available from: https://www.glopid-r.org/find-out-about-our-work/

38. Approach | CEPI [Internet]. [cited 2018 Feb 19]. Available from: http://cepi.net/approach

39. Priority Diseases [Internet]. CEPI. [cited 2018 Jan 18]. Available from: http://cepi.net/resources#Priority-diseases

40. Henao-Restrepo AM, Camacho A, Longini IM, Watson CH, Edmunds WJ, Egger M, et al. Efficacy and effectiveness of an rVSV-vectored vaccine in preventing Ebola virus disease: final results from the Guinea ring vaccination, open-label, cluster-randomised trial (Ebola Ça Suffit!). The Lancet. 2017 Feb 4;389(10068):505–18.

41. Pavot V. Ebola virus vaccines: Where do we stand? Clinical Immunology. 2016 Dec 1;173:44–9.

42. Winslow RL, Milligan ID, Voysey M, Luhn K, Shukarev G, Douoguih M, et al. Immune Responses to Novel Adenovirus Type 26 and Modified Vaccinia Virus Ankara–Vectored Ebola Vaccines at 1 Year. JAMA. 2017 Mar 14;317(10):1075–7.

43. CEPI·dx [Internet]. FIND. [cited 2018 Jan 18]. Available from: https://www.finddx.org/cepidx/

44. WHO. FluID - a global influenza epidemiological data sharing platform [Internet]. Influenza. 2010. [cited 2018 Jan 18]. Available from: http://www.who.int/influenza/surveillance_monitoring/fluid/en/

45. Center for Tropical Medicine and Global Health. Infectious Disease Data Observatory [Internet]. Available from: https://www.tropicalmedicine.ox.ac.uk/iddo-data-sharing

46. Argimón S, Abudahab K, Goater RJE, Fedosejev A, Bhai J, Glasner C, et al. Microreact: visualizing and sharing data for genomic epidemiology and phylogeography. Microbial Genomics [Internet]. 2016 Nov 30;2(11). Available from: http://www.microbiologyresearch.org/content/journal/mgen/10.1099/mgen.0.000093

47. Zika Online Data-sharing Platform [Internet]. Nuffield Department of Women's and Reproductive Health Obstetrics and Gynaecology. [cited 2018 Jan 18]. Available from: https://www.obs-gyn.ox.ac.uk/research/zika-online-data-sharing-platform

48. CDC. SEDRIC: System for Enteric Disease Response, Investigation, and Coordination [Internet]. Center for Disease Control and Prevention. [cited 2018 Jan 18]. Available from: https://www.cdc.gov/foodsafety/outbreaks/investigating-outbreaks/sedric.html

49. WHO. Zika Open [Internet]. Bulletin of the World Health Organization. 2016. [cited 2018 Jan 18]. Available from: http://www.who.int/bulletin/online_first/zika_open/en/

50. Ben Goldacre, Sian Harrison, Kamal R. Mahtani, Carl Heneghan. WHO consultation on Data and Results Sharing During Public Health Emergencies [Internet]. Oxford, United Kingdom: Centre for Evidence-Based Medicine; 2015 Sep. Available from: http://www.who.int/medicines/ebola-treatment/background_briefing_on_data_results_sharing_during_phes.pdf

51. Data Sharing [Internet]. Global Research Collaboration for Infectious Disease Preparedness. [cited 2018 Jan 18]. Available from: https://www.glopid-r.org/find-out-about-our-work/data-sharing-working-group/

52. Asha Herten-Crabb, Ria Vaidya, Julia Spencer, Suerie Moon, Louis Lillywhite. Infectious Disease Outbreaks, Travel and Tourism: Monitoring for Preparedness. Chatham House, The Royal Institute of International Affairs; 2017 Nov.

53. Managing the Risk and Impact of Future Epidemics [Internet]. World Economic Forum. 2018 [cited 2018 Feb 19]. Available from: https://www.weforum.org/projects/managing-the-risk-and-impact-of-future-epidemics/

54. Emergency Response Framework - 2nd Edition [Internet]. World Health Organization; 2017. Available from: http://apps.who.int/iris/bitstream/10665/258604/1/9789241512299-eng.pdf?ua=1

55. Level 3 (L3) Activation Procedures for Infectious Disease Events [Internet]. Inter-Agency Standing Committee; 2016. Available from: https://interagencystandingcommittee.org/system/files/final_-iasc_system-wide_level_3_activation_for_infectious_disease_events_-_iasc_principals.doc

56. WHO Simulation Exercise Manual [Internet]. World Health Organization; 2017 Feb. Report No.: WHO/WHE/CPI/2017.10. Available from: http://www.who.int/ihr/publications/WHO-WHE-CPI-2017.10/en/

57. Berlin Declaration of the G20 Health Ministers: Together Today for a Healthy Tomorrow [Internet]. 2017. Available from: http://www.g20.utoronto.ca/2017/170520-health-en.html

58. Osewe P. Pandemic simulations: Preparing for the catastrophe we hope will never happen [Internet]. Investing in Health. 2016 [cited 2018 Jan 18]. Available from: http://blogs.worldbank.org/health/pandemic-simulations-preparing-catastrophe-we-hope-will-never-happen

59. Osewe PL. Options for financing pandemic preparedness. Bull World Health Organ. 2017 Dec 1;95(12):794–794A.

60. Bank DF Human Development, and Treasury Vice-Presidencies. Pandemic emergency financing facility : global pandemic response through a financial intermediary fund [Internet]. The World Bank; 2016 May [cited 2016 Jun 19] p. 1–33. Report No.: 104838. Available from: http://documents.worldbank.org/curated/en/2016/05/26238695/pandemic-emergency-financing-facility-global-pandemic-response-through-financial-intermediary-fund

61. Health Emergencies Programme. Contingency Fund for Emergencies | Enabling quick action to save lives. World Health Organization; 2017 Dec.

62. The 4th GHSA High Level Ministerial Meeting. The Kampala Declaration on the Global Health Security Agenda [Internet]. Global Health Security Agenda; 2017. Available from: https://www.ghsagenda.org/docs/default-source/default-document-library/kampala-declaration-2017_web.pdf?sfvrsn=4

63. Sun LH. CDC to cut by 80 percent efforts to prevent global disease outbreak. Washington Post [Internet]. 2018 Feb 1 [cited 2018 Feb 10]; Available from: https://www.washingtonpost.com/news/to-your-health/wp/2018/02/01/cdc-to-cut-by-80-percent-efforts-to-prevent-global-disease-outbreak/

64. G7 Ise-Shima Vision for Global Health. 2016. Available from: http://www.mofa.go.jp/files/000160273.pdf

65. User S. About the Africa Centres for Disease Control and Prevention (Africa CDC) [Internet]. Africa CDC. 2018 [cited 2018 Feb 19]. Available from: http://www.africacdc.org/about/about-us

66. Preventing Epidemics [Internet]. Resolve to Save Lives. [cited 2018 Feb 19]. Available from: https://www.resolvetosavelives.org/preventing-epidemics/

67. Glancey M, Osei P, Patterson WA, Petney M, Scavo L, Ruparelia C, et al. Design Improvements for Personal Protective Equipment Used in Ebola and Other Epidemic Outbreaks. Global Health: Science and Practice. 2017 Jun 27;5(2):325–8.

68. Health Emergencies Programme. Update on the WHO Health Emergencies Programme. 2017 Dec 4; World Health Organization.

69. WHO | Global Coordination Mechanism [Internet]. WHO. [cited 2018 Jan 18]. Available from: http://www.who.int/blueprint/what/improving-coordination/global_coordination_mechanism/en/

70. Helen Branswell. As foreign powers approve Ebola vaccines, U.S. drug makers lag in development pipeline [Internet]. STAT. 2017. Available from: https://www.statnews.com/2017/12/08/ebola-vaccine-development/

71. Helen Branswell. Race for a Zika vaccine slows, a setback for efforts to head off outbreaks [Internet]. STAT. 2017 [cited 2017 Dec 28]. Available from: https://www.statnews.com/2017/09/13/zika-vaccine-sanofi-challenges/

72. Andrew Joseph. Cheap, fast test for Zika and dengue could cost just $1 [Internet]. STAT. 2017 [cited 2017 Dec 28]. Available from: https://www.statnews.com/2017/09/27/zika-dengue-test-one-dollar/; Bosch I, Puig H de, Hiley M, Carré-Camps M, Perdomo-Celis F, Narváez CF, et al. Rapid antigen tests for dengue virus serotypes and Zika virus in patient serum. Science Translational Medicine. 2017 Sep 27;9(409):eaan1589.

73. A Guide to Sharing the Data and Benefits of Public Health Surveillance [Internet]. Chatham House. 2018 [cited 2018 Feb 19]. Available from: https://datasharing.chathamhouse.org/

74. WHO R&D Blueprint. Building capacity for material transfer agreements in public health emergencies [Internet]. Geneva, Switzerland: World Health Organization; 2016 Dec. Available from: http://www.who.int/blueprint/what/norms-standards/MTA-meeting-report.pdf

75. The National Academies of Medicine. Integrating Clinical Research into Epidemic Response: The Ebola experience [Internet]. 2017 Apr [cited 2018 Jan 18]. Available from: http://nationalacademies.org/hmd/~/media/Files/Report%20Files/2017/epidemicclinicaltrials-report-highlights.pdf

76. Crisis Response Window [Internet]. International Development Association. 2016 [cited 2018 Feb 19]. Available from: http://ida.worldbank.org/financing/crisis-response-window

77. Disaster Risk Financing and Insurance (DRFI) Program [Internet]. The World Bank. 2018 [cited 2018 Feb 19]. Available from: http://www.worldbank.org/en/programs/disaster-risk-financing-and-insurance-program

78. Catherine Cheney. CEPI, a year in: How can we get ready for the next pandemic? | Devex [Internet]. 2018 [cited 2018 Feb 19]. Available from: https://www.devex.com/news/cepi-a-year-in-how-can-we-get-ready-for-the-next-pandemic-91987

79. Global Health Security Funding Tracking Dashboard [Internet]. Center for Global Health Science and Security. [cited 2018 Jan 17]. Available from: https://ghss.georgetown.edu/ghs_tracking

80. GHSA. GHSA Steering Group Meeting “Take Action: ACE for GHSA” [Internet]. 2017. Available from: https://www.ghsagenda.org/docs/default-source/default-document-library/21-may-2017-steering-group-meeting-agenda-and-concept-note.pdf

81. WHO. Joint External Evaluation Tool: International Health Regulations. IHR(2015) Monitoring and Evaluation Framework. 2016. Available from: http://apps.who.int/iris/bitstream/10665/204368/1/9789241510172_eng.pdf

82. Nuzzo J. Johns Hopkins Center for Health Security Teams with NTI and the Economist Intelligence Unit to Develop a Global Health Security Index [Internet]. The Bifurcated Needle. 2017 [cited 2018 Feb 10]. Available from: http://www.bifurcatedneedle.com/new-blog/2017/3/6/johns-hopkins-center-for-health-security-teams-with-nti-and-the-economist-intelligence-unit-to-develop-a-global-health-security-index

83. Harvard Global Health Institute. 2018. Global Monitoring of Epidemic and Pandemic Preparedness: A Shared Framework. Harvard University, Cambridge, MA. Available from: https://globalhealth.harvard.edu/

84. Welcome | Global Health Security 2019 [Internet]. Global Health Security 2019. [cited 2018 Feb 9]. Available from: http://ghs2019.com/welcome.php

85. Global Task Force on Cholera Control. Ending Cholera | A Global Roadmap to 2030 [Internet]. 2017 Oct. Available from: http://www.who.int/cholera/publications/global-roadmap.pdf

86. Global Strategy to Eliminate Yellow fever Epidemics (EYE) [Internet]. World Health Organization; 2016 Sep. Available from: http://www.who.int/immunization/sage/meetings/2016/october/2_EYE_Strategy.pdf

87. Pandemic Influenza Risk Management | A WHO guide to inform & harmonize national & international pandemic preparedness and response [Internet]. World Health Organization; 2017 May. Available from: http://apps.who.int/iris/bitstream/10665/259893/1/WHO-WHE-IHM-GIP-2017.1-eng.pdf?ua=1

88. Meningitis Vaccine Project: Deadly epidemic gives rise to groundbreaking partnership [Internet]. PATH. [cited 2018 Feb 19]. Available from: https://www.path.org/menafrivac/about-mvp.php

89. Regional Committee for the Eastern Mediterranean. Progress report on emerging and re-emerging diseases including dengue and dengue haemorrhagic fever [Internet]. World Health Organization; 2016 Sep. Report No.: EM/RC63/INF.DOC 2 Rev.2. Available from: http://applications.emro.who.int/docs/RC_technical_papers_2016_inf_doc_2_19010_EN.pdf?ua=1&ua=1

90. Zika Strategic Response Plan [Internet]. World Health Organization; 2016 Jul. Report No.: WHO/ZIKV/SRF/16.3. Available from: http://www.who.int/emergencies/zika-virus/strategic-response-plan/en/