

HUMANITARIAN ALTERNATIVES

Ebola: past, present and future

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Epidemiologists following the Ebola virus since its emergence in 1976 and involved in the heart of the response to this last and most terrible epidemic, Michael Edelstein and David L. Heymann realise a synthesis of medical data available in July 2015. They thus help us to better understand the dynamics of this virus, this “enemy” which still faces scientific and humanitarian actors, and the measures implemented or upgraded to cope with it. To get to the “end game”, in relation to this outbreak and anticipate other health crises of this magnitude.

The Ebola outbreak in West Africa, which, despite a major, but delayed global response, has just only been overcome, was the 24th recorded in Africa since the disease was first described in Yambuku, Democratic Republic of Congo in 1976¹. This outbreak has, however, become much larger and much longer than any previous ones, partly because it did not have a rapid and robust response when first reported in March 2014. As of July 2015, in Guinea, Liberia and Sierra Leone, the three most affected countries, it infected 27 642 and killed 11 261², almost ten times more than all other outbreaks combined. Ebola outbreaks are generally controlled within a few months, but this one will have lasted until the second semester of 2015. While the weekly number of new cases decreased from almost 1,000 in October 2014 to a few dozen in July 2015³, getting to zero proved to be a challenge. Six cases of Ebola have surfaced in Liberia in the two months since the country was declared disease-free on May 9 2015⁴, and transmission has not yet been interrupted in Sierra Leone or Guinea. What truly sets this outbreak apart is that it changed the perception of Ebola from a rural African disease with limited spreading potential to a global health threat extending to urban centres and developed countries, stretching the international community’s response capacity to its limits and highlighting the shortcomings of the World Health Organization (WHO) and other international technical agencies that usually respond to calls for support. This outbreak, the slow response to it and the lessons learnt will reshape the international community’s approach to global health security.

Emergence and spread of Ebola outbreaks

Ebola Virus disease (EVD) is a zoonotic disease caused by the Ebola Virus. It is thought that fruit bats are natural Ebola virus hosts. Ebola is probably introduced into the human population through close contact with the blood, secretions, organs or other bodily fluids of fruit bats or of

¹ US Center for disease control and prevention, *Outbreaks Chronology: Ebola Virus Disease*, <http://www.cdc.gov/vhf/ebola/outbreaks/history/chronology.html> (accessed July 20 2015).

² World Health Organization, Ebola Situation Report, 15 July 2015 (<http://apps.who.int/ebola/current-situation/ebola-situation-report-15-july-2015>) (accessed July 20 2015).

³ *Ibid.*

⁴ *Ibid.*

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animals that have become Ebola infected from fruit bats or possibly another unknown source in nature. These animals are thought to range from primates to forest antelopes and porcupines in the rainforest⁵. Exposure most commonly occurs when these animals are butchered for bushmeat production, or when they are found dead or ill⁶. It has been suggested that the index case of the West African outbreak was a 2 years old who became infected by playing in a hollow tree housing a colony of insectivorous free-tailed bats⁷. Once a human is infected, the Ebola virus spreads from human to human through direct contact with the blood, secretions, organs or other bodily fluids of infected people, and with surfaces and materials contaminated with these fluids⁸. This requirement for close contact with an actively ill individual means Ebola is not as infectious as other diseases: each case generates on average 1.5 to 2 new cases⁹, compared with 16 for measles¹⁰. However, transmission is amplified in specific settings where exposure to bodily fluids of an ill person is more likely, namely health facilities with poor infection control, and traditional burials¹¹, which involve practice such as washing the mouth or clipping the fingernails of the deceased¹². Health workers are usually the first persons outside the family to be in contact with persons infected, and they become the source of infection to their family members and the community; they also spread infection from one patient to others if hygiene and infection control measures are not applied¹³. In Bong County, Liberia, in 2014 as an example, five nurses and one doctor died treating a single Ebola patient¹⁴ which subsequently led to the disease spreading through the county.

The unprecedented number of Ebola cases in the West Africa has enabled to better understand the virus's behaviour in individuals who have recovered from EVD and potentially uncover new modes of transmission. In some male survivors, the Ebola virus has been isolated from semen as long as 82 days after symptom onset and viral RNA has been detected in semen up to 101 days after symptom onset¹⁵. In some instances the only epidemiological link established in infected individuals was sexual contact with a survivor¹⁶. In addition, viable Ebola virus was detected in the aqueous humor of the eye of a survivor 14 weeks after the onset of EVD and 9 weeks after the clearance of virus from the blood¹⁷. These new findings about how the virus behaves and transmits may explain why Ebola virus has re-emerged in Liberia after the country was declared free of the disease, as genomic evidence suggests the new cases have originated from a survivor rather than from neighbouring countries¹⁸. In addition, there is growing evidence of the

⁵ World Health Organization, *Ebola virus disease*, Fact sheet n° 103, april 2015 (<http://www.who.int/mediacentre/factsheets/fs103/en/>) (accessed July 20 2015)

⁶ *Ibid.*

⁷ Mari Saéz A, Weiss S, Nowak K *et al.*, "Investigating the zoonotic origin of the West African Ebola epidemic", *EMBO Mol Med.* 2014 Dec 30;7(1):17-23.

⁸ World Health Organization, *Ebola virus disease*, *op. cit.*

⁹ Chowell G., Nishiura H., "Transmission dynamics and control of Ebola virus disease (EVD): a review", *BMC Med.* 2014; 12: 196.

¹⁰ Heymann DL., "Control of Communicable Diseases Manual", 20th edition, American Public health Association. 2015, Washington: APHA Press.

¹¹ Legrand J., Grais RF, Boelle PY., "Understanding the dynamics of Ebola epidemics", *Epidemiol Infect.*, 2007 May; 135(4): 610–621.

¹² Heymann DL., "Ebola: learn from the past", *Nature*, 514, 299–300 (16 October 2014).

¹³ *Ibid.*

¹⁴ Freeman C., "One patient in a 200-bed hospital: how Ebola has devastated Liberia's health system", *The Telegraph*, August 15 2014, <http://www.telegraph.co.uk/news/worldnews/ebola/11037365/One-patient-in-a-200-bed-hospital-how-Ebola-has-devastated-Liberias-health-system.html> (accessed July 20 2015).

¹⁵ Christie A, Davies-Wayne GJ, Cordier-Lasalle T., "Possible sexual transmission of Ebola virus – Liberia", 2015, *MMWR Morb Mortal Wkly Rep.*, 2015 May 8;64(17):479-81.

¹⁶ *Ibid.* and Sonnenberg P, Field N., "Sexual and mother-to-child transmission of Ebola virus in the postconvalescent period", *Clin Infect Dis.*, 2015 Mar 15;60(6):974-5.

¹⁷ Varkey, J., Shantha J., Crozier I., "Persistence of Ebola Virus in Ocular Fluid during Convalescence", *N Engl J Med* 2015; 372:2423-2427, June 18, 2015.

¹⁸ World Health Organization, Ebola Situation Report, *op. cit.*

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occurrence of asymptomatic infection with Ebola virus¹⁹. These new findings are a challenge to ending the outbreak as the response focuses on the traditional understanding of Ebola transmission dynamics.

Why is this outbreak different?

Historically, all previous Ebola outbreaks were stopped before spreading outside of rural areas, using the same strategy: first, rapid identification and isolation of Ebola cases in health facilities with rigorous infection control; second, tracing and monitoring of all contacts, isolating those who developed symptoms; and third, social mobilisation in affected communities to reduce person-to-person spread, including hygiene measures, social distancing and safe burial practices²⁰. Arguably these measures are easier to implement when outbreaks are limited to rural areas where population density is lower and community ties are stronger²¹. Nevertheless, the strict application of these principles has reduced the number of new cases from over a thousand a week to a few dozen. Getting to zero, the so-called “endgame” is however proving challenging as this outbreak presents several unique features that require this strategy to be adapted.

First, the outbreak’s sheer size meant that initially cases could not be accommodated in treatment centres and hundreds, if not thousands of new contacts had to be located and followed up daily. By June 2014, Médecins Sans Frontières (MSF), the principal NGO responder to the outbreak with several treatment centres in all three affected countries, reached capacity and could no longer deploy teams to newly affected areas²². Because MSF concentrated much of the global Ebola-management expertise, they had to train other medical non-governmental organisations before these could operate, causing further delays²³. The outbreak was therefore beyond the international community’s response capacity and led to cases remaining in the community contacts not being followed up, which in turn amplified the outbreak. This phenomenon was made worse by the urban setting where it is harder to locate people and where there is less community cohesion. This eventually resulted in scaling up the response and in an intense focus on community engagement, including the Global Outbreak and Alert Response Networks (GOARN), the WHO’s current mechanism to rapidly mobilise technical experts from partner organizations, deploying anthropologists and sociologists alongside epidemiologists and other technical experts. As the number of cases decreased, breaking the last chains of transmission required continued efforts for an exhausted healthcare workforce that may have felt less supported as international attention waned. In addition, other health priorities competed for healthcare workers’ time as the Ebola burden decreased²⁴.

Second, the outbreak must be understood in the socio-political context of the affected countries: Liberia and Sierra Leone experienced extremely violent civil wars that ended only 10 years ago, while Guinea’s difficult decolonisation process arguably contributes to an ambivalent attitude towards foreign intervention. As a result, there is deep mistrust in both national and foreign

¹⁹ Akerlund E., Prescott J., Tampellini L., “Shedding of Ebola Virus in an Asymptomatic Pregnant Woman”, *N Engl J Med* 2015; 372:2467-2469, June 18, 2015; Bellan S. Pulliam J., Dushoff J., “Ebola control: effect of asymptomatic infection and acquired immunity”, *Lancet*, 2014 Oct 25;384(9953):1499-500.

²⁰ Edelstein M, Angelides PK, Heymann DL., “Ebola and future health crises: the role of the G7. G7/G20 Research group”, April 2015. <http://www.g7g20.com/articles/michael-edelstein-david-l-heyman-and-philip-k-angelides-ebola-and-future-health-crises-the-role-of-> (Accessed July 20 2015).

²¹ David L. Heymann, “Ebola: learn from the past”, *op. cit.*

²² Michael Edelstein, Philip K. Angelides, David L. Heymann, “Ebola and future health crises: the role of the G7”, *op. cit.*

²³ *Ibid.*

²⁴ *Ibid.*

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authorities which have led to the emergence of conspiracy theories²⁵ at best and lethal attacks on healthcare staff²⁶ at worst.

The Ebola outbreak in West Africa is also a consequence of weak healthcare and public health systems. Weak surveillance allowed the outbreak to rapidly spread across a wide geographic region initially undetected²⁷ and the insufficient healthcare workforce²⁸ has further shrunk with health-care workers being disproportionately infected by the virus, in turn limiting national response capacity. The consequences of these fragile health systems being overwhelmed by Ebola extended well beyond Ebola-associated morbidity and mortality.

The first consequence is decreased vaccination coverage, particularly for measles, resulting in an increase in the number of cases²⁹. In 2015, Liberia reported over 850 measles cases, including deaths, the worst outbreak in years³⁰, while Guinea reported 500 cases and three deaths since the beginning of the year³¹. In addition, the repurposing of healthcare workers to the Ebola response brought routine health programmes tackling common diseases such as malaria, tuberculosis or HIV to a halt³². Models suggest that untreated malaria cases as a result of reduced health-care capacity may have contributed an additional 11,000 malaria deaths³³, a figure comparable to mortality directly attributable to Ebola infection.

After the outbreak

In February and March of 2015, clinical trials to examine the efficacy of some of the Ebola vaccines that have been developed since the early 2000s have been undertaken in countries where outbreaks are occurring. One trial – in Guinea – has shown that these vaccines may hold great potential as an added tool for containing future Ebola outbreaks, and study continues³⁴.

But whether there are effective vaccines to protect against Ebola infection or not, at the national level, focus must be on rebuilding health systems, and this will be a challenge: while the discourse has shifted to recovery, all three countries are still experiencing active transmission, and getting to zero should remain the priority. Despite pledged funding for reconstruction, rebuilding the workforce will take time as a significant proportion of the healthcare workforce has died³⁵ and the closure of medical and nursing schools through the outbreak has slowed capacity building³⁶.

²⁵ Edelstein M., “Ebola Thrives in Brittle West African Health Systems”, *Chatham House*, October 2014, <http://www.chathamhouse.org/expert/comment/15955> (accessed July 2015).

²⁶ BBC, “Ebola outbreak: Guinea health team killed”, September 2014, <http://www.bbc.co.uk/news/world-africa-29256443> (accessed July 20 2015).

²⁷ Michael Edelstein, Philip K. Angelides, David L. Heymann, “Ebola and future health crises: the role of the G7”, *op. cit.*

²⁸ There are about 100 000 patients per physician in Liberia, 50 000/1 in Sierra Leone, and 10 000/1 in Guinea, compared with 400 patients per physician in the USA. World Health Organization, WHO country profiles, WHO, Geneva; 2015, <http://www.who.int/countries/en/>. (accessed July 20, 2015); The World Bank, Open data: physicians (per 1000 people), <http://data.worldbank.org/indicator/SH.MED.PHYS.ZS> (accessed July 20, 2015).

²⁹ Edelstein M, Angelides P, Heymann DL., “Ebola: the challenging road to recovery”, *Lancet*, 2015 Feb 8;385(9984):2234-5.

³⁰ World Health Organization, *Liberia tackles measles as the Ebola epidemic comes to an end*, June 2015, <http://www.who.int/features/2015/measles-vaccination-liberia/en/> (accessed July 20 2015).

³¹ Unicef, *Measles Situation report*, March 2015,

http://www.unicef.org/appeals/files/UNICEF_Guinea_Measles_SitRep_24Mar2015.pdf (accessed July 20 2015).

³² Michael Edelstein, Philip K. Angelides, David L. Heymann, “Ebola: the challenging road to recovery”, *op. cit.*

³³ Walker P. et al., “Malaria morbidity and mortality in Ebola-affected countries caused by decreased health-care capacity, and the potential effect of mitigation strategies: a modelling analysis”, *Lancet Infect Dis.*, 2015 Jul;15(7):825-32.

³⁴ Ana Maria Henao-Restrepo, Ira M Longini, Matthias Egger et al., “Efficacy and effectiveness of an rVSV-vectored vaccine expressing Ebola surface glycoprotein: interim results from the Guinea ring vaccination cluster-randomised trial”, July 31, 2015, [http://dx.doi.org/10.1016/S0140-6736\(15\)61117-5](http://dx.doi.org/10.1016/S0140-6736(15)61117-5) (accessed August 3 2015).

³⁵ Edelstein M, Angelides P, Heymann DL. Ebola: the challenging road to recovery, *op. cit.*

³⁶ *Ibid.*

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At the global level, the slow and insufficient response from the international community, including WHO, has highlighted the need to review emergency response mechanisms³⁷. The outbreak has also re-highlighted low compliance with International Health Regulations obligations on building national core public health capacities, particularly in low income countries³⁸. Had this capacity been in place, the outbreak may have been detected and controlled where and when it emerged.

The Ebola outbreak in West Africa demonstrated once more the ability of a weak public health system in one country to threaten global health security for all. As the three most affected countries, with the support of the international community, continue their efforts to break the last chains of transmission, there are several lessons to be learnt: first, the global response mechanism to such public health crises, in particular the WHO's capacity and processes needs examination and strengthening or revision³⁹. Several proposals have already been made, in particular around the creation of a new emergency fund, or the increase of the sums available in an existing contingency fund; and the creation of an international global health workforce⁴⁰. How this workforce will relate to GOARN is not yet defined. Second, core public health capacity-building must be accelerated. This is in part being addressed by the US-led *Global Health Security Agenda*, which supports 44 countries to achieve full implementation of the IHR⁴¹, although it remains unclear how this initiative links with the WHO mandate to strengthen core public health capacity. Third, the Ebola outbreak saw the emergence of new, non-traditional actors such as the private sector and armed forces. Their mandate and ongoing involvement in future health crises remains to be defined⁴². Ebola will not be the last Public Health Event of International Concern—these questions need urgent answers before the emergence of the next global health crisis.

Biographies

Michael Edelstein • is a public health medical doctor specialised in infectious diseases epidemiology, with expertise in surveillance systems, outbreak investigations and global health policy, in both routine and emergency contexts. Currently a research fellow at the Centre on Global Health Security, he has an MPH from the London School of Hygiene and Tropical Medicine and is a graduate of the European Programme in Intervention Epidemiology (EPIET). He has worked for national public health agencies and international public health organisations in Europe, Africa and South East Asia. His most recent emergency responses were in the Philippines following typhoon Haiyan (2013), in Nepal following the 2015 earthquakes, and in Liberia where he worked in 2014 as a field coordinator during the Ebola outbreak.

David L. Heymann • is a medical epidemiologist with expertise in infectious diseases, and currently Professor of Infectious Disease Epidemiology at the London School of Hygiene and Tropical Medicine. Upon completion of medical training he worked for two years as a field epidemiologist for the WHO smallpox eradication programme in India. In 1976, beginning with

³⁷ World Health Organization, *Report of the Ebola Interim Assessment Panel*, July 2015, <http://www.who.int/csr/resources/publications/ebola/report-by-panel.pdf?ua=1> (accessed July 20 2015).

³⁸ Fidler D., *Ebola Report Misses Mark on International Health Regulations*, Chatham House, July 2015, <http://www.chathamhouse.org/expert/comment/ebola-report-misses-mark-international-health-regulations> (accessed July 20 2015).

³⁹ World Health Organization, *Report of the Ebola Interim Assessment Panel*, op. cit.

⁴⁰ World Health Organization, *WHO response to the Ebola Interim Assessment Panel report*, July 2015, <http://www.who.int/mediacentre/news/statements/2015/ebola-panel-report/en/> (accessed July 20 2015).

⁴¹ Center for Disease Control and Prevention, *Global Health Security Agenda*, <http://www.cdc.gov/globalhealth/security/> (accessed July 2015).

⁴² Michael Edelstein, Philip K. Angelides, David L. Heymann, "Ebola and future health crises: the role of the G7", op. cit.

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investigation of the first outbreak of Ebola in DRC in 1976, he spent 13 years on assignment from the U.S. Centers for Disease Control and Prevention (CDC) to ministries of health in sub-Saharan Africa working on outbreak investigation, including hemorrhagic fevers; malaria; vaccine preventable diseases; and strengthening of disease surveillance systems. In 1989 he was seconded from CDC to the World Health Organization where he worked as research coordinator in the Global Programme on AIDS, and then set up and directed the Programme on Emerging Infections, followed by executive positions from which he coordinated the global response to the SARS outbreak in 2003, headed the polio eradication programme, and became assistant director general for health security and the environment.

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