Pandemonics—
A Case Study on the Ebola Outbreak

Vincent Lepez

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Pandemics
A case study on the Ebola Outbreak

Vincent LEPEZ, PhD, IAF
Geneva Association, March 25 2015
Ebola Virus Disease (EVD)

- Previously called Ebola hemorrhagic fever
- Filovirus: enveloped, negative-stranded RNA virus
- 5 species of *Ebola virus*
  - Zaire Ebola virus (2014 outbreak)
  - Bundibugyo Ebola virus
  - Reston Ebola virus
  - Sudan Ebola virus
  - Tai Forest Ebola virus

- Severe disease with high case fatality
- Death rates for Ebola range from 50-90%
- Absence of specific treatment or vaccine
Ebola Virus Disease

- Zoonotic virus – bats the most likely reservoir
- Spread from infected wild animals (e.g. fruit bats, monkey) to humans, followed by human to human transmission
Human-to-Human Transmission

- Infected persons are not contagious until onset of symptoms

- Infectiousness of body fluids (e.g., viral load) increases as patient becomes more ill
  - Remains from deceased infected persons are highly infectious

- Human-to-human transmission of Ebola virus via inhalation (aerosols) has not been demonstrated

**HOW IT SPREADS**
Direct contact with body fluids of an infected person (incl. dead bodies) – most infectious: blood, faeces, vomit

**EBOLA IS NOT AIRBORNE**
Unlike influenza or tuberculosis, Ebola does not spread through the air
Ebola Outbreaks, 1976-2014

Number of infections in each outbreak

- 1,000
- 250
- 50

Sources: WHO; IUCN

Economist.com/graphicsdetail
Affected countries

- Widespread transmission
  - Sierra Leone
  - Liberia
  - Guinea

- Outbreak declared over
  - Nigeria
  - Senegal
  - Mali

Geographical distribution of new cases and total cases in Guinea, Liberia, and Sierra Leone

WHO updated 18 March 2015
Ebola Outbreak 2014 – Key events (1/3)

06-Dec: Death of index case
2 year old, Meliandou village, Guéckédou, Guinea
All retrospectively identified

18 Mar: Guinea announces outbreak
20 Mar: Lab tests confirm Ebola
23 Mar: WHO notified outbreak in Guinea
25 Mar: First WHO report released
31 Mar: Liberia reports first case

01 Apr: MSF warns outbreak unprecedented
Ebola Outbreak 2014 – Key events (2/3)

- **12 May**: EVD cases in Guinean capital, Conakry
- **17 Jun**: EVD cases in Liberian capital, Monrovia
- **25 Jul**: Nigeria reports first EVD case
- **29 Aug**: Senegal reports first EVD case
- **08 Aug**: WHO declares Public Health Emergency of International Concern
- **12 Aug**: Deaths >1,000 (WHO)
- **21 Aug**: Two medically evacuated cases in US, successfully treated with experimental therapy ZMapp
- **29 Aug**: Senegal reports first EVD case
**Ebola Outbreak 2014 – Key events (3/3)**

- **28 Sept:** First EVD case in US
  - Obama sends 3,000 troops for support
- **06 Oct:** First EVD case in Europe
  - *nurse in Spain*
- **08 Oct:** Death of first US EVD case
- **12 Oct:** 2° case tests positive in US
- **17 Oct:** Outbreak declared over in Senegal
- **20 Oct:** Outbreak declared over in Nigeria
- **23 Oct:** First EVD case in Mali
- **02 Dec:** Outbreak declared over in Spain
- **29 Dec:** First EVD case diagnosed in UK
  - *Scottish nurse*
  - Obama urges Congress to approve $6 billion for Ebola fight
- **18 Jan:** Outbreak declared over in Mali

**Worldbank provides $1bn financing for emergency response and local economy support**
### Cases of EVD by country, 2014/2015

- **WHO Update 18th February 2015**

<table>
<thead>
<tr>
<th>Country</th>
<th>Cases*</th>
<th>Deaths*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guinea</td>
<td>3 389</td>
<td>2 224</td>
</tr>
<tr>
<td>Liberia</td>
<td>9 526</td>
<td>4 264</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>11 751</td>
<td>3 691</td>
</tr>
<tr>
<td>Mali</td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td>Nigeria</td>
<td>20</td>
<td>8</td>
</tr>
<tr>
<td>Senegal</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Spain</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>United States</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>24 701</td>
<td>10 194</td>
</tr>
</tbody>
</table>

*Confirmed, probable or suspected*
Number of new confirmed cases per report week

Source: WHO
The basic reproduction number, $R_0$, is defined as the expected number of new infections from one infected individual in a fully susceptible population through the entire duration of the infectious period.

The basic reproductive rate ($R_0$)

$$R_0 = \kappa \beta D$$

-$\kappa$ - number of contacts per time unit
  - Isolation, closing schools, public campaigns $\rightarrow \kappa \downarrow$

-$\beta$ - probability of transmission per contact
  - Individual protection, face masks, hand washing $\rightarrow \beta \downarrow$

-$D$ - duration of infectiousness
  - Specific for an infectious disease
  - Early diagnosis and treatment, screening, contact tracing $\rightarrow D \downarrow$
Ebola VS other viruses

The Microbe-scope

Ebola
SARS
Swine Flu

Contagiousness
average basic reproduction number (R₀)
no. of people one person will likely infect

Sources: Centers for Disease Control, World Health Org., CIDRAP, studies.
Fatality rate for health adult in developed nation, * = infants

Data: bit.ly/KIB_MicrobeScope
Part of KnowledgeIsBeautiful
Ebola outbreak $R_0$ evolution

$\displaystyle R_0 = \left( \frac{\text{Number of contacts per unit time}}{\text{Probability of transmission per contact}} \right) \left( \frac{\text{Duration of infection}}{} \right)$

**A** Guinea

- Median estimated $R_t$
- 95% CI

**B** Liberia

- Median estimated $R_t$
- 95% CI

**C** Sierra Leone

- Median estimated $R_t$
- 95% CI

- Data
- Fitted

$R_0 < 1$ epidemic extinction

$R_0 > 1$ epidemic spread

Ebola vaccine trials

Planned Ebola vaccine trials

1. LIBERIA
   Led by: NIH
   Participants: 30,000
   Design: Randomized trial with control arm in general population
   Vaccines: GSK, Merck

2. GUINEA
   Led by: International consortium
   Participants: 9000
   Design: 1. Ring vaccination trial; 2. Observational study in Ebola workers
   Vaccines: To be determined

3. SIERRA LEONE
   Led by: CDC
   Participants: 6000
   Design: Stepped-wedge trial in Ebola workers
   Vaccines: To be determined
Takeaways on the medical aspects of the Outbreak

- Outbreak seems to slow and to stop in some regions

- Only one drug trial shows encouraging results

- Diminution of cases perturb vaccine and drug trials

⇒ But severe damages to local economies
Even starting from very low, the Ebola affected countries showed good signs of progress on the public health related MDGs (Millenium Development Goals)

- To eradicate extreme poverty and hunger
- To achieve universal primary education
- To promote gender equality and empower women
- **To reduce child mortality**
- **To improve maternal health**
- **To combat HIV/AIDS, malaria, and other diseases**
- To ensure environmental sustainability
- To develop a global partnership for development

➔ Liberia/Guinea/Sierra Leone halved their under 5yo mortality over the last 20 years

➔ Coverage ratios for Skilled Birth Attendance steeply increased over the last decade, alongside family planning (except Guinea)
The public health landscape before the Ebola Outbreak (2/2)

- However global health expenditures, public funding and their development remain extremely low:

<table>
<thead>
<tr>
<th>2012 figures - WHO</th>
<th>Guinea</th>
<th>Sierra Leone</th>
<th>Liberia</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of Global Government Expenditures dedicated to Health</td>
<td>7%</td>
<td>12%</td>
<td>19%</td>
<td>15% (Abuja 2001)</td>
</tr>
<tr>
<td>Corresponding $ amount</td>
<td>9$</td>
<td>16$</td>
<td>20$</td>
<td>36/55/86$ (various figures)</td>
</tr>
<tr>
<td>Out of pocket payment as % of Total Health Expenditures</td>
<td>66%</td>
<td>75%</td>
<td>21%</td>
<td>#NA</td>
</tr>
</tbody>
</table>
Local Public Health system proved to be highly non-resilient to such crisis

- **Guinea (Aug 2014/Aug 2013)**
  - 58% drop in outpatient visits
  - 54% drop in hospital admissions
  - 16% drop in cesarean sections and 11% in institutional delivery

- **Sierra Leone (Sept 2014/May 2014)**
  - 23% drop in institutional delivery
  - 21% drop in children receiving DPT vaccines
  - 39% drop in children treated for malaria

- **Liberia (Q3 2014/Q1 2014)**
  - 50% drop in institutional deliveries
  - 26% drop in child immunization
  - 62% of health facilities closed

Source: WHO
Consequences go far beyond the domain of public health

Successive Growth Projections (%)
*Source: World Bank Analysis*

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Liberia</th>
<th>Sierra Leone</th>
<th>Guinea</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2014</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June (pre-Ebola)</td>
<td>5.9</td>
<td>11.3</td>
<td>4.5</td>
</tr>
<tr>
<td>October</td>
<td>2.5</td>
<td>8.0</td>
<td>2.4</td>
</tr>
<tr>
<td>December</td>
<td>2.2</td>
<td>4.0</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>2015</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June (pre-Ebola)</td>
<td>6.8</td>
<td>8.9</td>
<td>4.3</td>
</tr>
<tr>
<td>October</td>
<td>1.0</td>
<td>7.7</td>
<td>2.0</td>
</tr>
<tr>
<td>December</td>
<td>3.0</td>
<td>-2.0</td>
<td>-0.2</td>
</tr>
</tbody>
</table>
Conclusion and implications

- Significant MDG-related investment performed, that gave signs of success but the overall public health system is...
  - Too fragmented
  - Too much relying on Out of Pocket and External funding
  - Unable to face sudden and significant stress on its own

- The recent progress made over the last decade are now considered endangered and actions should be taken in order to orientate investment/subsidization towards multidimensional approach:
  - Regional VS Local, in particular in terms of surveillance
  - Transversal (health workforce, social services network, global infrastructure – education, nutrition, construction, …), supporting local economic development
  - Creation of a Universal Health Coverage

⇒ Opportunity for intervention of the private sector (Insurers ?...)
How did a reinsurer like SCOR live the Outbreak? (1/2)

- Pandemics is a key concern for the insurance world, and particularly reinsurers
  - Weight of standalone Pandemic risk in reinsurers balance sheet is particularly heavy
  - Hence the close monitoring of this risk and (partial) coverage strategies through mortality bonds

- (Re-)Insurers have been closely monitoring the Outbreak, but remained rather passive, despite some demand, but mostly uninsurable demand:
  - No room for individual cases of course
  - Some specific demands for group coverage (foreign NGO volunteers mostly, as other categories already fall under an existing Group contract, or are non insurable)

- Early in the outbreak, SCOR was ready to provide significant capacity for mortality risk, in order to help the continuance of support to local economies and public health
An example of product

**Example (illustrative): Group product for NGO volunteers**

Sum insured in case of death due to EBOLA virus: 100k€ per individual

- **Weekly premium rate:** 0.2%
- **Premium Guarantee:** 1 month
- **Size of the group:** 1,000
- **Return on Premium:**
  - 90% if 0 casualty 1 month after the return of last group member
  - 70% if 1 casualty
  - 50% if 2 to 3 casualties
  - 30% if 4 to 6 casualties
  - 10% if 7 to 9 casualties
There were no sales…

but no active marketing around Ebola-specific covers either.

However, Ebola clearly created *protection awareness* in a region where

- Institutional investors now count on the private sector to help support local economy and public health quality development
- Demography will be extremely dynamic over the course of the XXIth century

Maybe now is the right timing for (Re-)Insurers to tackle the need for Death/Disability/Health coverage and associated insurance in the region, starting with:

- Micro-insurance for individuals
- Group insurance for local firms
- Specific group programs for foreign companies that mostly rely on self-insurance ?...
Or maybe not…

Thanks for your attention