EXPERT JUDGEMENT IN PANDEMIC ALERTS

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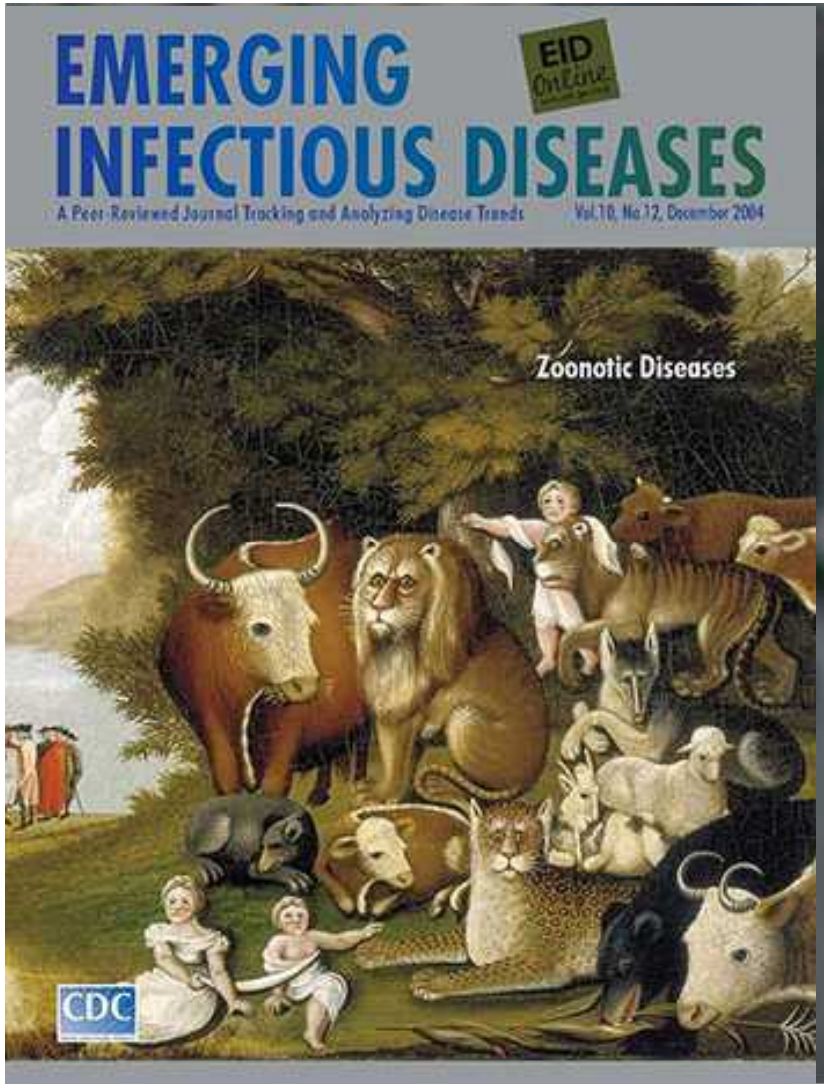
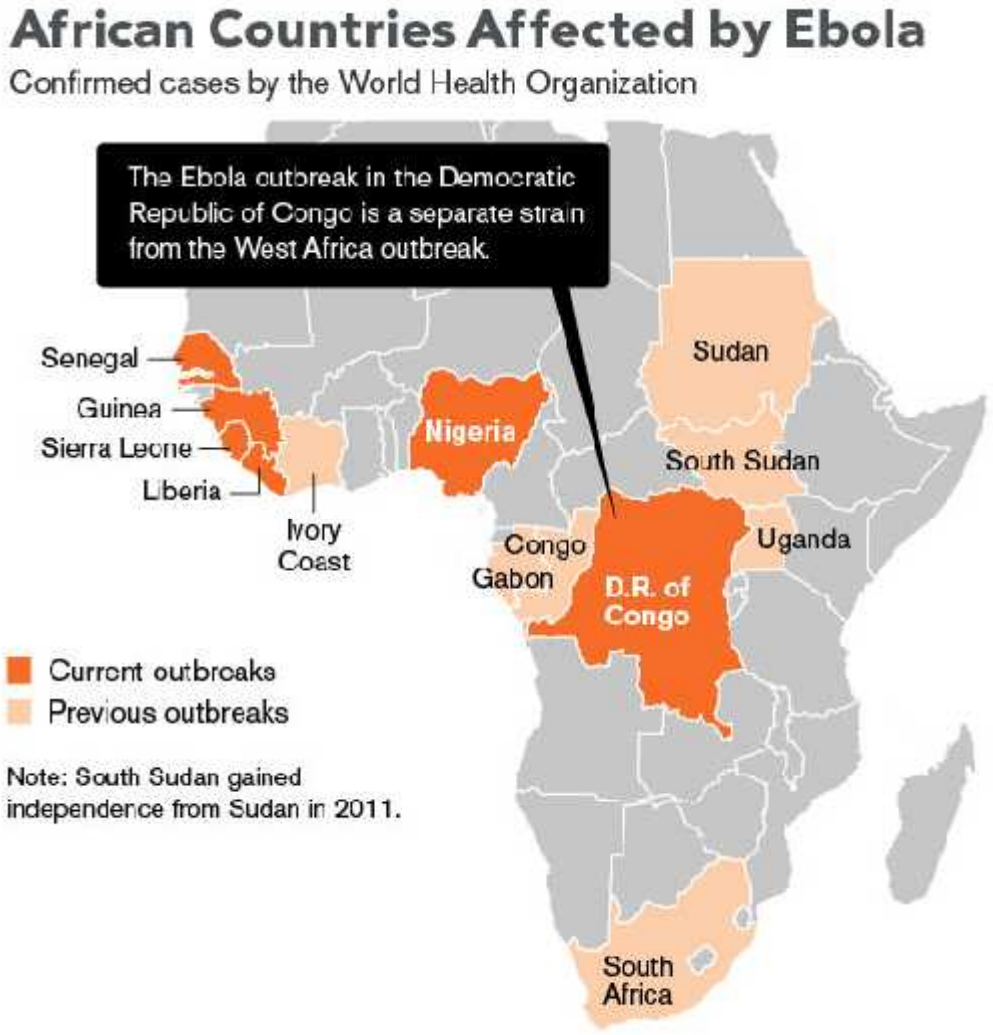
Expert judgement to enhance health decision making

7th October, 2015

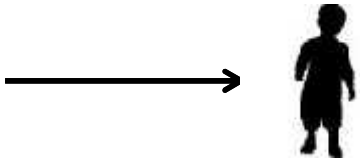

EMERGING
INFECTIOUS DISEASES
EID
Online
A Peer-Reviewed Journal Tracking and Analyzing Disease Trends
Vol.10, No.12, December 2004
Zoonotic Diseases
CDC

The first known outbreak of Ebola virus disease (EVD) occurred in 1976 in South Sudan.

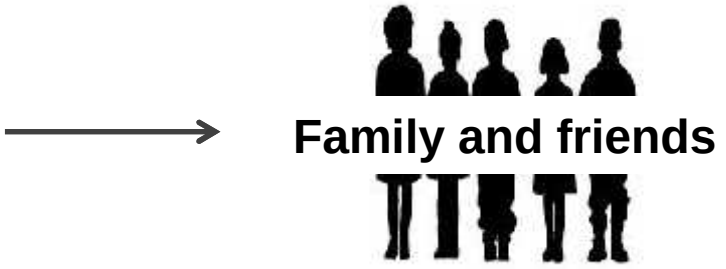
Outbreaks in D.R. Congo occurred sporadically in 1976, 1994, 2003, 2007 and 2012.




Bats roost in huge colonies, packed tightly into caves, which makes it easy for a virus to spread among them.
The more a virus leaps from host to host, the greater the chance for it to mutate into a form even deadlier to humans.



Emile



Family and friends

In December 2013, a child was infected with Ebola. He soon died along with his family. The infection was passed on to health workers attending to the family.

In January and February 2014, the disease outbreak was thought to be cholera or malaria.

It was only in late March that the disease outbreak was confirmed through laboratory testing to be Ebola.

Nurses and doctors

and funeral workers

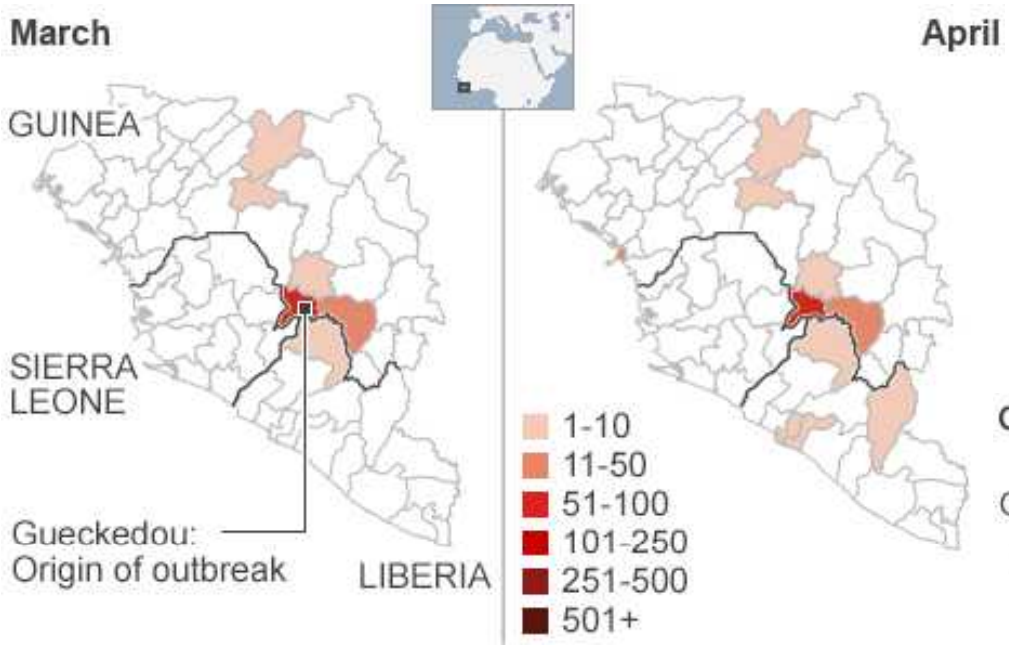
[a] Meliandou
Boy; family

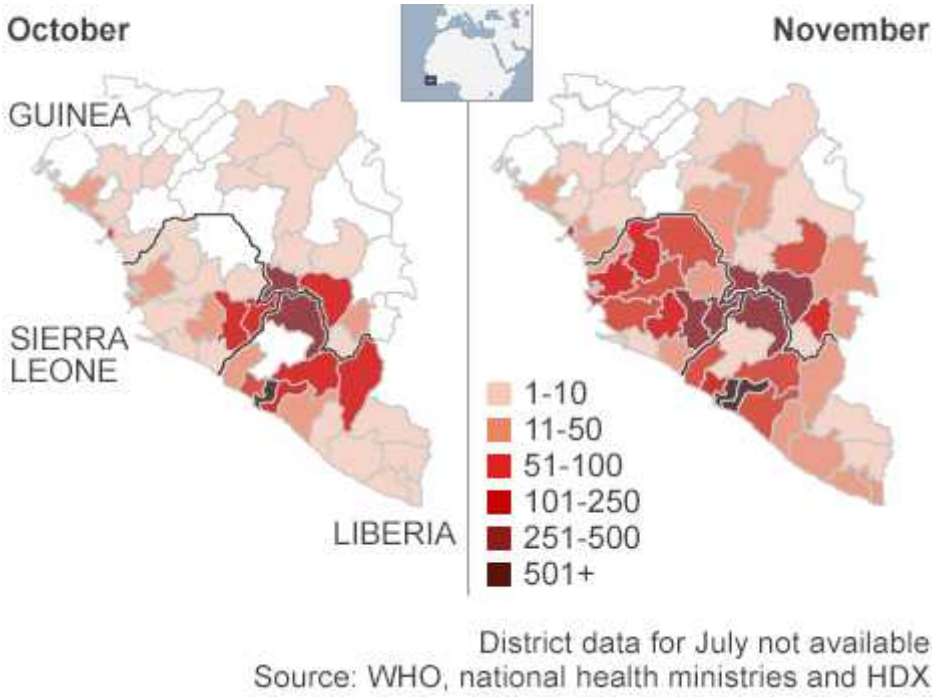
[b] Gueckedou
Nurse

[c] Kissidougou
Doctor

[d] Conakry
Trader from the
Forested region

Regional death tolls





The 2014 epidemic killed more than all other known Ebola outbreaks combined.

Transmissibility and virulence

- In general, diseases with high virulence tend to have lower transmissibility since the dead and injured are not effective transmitters of the disease. From an evolutionary perspective, excessive killing of hosts would limit the propagation of a virus.
- Ebola is much less contagious than many other more common diseases. The virus, much like HIV or hepatitis, is spread through blood or bodily fluids and is not airborne.
- The incubation period, or the time interval from infection to onset of symptoms, is from 2 to 21 days. The patients become contagious once they begin to show symptoms. They are not contagious during the incubation period.

Virulence: case fatality rate

- Virulence is a measure of the relative ability of a pathogen to cause disease and mortality
- Pandemic and seasonal influenza strains since 1900 have had a case fatality rate of less than 2.5% in developed countries.

Year(s)	Type	CFR
1510		Very low
1557-1558		Highly fatal
1580		Highly fatal
1729-1730, 1732-1733		High
1761-1762		
1780-1782		Very low
1788-1790		Low
1830-1831, 1832-1833, 1836-1837		Low
1889-1893	H2N2? H3N8?	0.1-0.28%
1918-1919	H1N1	>2%
1957-1958	H2N2	0.13%
1968	H3N2	<0.1%
1977-1978	H1N1	
2009	H1N1	0.05%

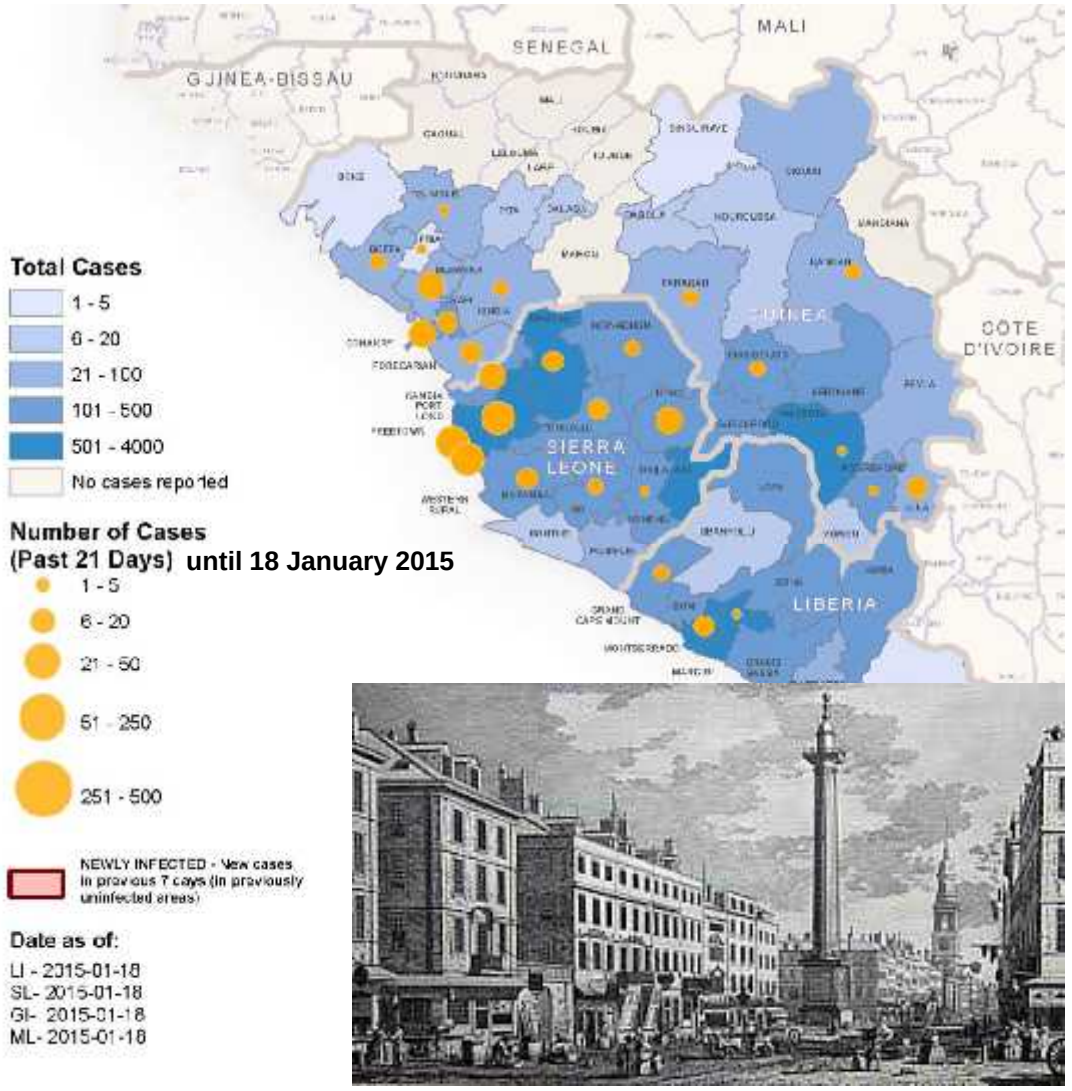
Asymptomatic transmission of Influenza

With SARS, people became sick (symptomatic) *before* they were maximally infective.
The disease was easier to control because apparently well people were not infectious.

With influenza, on the other hand, the infectious period begins about 24 hours *before* the symptomatic period.
This gives influenza a head start in infecting people, before the person knows he is sick
and thus more likely to have contact with others.

The **WHO** has likened the Ebola crisis in 2014 to a fire in a peat bog.

It flares up on the surface and is stamped out, but continues to smoulder underground, flaring up again in the same place or somewhere else.



Failed health infrastructure in Sierra Leone

The medical care infrastructure of Sierra Leone is very primitive. There are only two doctors for every 100,000 people. (Cuba has more than 500). There are just 40 hospital beds per 100,000.

Sierra Leone has the highest maternal mortality rate in the world ~ 1%.

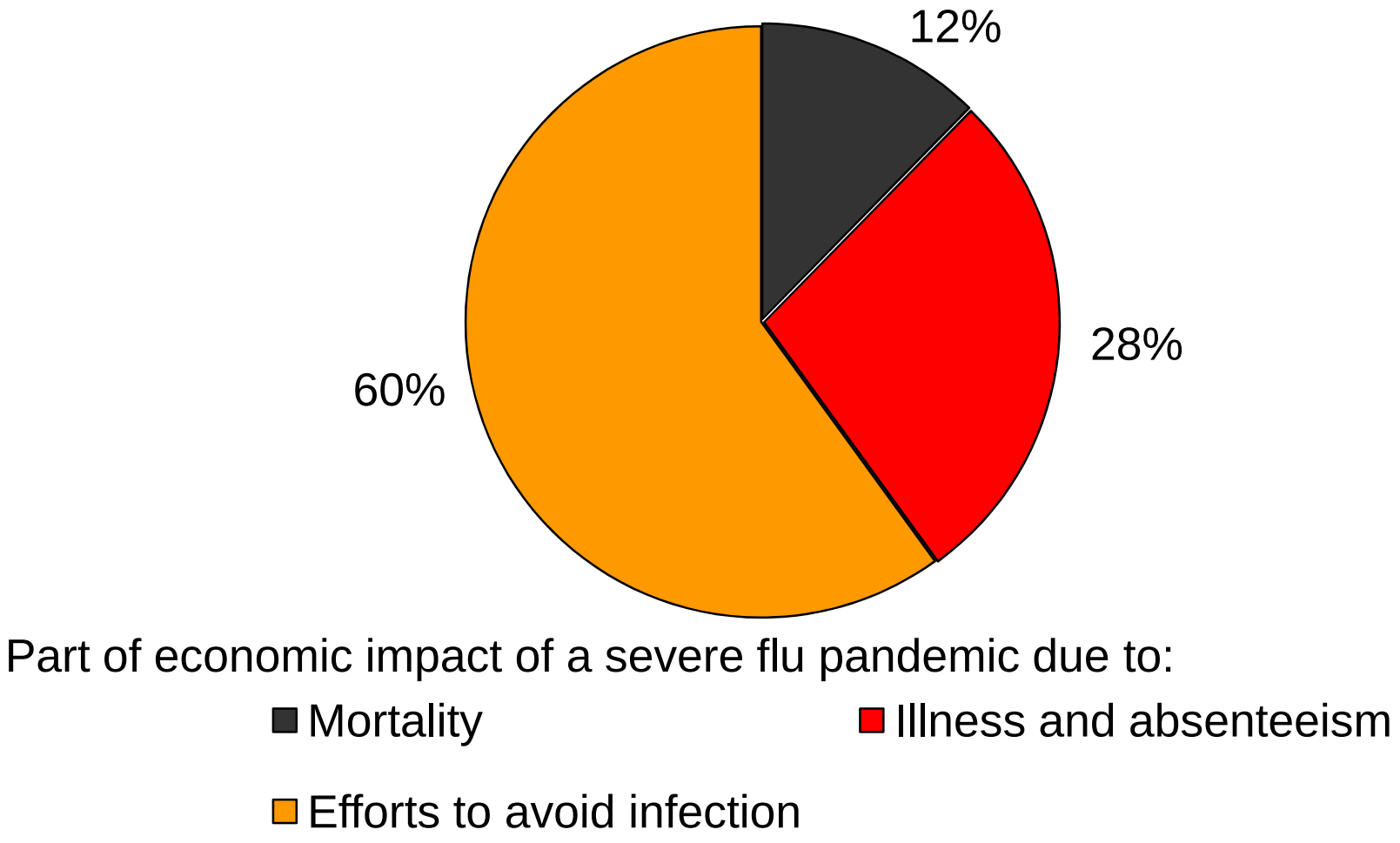
Maternity hospital funded by the Italian Committee for UNICEF

World Bank review of regional poverty

Guinea is among the poorest countries in West Africa, and has a poverty rate of 55%. It has suffered from years of conflict and poor leadership. Mining of iron ore and bauxite is a major industry.

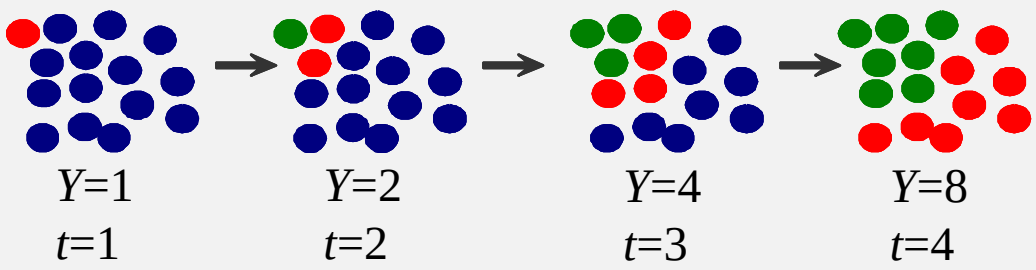
Liberia is one of the poorest countries in all of Africa, with 60% living below the poverty line. More than half of the population is urban. Informal activities occupy three-quarters of the labour force.

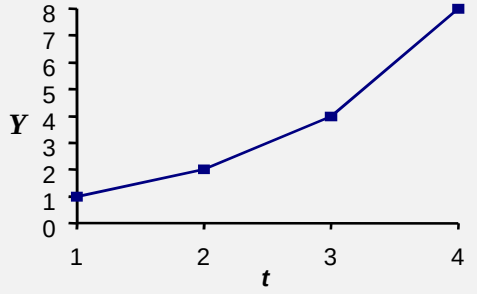
Sierra Leone has widespread poverty with 53% living below the poverty line. Three quarters of the population is under 35, with most engaged in part-time activities related to agriculture. There is little formal employment. Chronic malnutrition is a serious problem, with 35% of young children stunted.



Source: World Bank (2008)

INFECTIOUS DISEASE EPIDEMICS

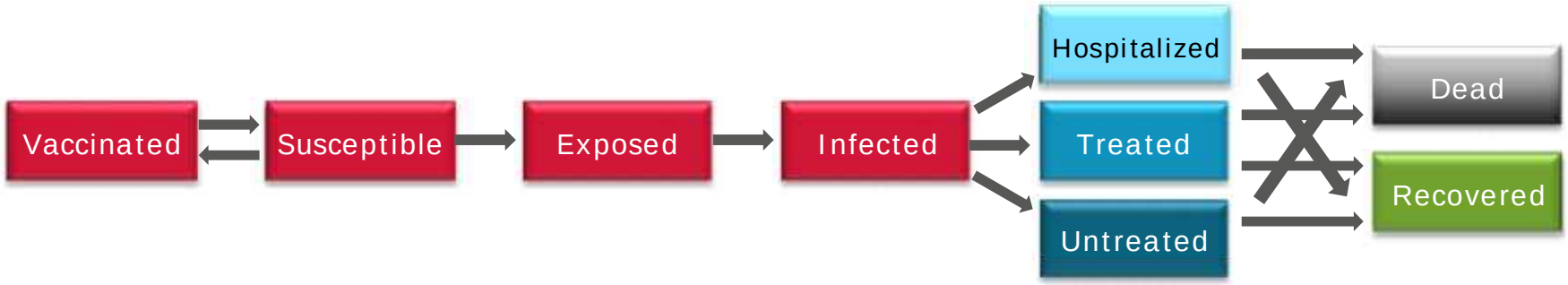




R_0 , called the basic reproductive ratio, is the number of secondary infections caused by one primary case at the start of an epidemic.

R_0 needs to be >1 for an epidemic to take off.

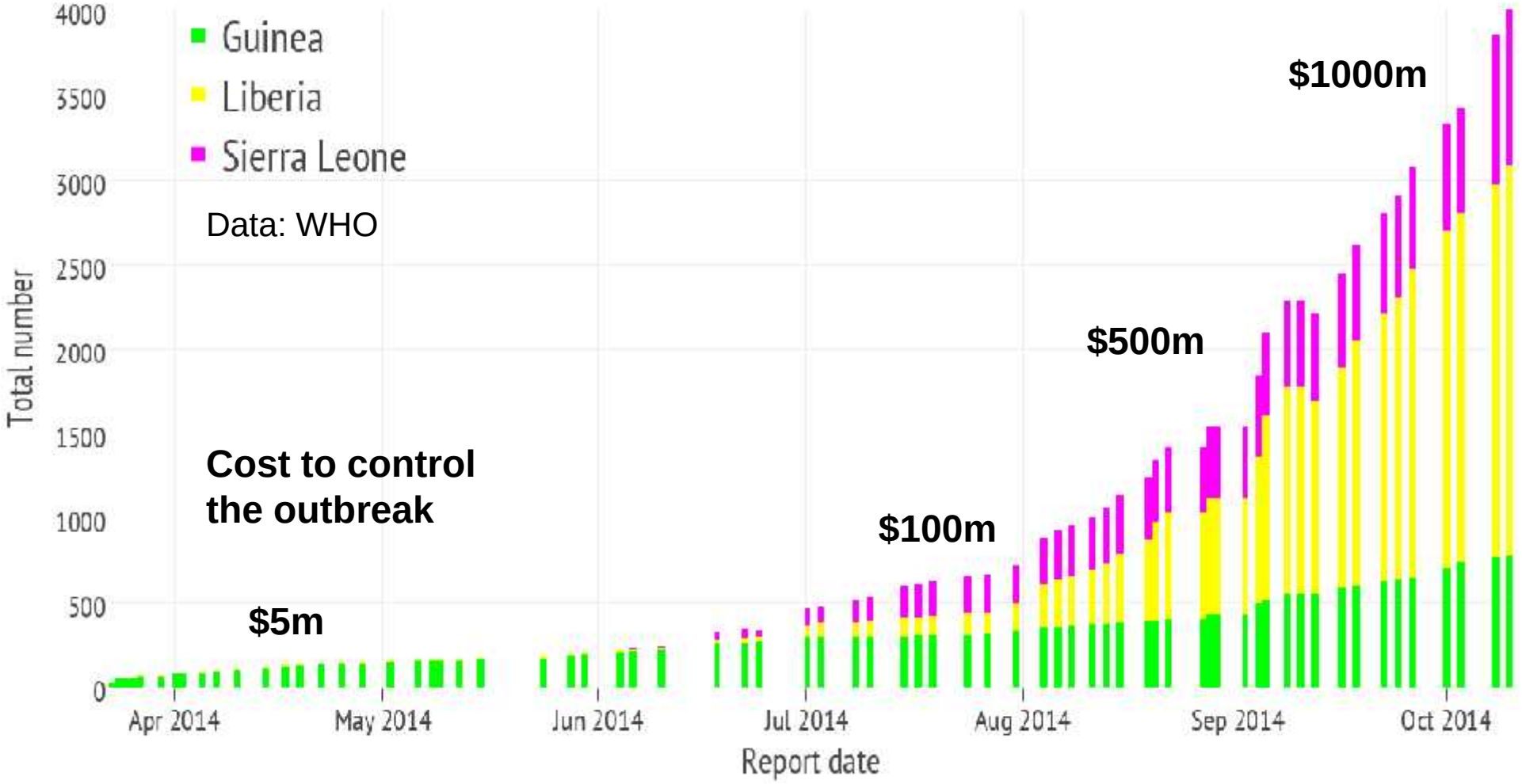
Epidemiologic S-I-R modelling



The S-I-R model accounts for:

- Geography
- Vaccination
- Residual Immunity
- Quarantine
- Medical Interventions
- Country Specific Transmission Variables

Escalation in the Ebola death count in West Africa



Epidemic doubling time

- The disease generation time T_g is the mean time interval between infection of one person and infection of the people that individual infects.

- The doubling time for the number of cases in a growing outbreak is of order of $Ln(2)*T_g/(R_0-1)$.

Fraser C., Riley S., Anderson R.M., Ferguson N. M. (2004) Factors that make an infectious disease outbreak controllable. *Proc. Nat. Acad. Sci., 101, No.16.*

Epidemic control: September 2014

- R_0 for Ebola transmission has been above 1, so there has been an epidemic.
- However, R_0 has been less than 2, so control could be attained by preventing over half of the secondary transmissions per primary case.
- Transmission in the community, in hospital and treatment centres, and funeral settings all contribute to R_0 .
- Approximately 70% of Ebola cases need to be placed in medical care facilities or Ebola treatment units, or else in the community where disease transmission is minimal.

Pandemic forecasting

- At any stage in the evolution of a pandemic, probabilistic forecasts are needed of the number of cases, fatalities, demand for healthcare facilities, equipment and medical personnel at future times.
- Projections may be made using epidemiological models. However the parameter uncertainty is large, especially for developing countries, and in the early stages of a pandemic, where data are sparse.
- The formal elicitation of expert judgement would help to improve the forecasting process, and thereby the emergency response.

Dynamic R_0

- R_0 depends on:
  - [a] the number of people that an infected person comes into contact with
  - [b] the likelihood of infecting another person
- The first factor is a function of the social network of an individual.
- The second factor is a function of the transmissivity characteristics of the pandemic virus, and protective measures taken to avoid contagion.

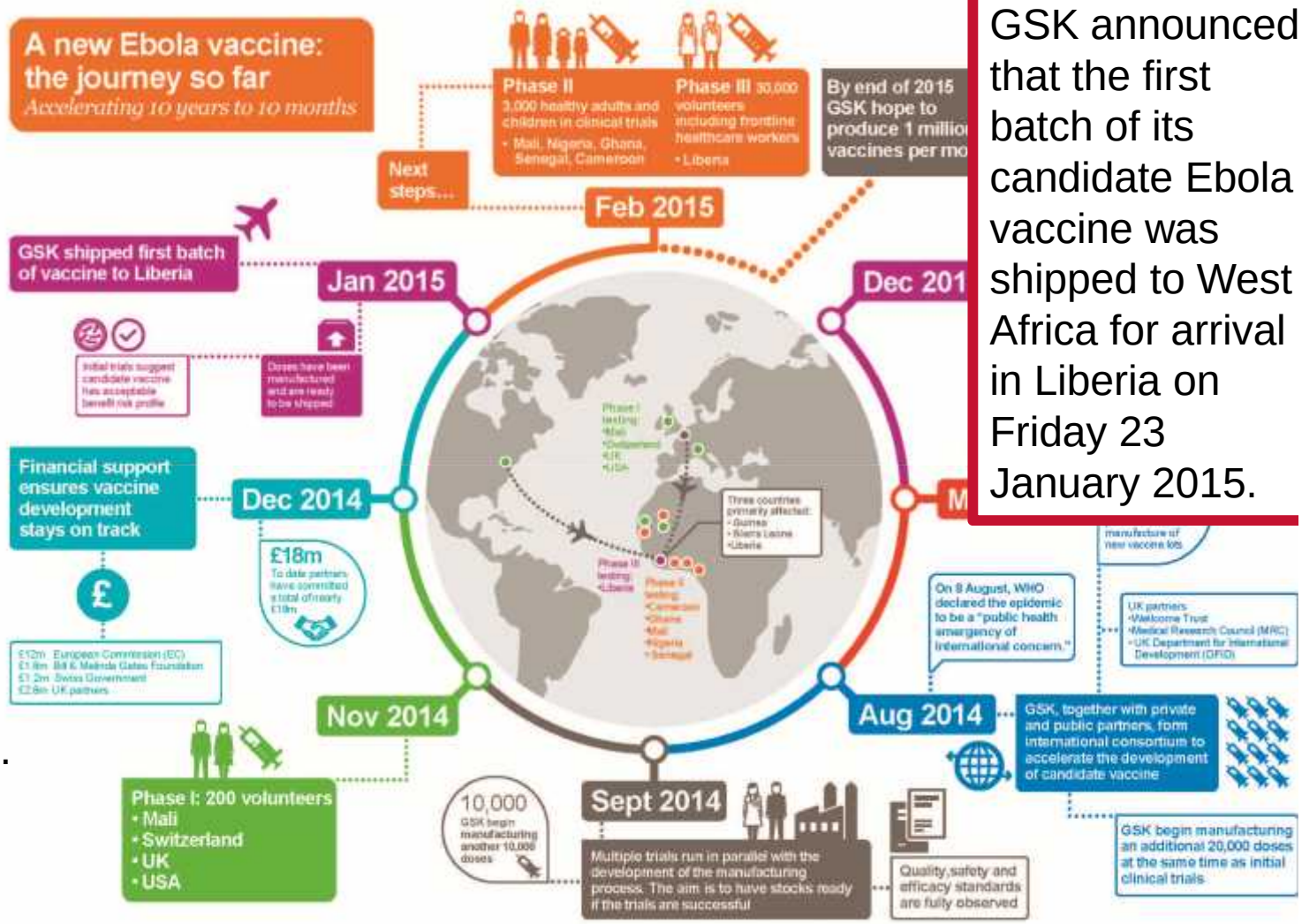
R_0 influences for elicitation

- Personal hygiene standards
- Social interaction: greetings, etc..
- Funeral practices: burial, cremation etc..
- Population compliance with curfew and quarantine orders
- Efficacy of the public health care system
- The scope of intensive care facilities
- Development of effective treatments
- Production of a safe vaccine

VSV-EBOV was developed by the Public Health Agency of Canada.

The vaccine was licensed to NewLink Genetics.

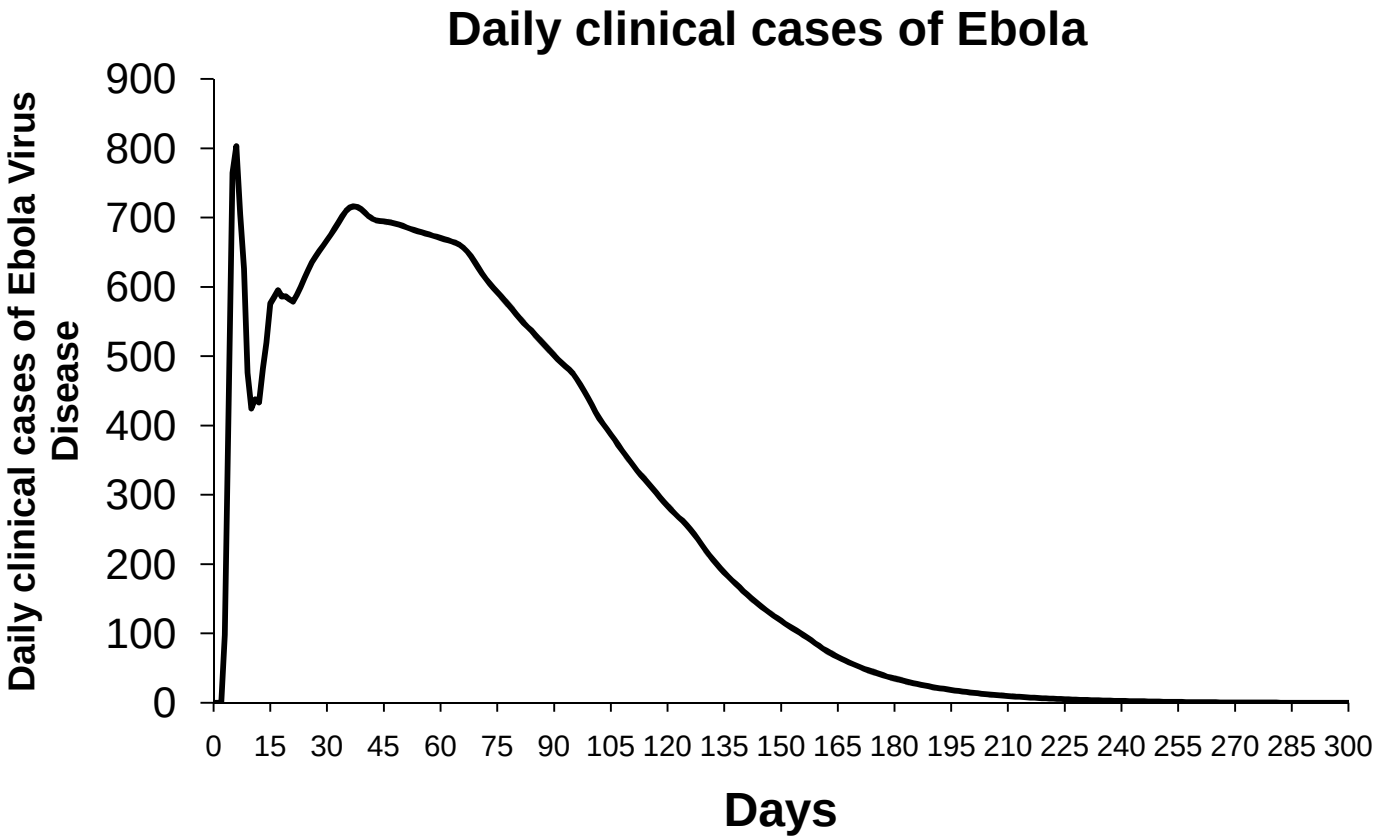
On 24 November 2014, Merck & NewLink Genetics entered into an exclusive worldwide licensing agreement.



GSK announced that the first batch of its candidate Ebola vaccine was shipped to West Africa for arrival in Liberia on Friday 23 January 2015.

Time horizon	Category of treatment	% patients
0 to 30 days	Hospitalized	**10%**
	Effective home treatment	**20%**
	No effective home treatment	**70%**
31 to 60 days	Hospitalized	**20%**
	Effective home treatment	**25%**
	No effective home treatment	**55%**
61 to 90 days	Hospitalized	**35%**
	Effective home treatment	**30%**
	No effective home treatment	**35%**

CDC projections for Liberia



DIARY OF AN EVOLVING PUBLIC HEALTH CRISIS

MARCH 2014

23 March: The Ministry of Health (MoH) of Guinea has notified WHO of a rapidly evolving outbreak of Ebola virus disease (EVD) in forested areas of south-eastern Guinea.

APRIL 2014

5 April: The WHO Country Office in Liberia is working closely with the national health ministry to carry out needs assessments in areas such as procurement and the supply chain for critical materials and equipment need in the response to the outbreak.

DIARY OF AN EVOLVING PUBLIC HEALTH CRISIS

MAY 2014

15 May: WHO continues to support the Ministries of Health of Guinea and Liberia in their EVD prevention and control activities.

WHO does not recommend that any travel or trade restrictions be applied to Guinea or Liberia based on the current information available for this event.

JUNE 2014

23 June: WHO and partners are providing the necessary technical support to the Ministries of Health.

This includes a high-level advocacy meeting with the governments of the three affected countries to enhance coordination, information management, and communication.

JULY 2014

24 July: The Director General of WHO held discussions with the donor community and development partners in Geneva.

Countries and agencies again pledged their assistance and support to the outbreak and efforts were underway to secure additional human and financial resources.

DIARY OF AN EVOLVING PUBLIC HEALTH CRISIS

AUGUST 2014

1 Aug: WHO and the government of Sierra Leone, Guinea and Liberia launched a joint US$ 100 million response plan.

8 Aug: WHO declared the Ebola outbreak in West Africa a Public Health Emergency of International Concern (PHEIC).

28 Aug: WHO issued a "roadmap" to scale up the international response.

SEPTEMBER 2014

19 Sep: UN Mission for Ebola Emergency Response (UNMEER) established.

30 Sep: CDC confirmed the first laboratory-confirmed case of Ebola to be diagnosed in the United States in a man who had traveled to Dallas, Texas from Liberia.

OCTOBER 2014

17 Oct: WHO declared Senegal free of Ebola virus transmission.

20 Oct: WHO declared Nigeria free of Ebola virus transmission.

24 Oct: Mali confirmed its first case of Ebola.