



Robert Stempel College
of Public Health
& Social Work

8th International Conference
GLOBAL HEALTH CONSORTIUM
Building Alliances in Global Health
Miami, May 22-25, 2018

EPIDEMICS AND PANDEMICS: PREDICTION, PREVENTION, CONTROL?

José Esparza MD, PhD

- Adjunct Professor, Institute of Human Virology, University of Maryland School of Medicine, Baltimore, MD, USA
- Robert Koch Fellow, Robert Koch Institute, Berlin, Germany
- Associate Investigator, Instituto de Investigaciones Clínicas, University of Zulia, Maracaibo, Venezuela.

Formerly: - Bill & Melinda Gates Foundation, Seattle, WA, USA

- World Health Organization, Geneva, Switzerland
- Instituto Venezolano de Investigaciones Científicas (IVIC), Caracas, Venezuela.

In the last 15 years at least 11 different viruses have emerged or re-emerged causing large epidemics or pandemics:

- From 2013 to 2015 were Ebola and chikungunya**
- In 2016 was Zika**
- Yellow Fever and Lassa are currently causing large outbreaks in Brazil and Nigeria (and monkeypox!).**

In the last 15 years at least 11 different viruses have emerged or re-emerged causing large epidemics or pandemics:

- From 2013 to 2015 were Ebola and chikungunya**
- In 2016 was Zika**
- Yellow Fever and Lassa are currently causing large outbreaks in Brazil and Nigeria (and monkeypox!).**

Yellow fever in Brazil: (from July 2017): 1257 cases and 394 deaths.
Lassa in Nigeria: Since early 2018 more than 120 deaths
Monkeypox in Nigeria: Since September 2017, 61 cases

In the last 15 years at least 11 different viruses have emerged or re-emerged causing large epidemics or pandemics:

- From 2013 to 2015 were Ebola and chikungunya**
- In 2016 was Zika**
- Yellow Fever and Lassa are currently causing large outbreaks in Brazil and Nigeria (and monkeypox!).**

THE QUESTION IS NOT IF A NEW INFECTIOUS DISEASE EPIDEMIC OR PANDEMIC WILL OCCUR, BUT WHEN AND BY WHAT AGENT ?

In the last 15 years at least 11 different viruses have emerged or re-emerged causing large epidemics or pandemics:

- From 2013 to 2015 were Ebola and chikungunya**
- In 2016 was Zika**
- Yellow Fever and Lassa are currently causing large outbreaks in Brazil and Nigeria (and monkeypox!).**

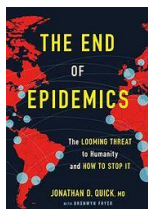
THE QUESTION IS NOT IF A NEW INFECTIOUS DISEASE EPIDEMIC OR PANDEMIC WILL OCCUR, BUT WHEN AND BY WHAT AGENT ?

Recent emergence of Ebola in the Democratic Republic of Congo: 23 deaths

A century of epidemics

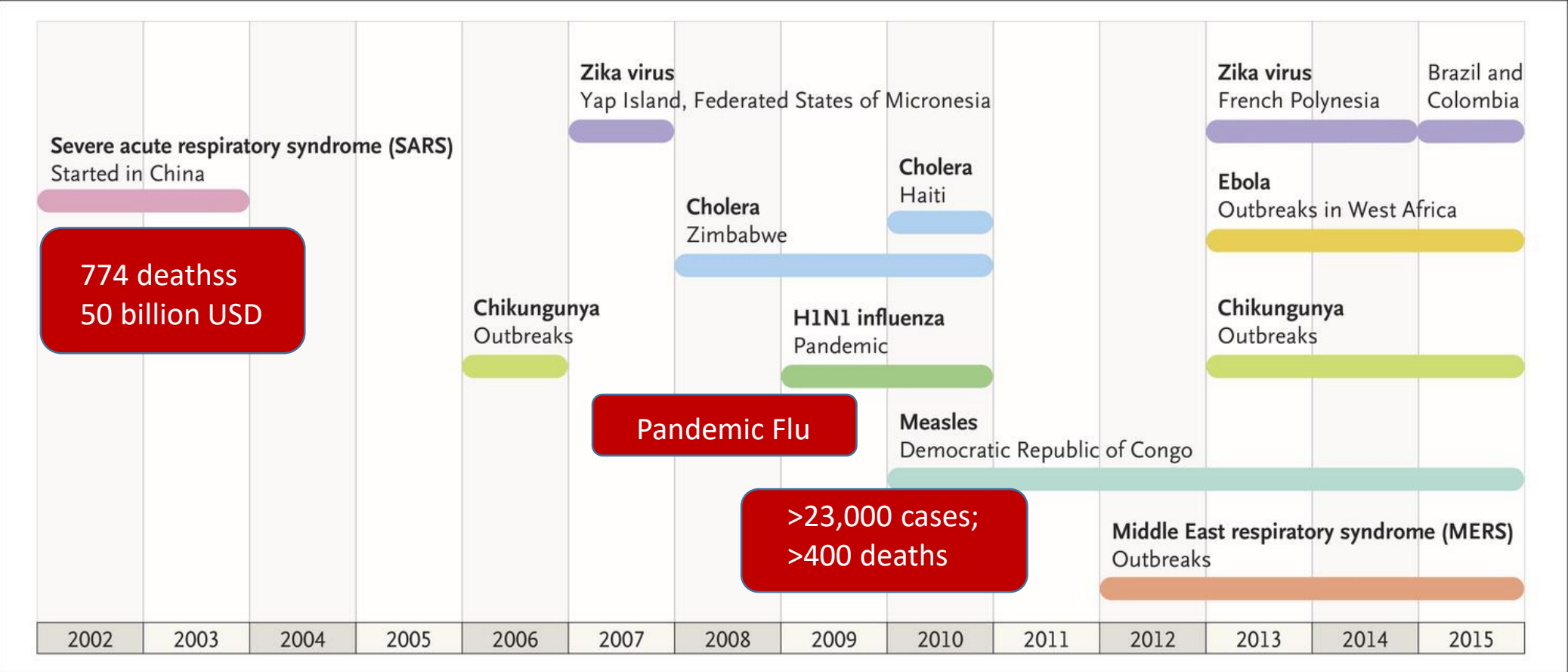
YEAR	EPIDEMIC	DEATHS
1918	Spanish Flu (H1N1)	50-100 millions
1937	West Nile Virus	> 15,000
1957	Asian Flu (H2N2)	~ 100,000
1968	Hong Kong Flu (H3N2)	
1976-2012	Ebola Virus	
1981-2017	HIV/AIDS	~ 40 millions
1999-2000	Flu (H5N2 & H7N7)	
2002	SARS coronavirus	774

YEAR	EPIDEMIC	DEATHS
2003-2016	Avian Flu (H5N1)	449
2009	Swine Flu (H1N1)	284,5000
2012-2016	MERS Coronavirus	> 750
2013-2016	Avian Flu (H7N9)	295
2014-2016	West Africa Ebola	11,325
1981-2017	Zika	20
Ongoing	Yellow Fever (Brazil, Africa)	
Ongoing	Lassa (Nigeria)	



Adapted from: Jonathan Quick, The End of Epidemics, 2018

IMPORTANT EPIDEMICS OR PANDEMICS DUE TO EMERGENT OR RE-EMERGING DISEASES (2002-2015)



774 deathss
50 billion USD

Pandemic Flu

>23,000 cases;
>400 deaths

Millions of cases since 2016;
Microcephaly
3.5 billion USD

11,300 deaths;
2.2 billion USD

Millions of cases since 2013.

643 deaths (2012- 2015);
26 countries

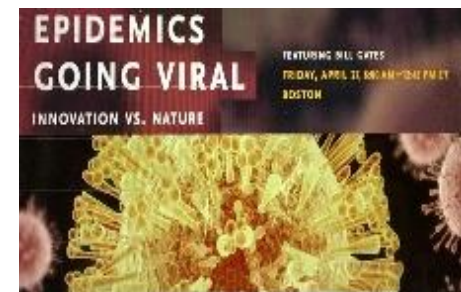
Sands P, Mundaca-Shah C, Dzau VJ. The Neglected Dimension of Global Security — A Framework for Countering Infectious-Disease Crises. *New England Journal of Medicine*, January 13,2016

“Life can only be understood backwards;
but it must be lived forwards”



Søren Kierkegaard (1813-1855)

Quoted by Harvey V. Fineberg (Epidemics going viral, April 27, 2018)



LESSONS LEARNED FROM RECENT EPIDEMICS AND PANDEMICS

- **Emerging and re-emerging diseases can be caused by multiple different agents, especially by many different families of viruses;**
- **Emerging and re-emerging diseases are nothing new;**
- **Emerging viruses can circulate locally for years before causing epidemics or pandemics (opportunities for early detection);
Some emerging and re-emerging viral epidemics will not go away; and**
- **The economic cost of epidemics and pandemics is enormous!**

MEMBERS OF MANY VIRUS FAMILIES CAN CAUSE EMERGING AND RE-EMERGING EPIDEMICS

SMALLPOX

CRIMEAN CONGO HF
RIFT VALLEY FEVER
SFTS

NIPAH

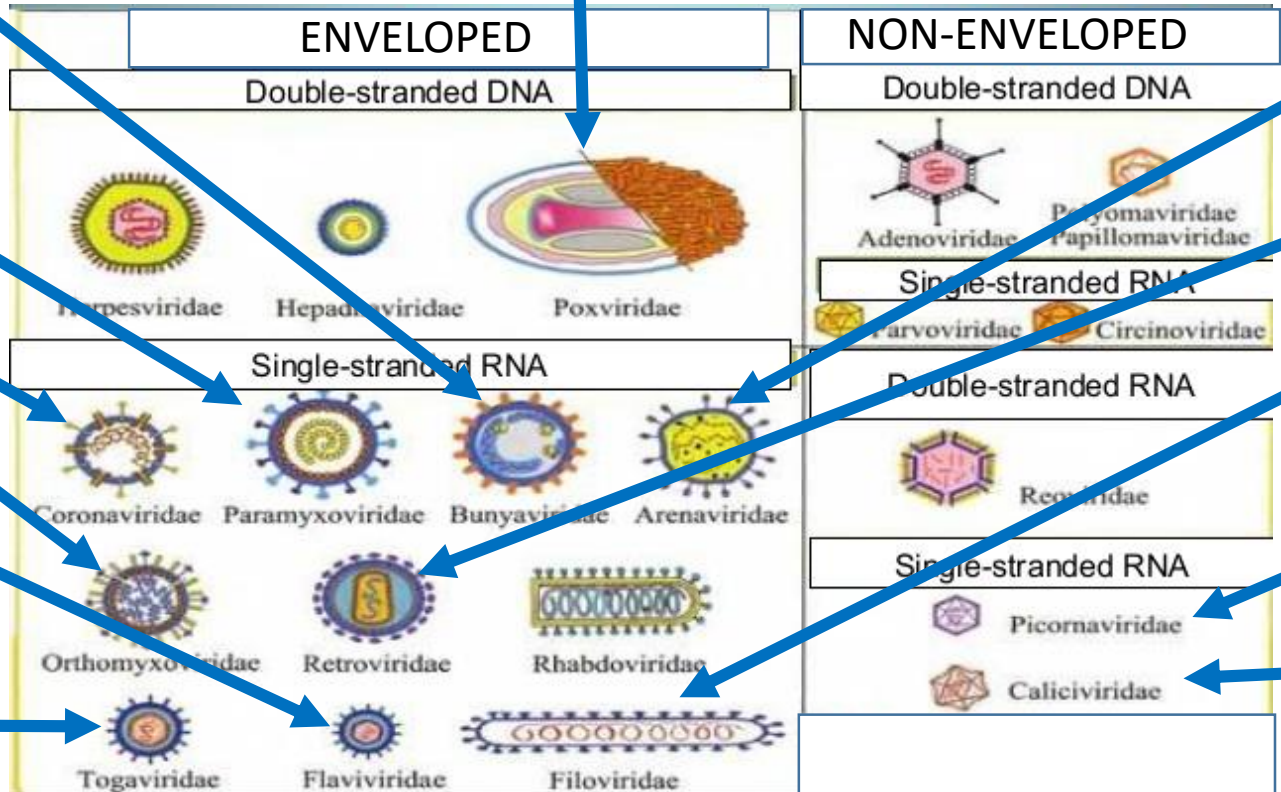
SARS
MERS

INFLUENZA

YELLOW FEVER
DENGUE
WEST NILE
ZIKA

CHIKUNGUNYA

Arthropod borne



LASSA
JUNIN
LUJO

HIV, HTLV I

EBOLA
MARBURG

POLIO

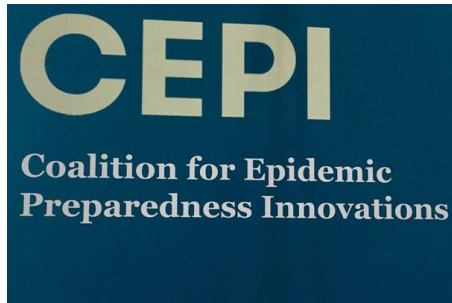
NORO



WHO PRIORITY DISEASES (2018)

- Crimean-Congo hemorrhagic fever (CCHF)
 - Ebola virus disease and Marburg virus disease
 - Lassa fever.
 - Middle East respiratory syndrome coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS)
 - Nipah and henipaviral diseases
 - Rift Valley fever (RVF)
 - Zika
 - Disease X
-
- Others: chikungunya, monkeypox, severe fever with thrombocytopenia syndrome

From: 2018 Annual Review of diseases prioritized under the Research and Development Blueprint.
Informal consultation. 6-7 February 2018. Geneva, Switzerland .



- New CEPI funding for vaccine development:
 - Lassa fever
 - Nipah
 - Middle East Respiratory Syndrome (MERS)
- Other needed vaccines:
 - Universal influenza vaccine
 - Highly pathogenic filoviruses (Ebola, Marburg)
 - Novel orthopoxvirus vaccines (smallpox, monkeypox)
 - Zika
 - Etc.

Why are we at risk from local outbreaks turning into global pandemics?

- Population growth: urbanization and encroachment into new environments
- Spread of infectious diseases through global travel and trade
- Increased risk of infectious pathogens “spilling over” from animals to humans (zoonosis)
- Climate change
- Development of antimicrobial resistance
- Weak public health infrastructures (few medical personnel doctors in outbreak regions)
- Civil conflicts
- Acts of bioterrorism

Source (modified from): CDC Global Health Protection and Security. Why it Matters: The Pandemic Threat. Online March 22, 2018. <https://content.govdelivery.com/accounts/USCDC/bulletins/1ea4555>

POPULATION GROWTH: URBANIZATION AND ENCROACHMENT INTO NEW ENVIRONMENTS

- 1800: 1 billion
- 1900: 1.65 billion
- 2000: 8 billion
- 2050: 9.7 billion

Urbanization and overcrowding facilitates transmission.

SPREAD OF INFECTIOUS DISEASES THROUGH GLOBAL TRADE AND TRADE

- 1975: 500 million
- 1990: 1 billion
- 2017: 3 billion

Why are we at risk from local outbreaks turning into global pandemics?

- Population growth: urbanization and encroachment into new environments
- Spread of infectious diseases through global travel and trade
- Increased risk of infectious pathogens “spilling over” from animals to humans (zoonosis)
- Climate change
- Development of antimicrobial resistance
- Weak public health infrastructures (few medical personnel doctors in outbreak regions)
- Civil conflicts
- Acts of bioterrorism

Source (modified from): CDC Global Health Protection and Security. Why it Matters: The Pandemic Threat. Online March 22, 2018. <https://content.govdelivery.com/accounts/USCDC/bulletins/1ea4555>

ZOONOSIS: a disease that can be transmitted to humans from animals

Influenza epidemic cycles

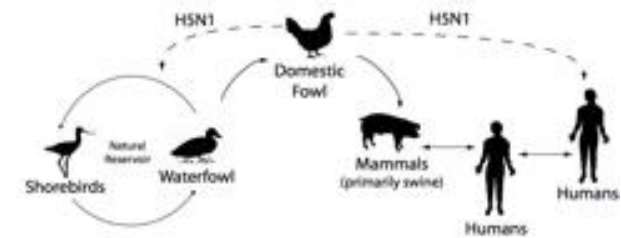
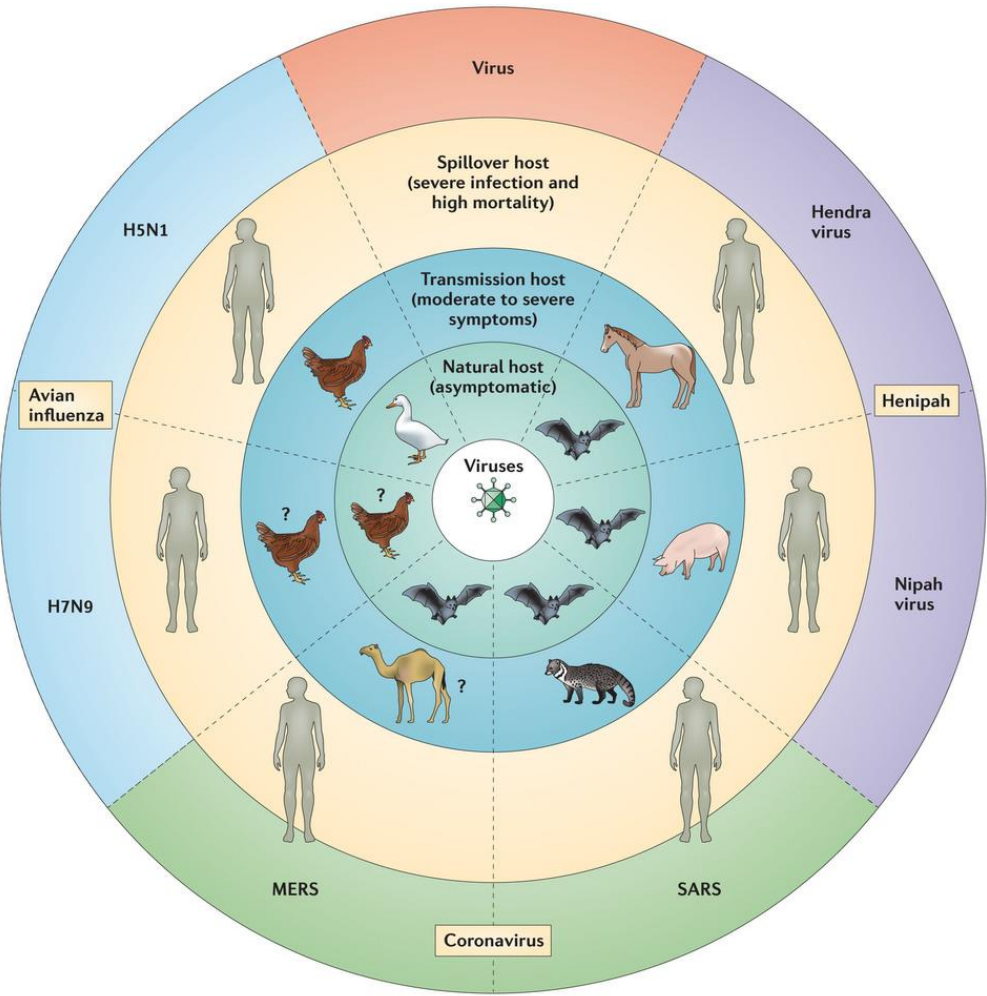


Figure 1. Possible transmission pathways for avian influenza.
 U.S. Department of the Interior
 U.S. Geological Survey



Ebola epidemic cycle

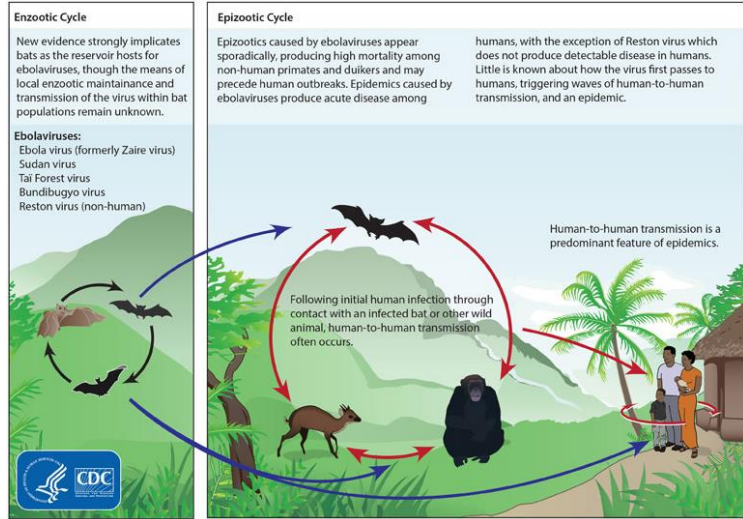
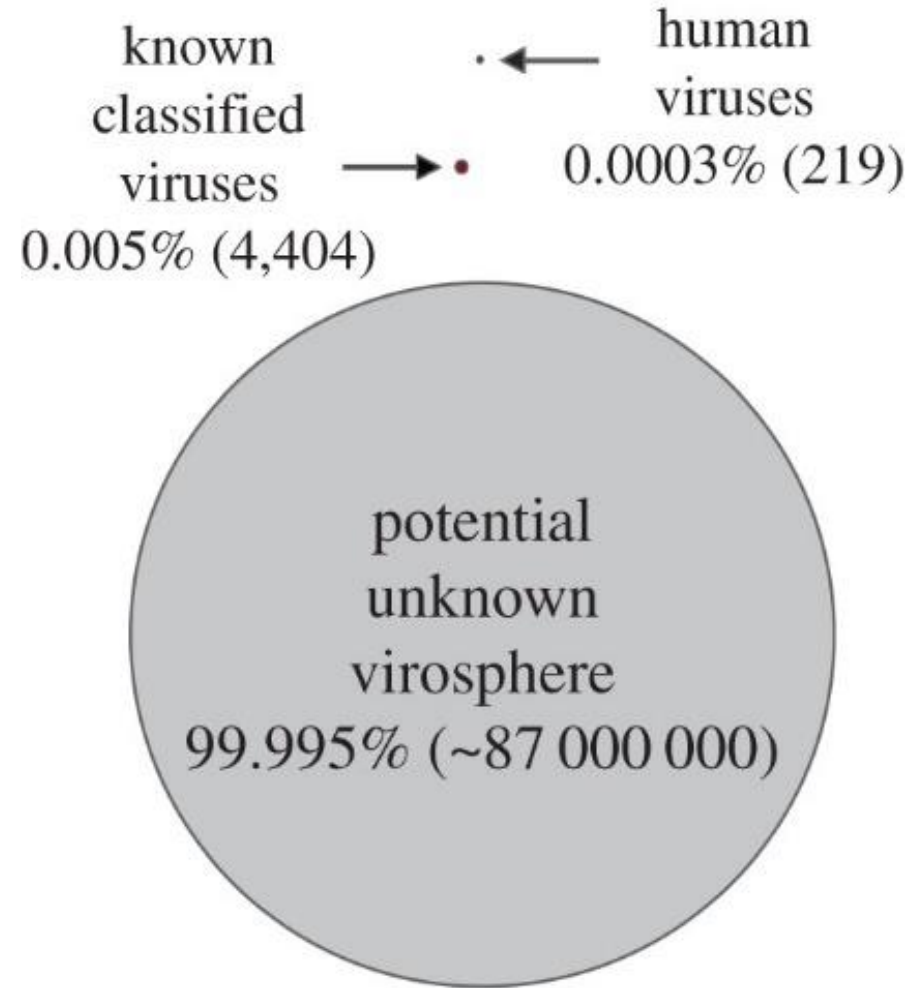
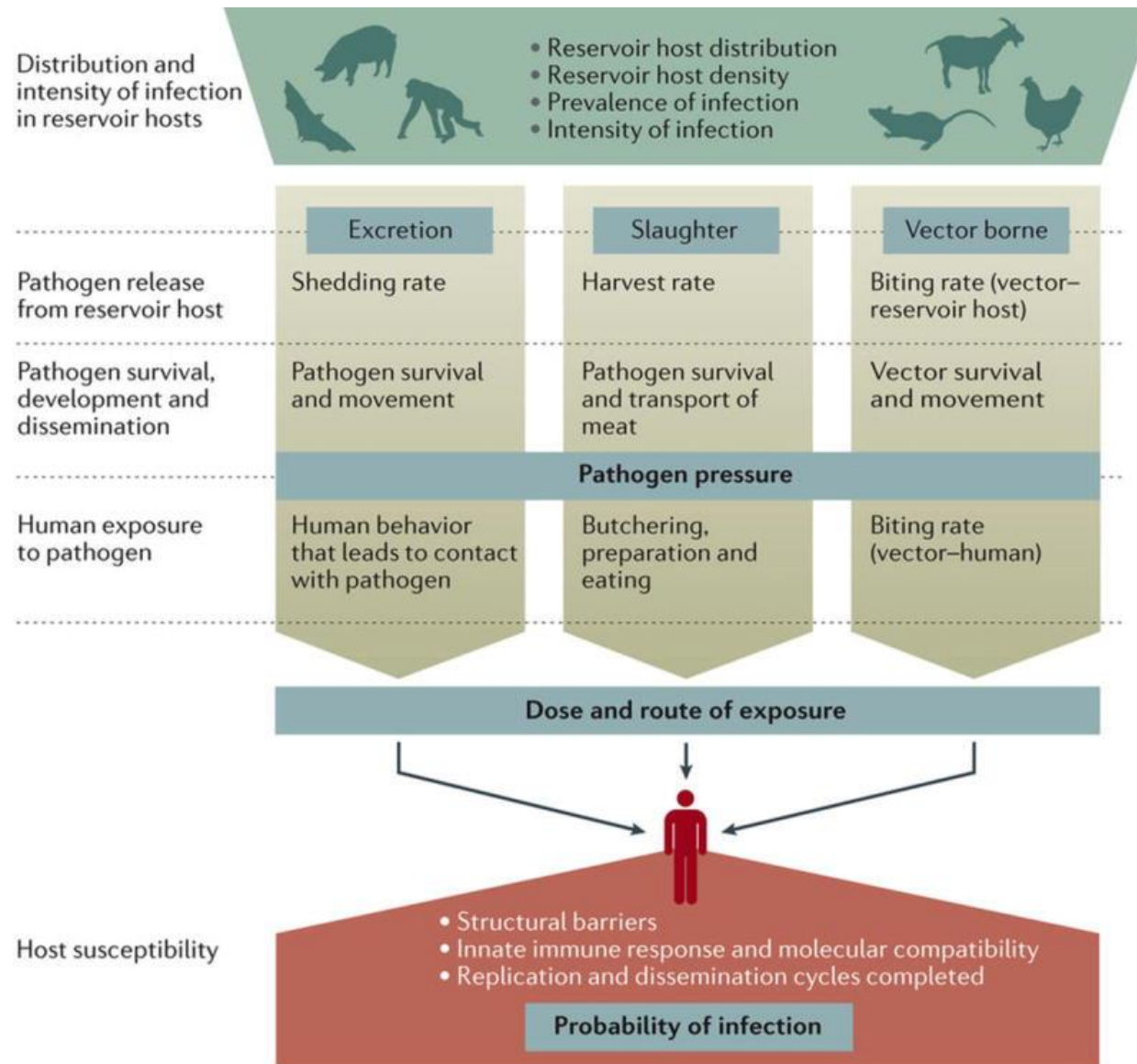


Illustration of the relative size of the potentially unknown virosphere



Pathways to zoonotic spillover

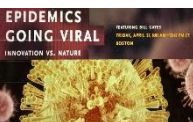
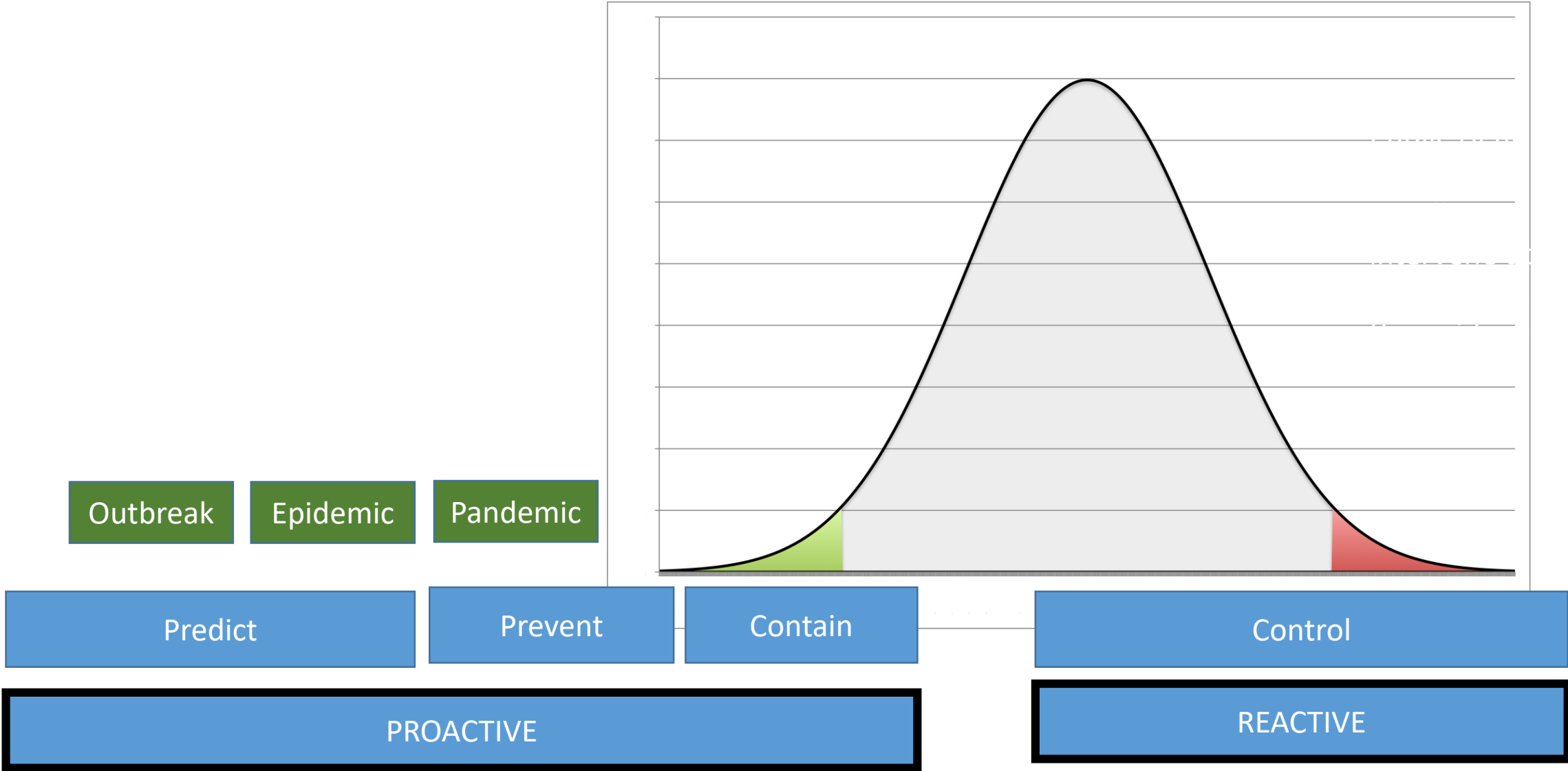


Why are we at risk from local outbreaks turning into global pandemics?

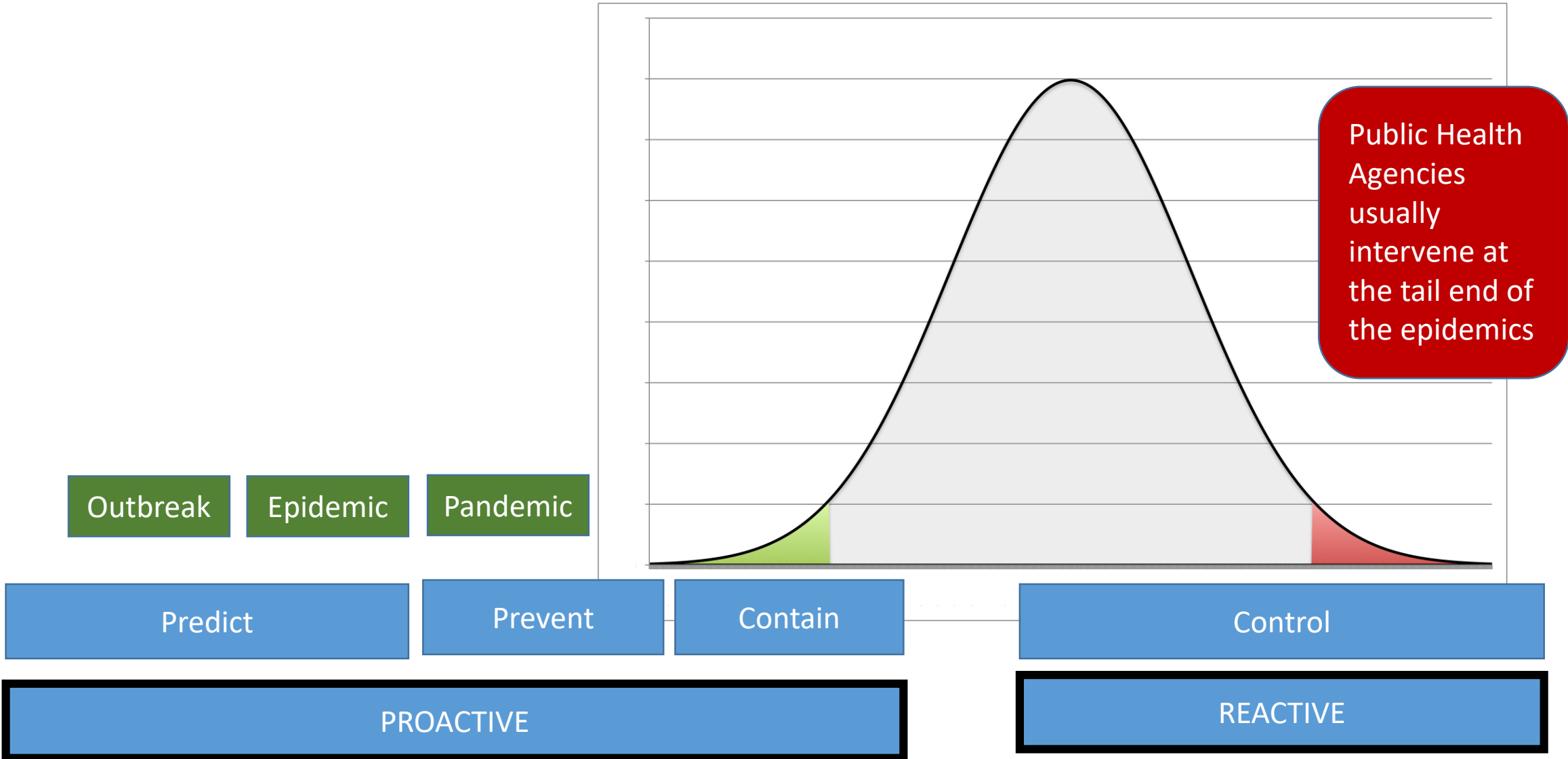
- Population growth: urbanization and encroachment into new environments
- Spread of infectious diseases through global travel and trade
- Increased risk of infectious pathogens “spilling over” from animals to humans (zoonosis)
- Climate change
- Development of antimicrobial resistance
- Weak public health infrastructures (few medical personnel doctors in outbreak regions)
- Civil conflicts
- Acts of bioterrorism

Source (modified from): CDC Global Health Protection and Security. Why it Matters: The Pandemic Threat. Online March 22, 2018. <https://content.govdelivery.com/accounts/USCDC/bulletins/1ea4555>

THE GLOBAL RESPONSE TO EPIDEMICS IS USUALLY TOO LITTLE TOO LATE



THE GLOBAL RESPONSE TO EPIDEMICS IS USUALLY TOO LITTLE TOO LATE



THE GLOBAL RESPONSE TO EPIDEMICS IS USUALLY TOO LITTLE TOO LATE

EARLY DETECTION

- Astute clinical observation
- Laboratory tests
- Event-based surveillance

Outbreak

Epidemic

Pandemic

Predict

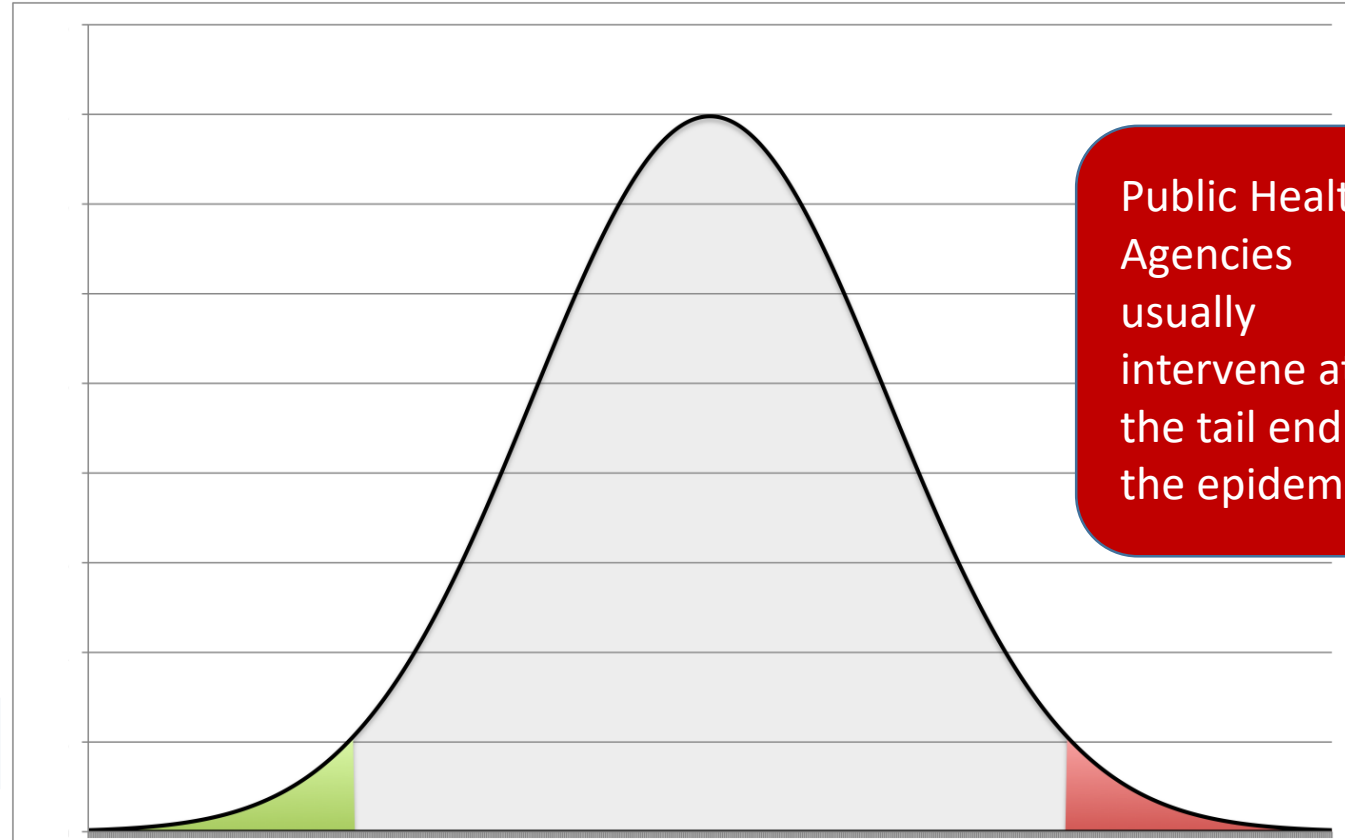
Prevent

Contain

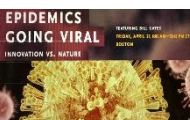
Control

PROACTIVE

REACTIVE



Public Health Agencies usually intervene at the tail end of the epidemics



THE GLOBAL RESPONSE TO EPIDEMICS IS USUALLY TOO LITTLE TOO LATE

EARLY DETECTION

- Astute clinical observation
- Laboratory tests
- Event-based surveillance

INNOVATIVE DETECTION TOOLS

- Global Surveillance and modeling
- Link with travel, climate, etc.
- Monitoring social media

Outbreak

Epidemic

Pandemic

Predict

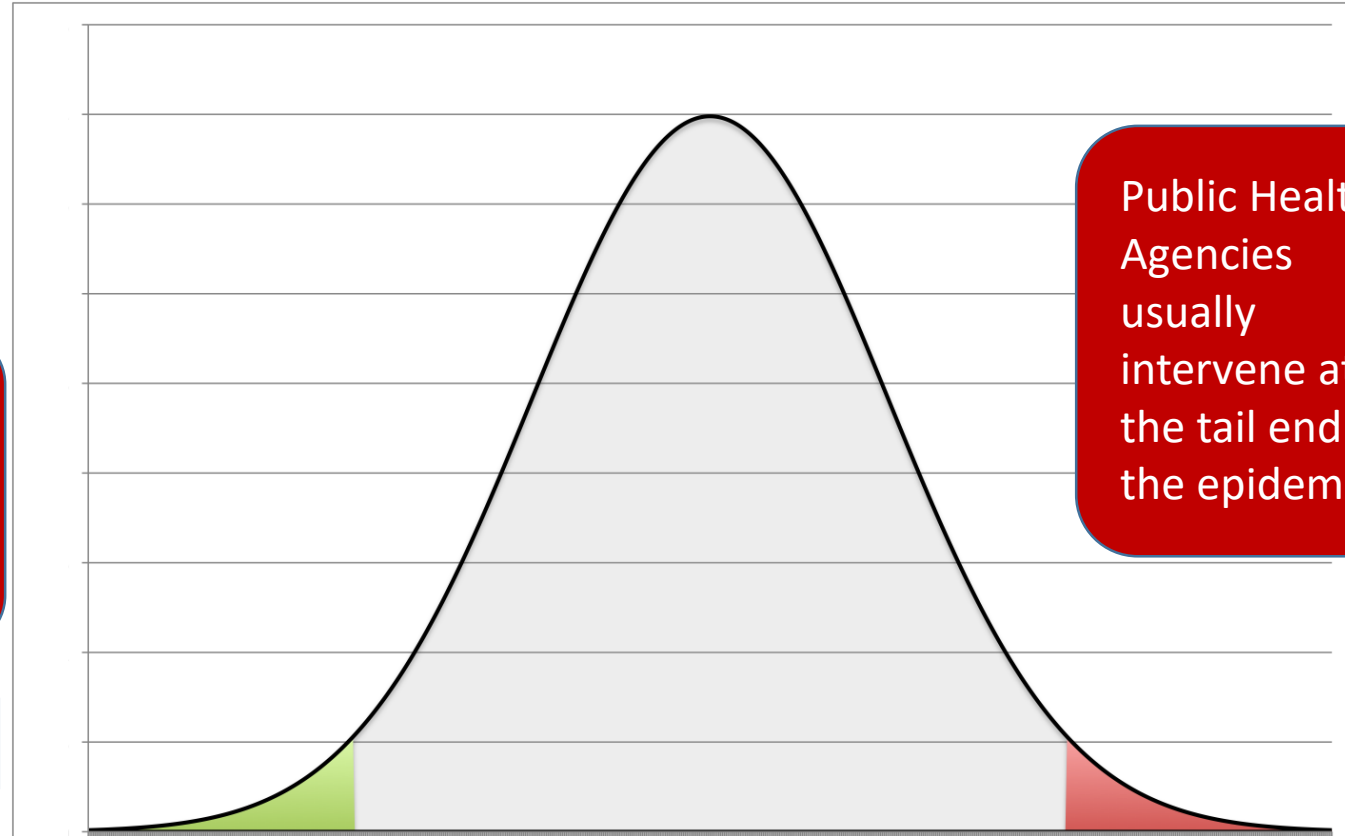
Prevent

Contain

Control

PROACTIVE

REACTIVE



Public Health Agencies usually intervene at the tail end of the epidemics

THE GLOBAL RESPONSE TO EPIDEMICS IS USUALLY TOO LITTLE TOO LATE

EARLY DETECTION

- Astute clinical observation
- Laboratory tests
- Event-based surveillance

DECISION:
When to
initiate
a proactive
response?

INNOVATIVE DETECTION TOOLS

- Global Surveillance and modeling
- Link with travel, climate, etc.
- Monitoring social media

Outbreak

Epidemic

Pandemic

Predict

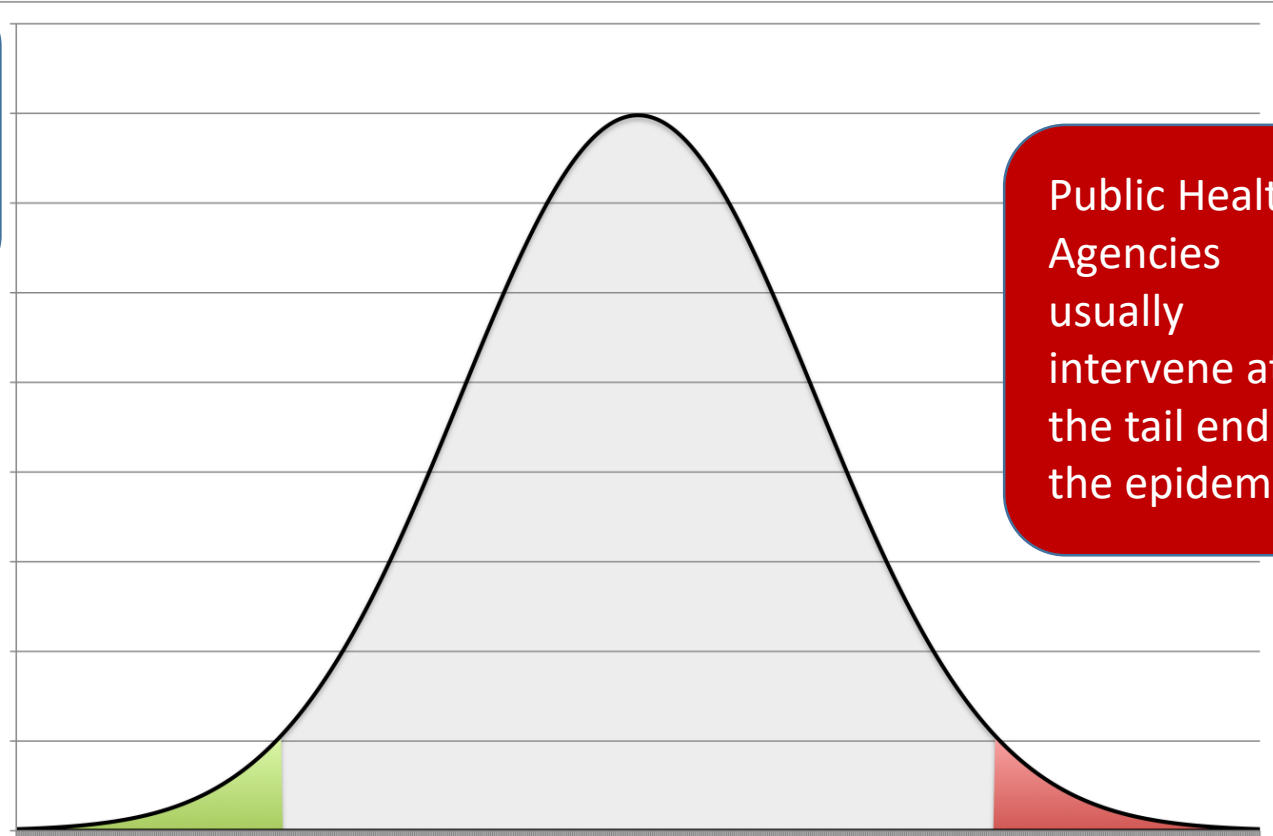
Prevent

Contain

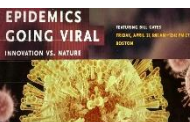
Control

PROACTIVE

REACTIVE



Public Health
Agencies
usually
intervene at
the tail end of
the epidemics



THE GLOBAL RESPONSE TO EPIDEMICS IS USUALLY TOO LITTLE TOO LATE

EARLY DETECTION

- Astute clinical observation
- Laboratory tests
- Event-based surveillance

DECISION:
When to
initiate
a proactive
response?

PREVENTIVE
INTERVENTIONS

- Vaccination
- Vector control
- Antivirals
- Social isolation

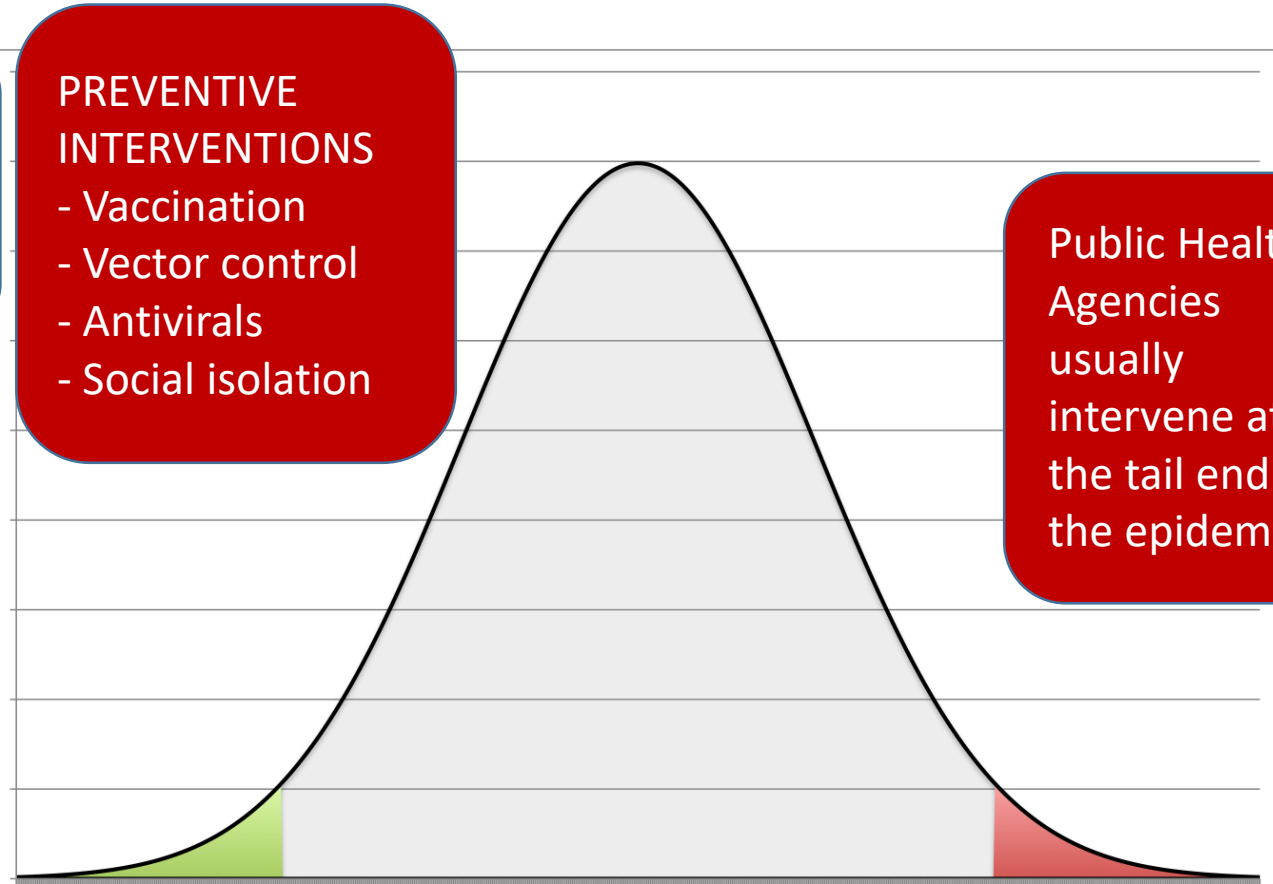
INNOVATIVE DETECTION TOOLS

- Global Surveillance and modeling
- Link with travel, climate, etc.
- Monitoring social media

Outbreak

Epidemic

Pandemic



Public Health
Agencies
usually
intervene at
the tail end of
the epidemics

Predict

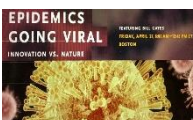
Prevent

Contain

Control

PROACTIVE

REACTIVE



THE GLOBAL RESPONSE TO EPIDEMICS IS USUALLY TOO LITTLE TOO LATE

POLITICAL COMMITMENT

EARLY DETECTION

- Astute clinical observation
- Laboratory tests
- Event-based surveillance

DECISION:
When to initiate
a proactive
response?

- ### PREVENTIVE INTERVENTIONS
- Vaccination
 - Vector control
 - Antivirals
 - Social isolation

INNOVATIVE DETECTION TOOLS

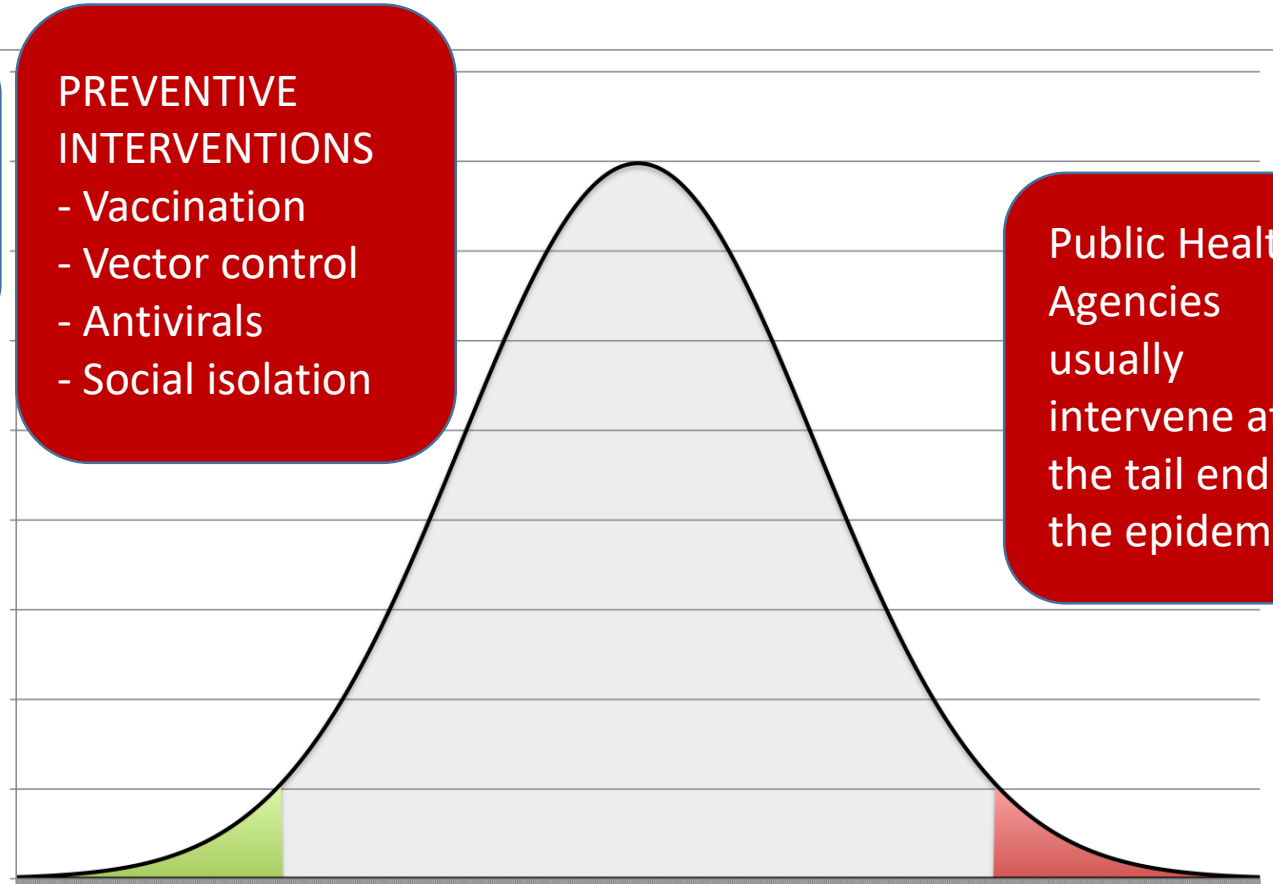
- Global Surveillance and modeling
- Link with travel, climate, etc.
- Monitoring social media

Outbreak

Epidemic

Pandemic

Public Health
Agencies
usually
intervene at
the tail end of
the epidemics



Predict

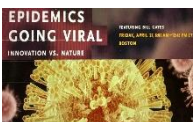
Prevent

Contain

Control

PROACTIVE

REACTIVE



SOME EXAMPLES OF SUCCESSFUL CONTROL OF PREVIOUS EPIDEMICS OR PANDEMICS

- Smallpox: Vaccination
- Yellow Fever: Vaccination
- Polio: Vaccination
- HIV/AIDS: Combination prevention (a vaccine is needed)
- Influenza: Social isolation (an Universal Flu Vaccine needed.)

Vaccines is the best tool to prevent and control epidemics. But not the only one.

RECOMMENDATIONS FOR PREPARING FOR FUTURE EPIDEMICS

- The world needs to build a **warning and response system** for outbreaks. This system should
 - be **coordinated by a global institution** that is given enough authority and funding to be effective,
 - enable **fast decision making** at a global level,
 - **expand investment in research and development** and clarify regulatory pathways for developing new tools and approaches,
 - **improve early warning and detection systems**, including scalable everyday systems that can be expanded during an epidemic,
 - involve a **reserve corps of trained personnel** and volunteers,
 - **strengthen health systems** in low- and middle-income countries, and
 - incorporate **preparedness exercises** to identify the ways in which the response system needs to improve.

THE COST OF PANDEMICS AND OF PREVENTING THEM

“The Neglected Dimension of Global Security — A Framework for Countering Infectious-Disease Crises”

(a 2016 Report of the US National Academy of Sciences)

- Expected economic losses due to pandemics: USD 60 billion/year
- Cost of implementing NAS recommendations: USD 4.5 billion/year
 - Upgrading the public health systems in low and middle income countries: USD 3.4 billion
 - Enhancing the WHO prevention and response capabilities: USD 130-150 million
 - Incremental research and development: USD 1 billion

The next pandemic is not a matter of “if”, it’s a matter of “when”.

... and we have to prepare for it, because it will affect individuals, families, business and communities, everywhere in the world.