Lesson Learned from Emerging Infectious Diseases: Are We Ready for the Next Pandemic?

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Joint Graduate Seminar
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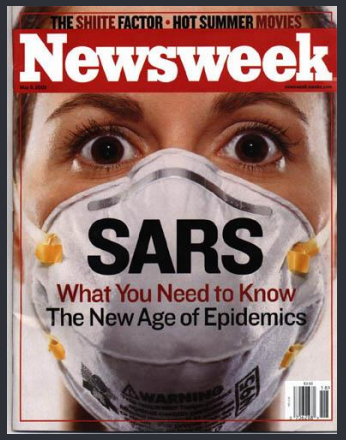


1

What are Emerging Infectious Diseases?

Why does it matters?

Emerging Infectious Diseases (EIDs)

Definition

Increasing frequency to describe the appearance of

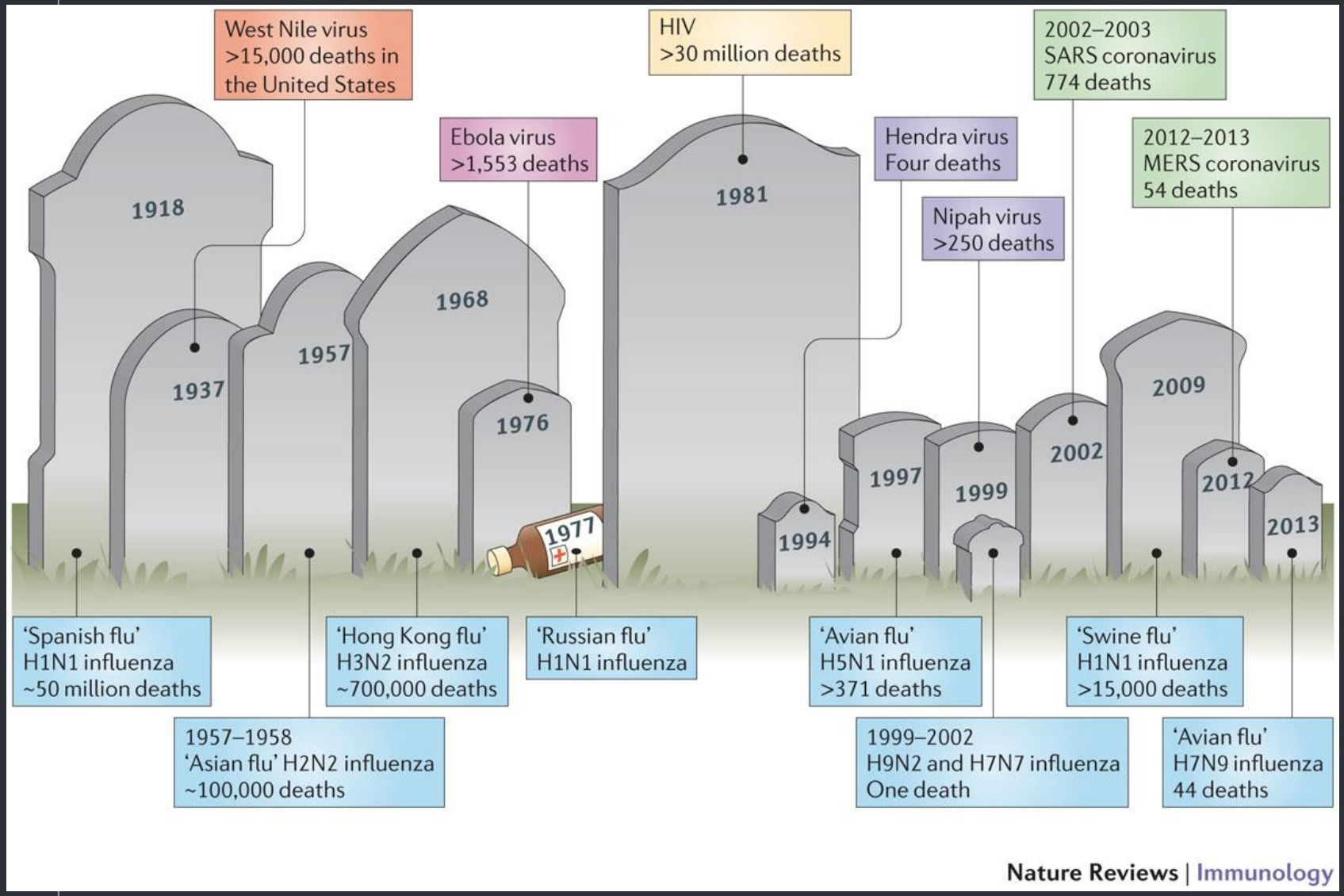
1. An **unrecognised** infection
2. A previously recognised infection → to a new ecological niche/geographical zone → significant change in pathogenicity

Facts

- Infectious diseases are **continuously emerging**
- Majority of human emerging infectious diseases are **zoonoses**
- Those that are not zoonoses have zoonotic origins
- Globalisation and human invasiveness → emergence opportunities ↑

(Howard and Fletcher, Emeging Microbes and Infections, 2012; van Doorn, Medicine (Abingdon), 2014)

Severity of Emerging Infectious Diseases



(Bean *et al.* Nature Reviews Immunology, 2013)

List of Blueprint Priority Diseases 2018

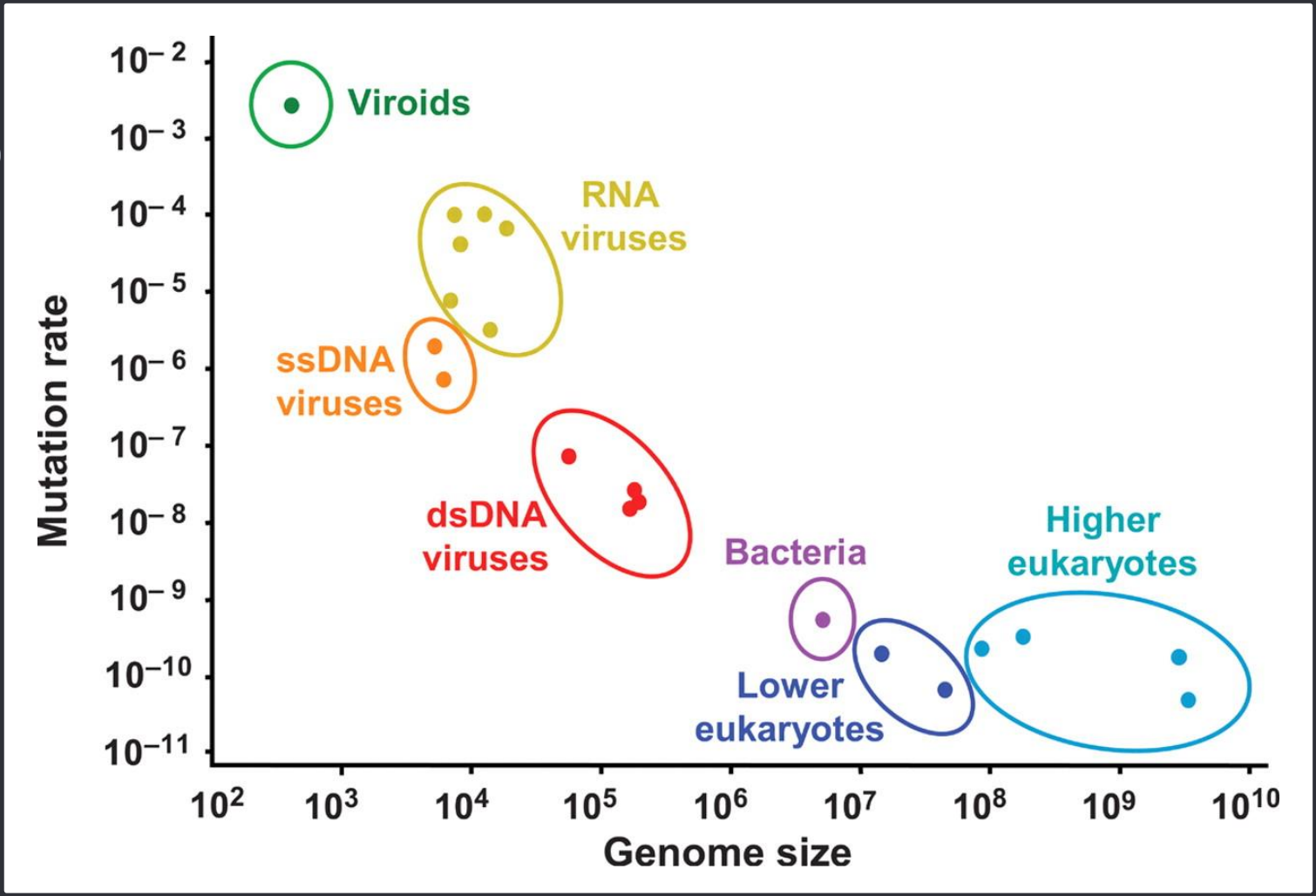
- Crimean-Congo haemorrhagic fever (CCHF)
- Ebola virus disease and Marburg virus disease
- Lassa fever
- Middle East respiratory syndrome coronavirus (MERS-CoV) and Severe Acute Respiratory Syndrome (SARS)
- Nipah and henipaviral diseases
- Rift Valley fever (RVF)
- Zika
- Disease X

World Health Organization

Why most of them are viral diseases?

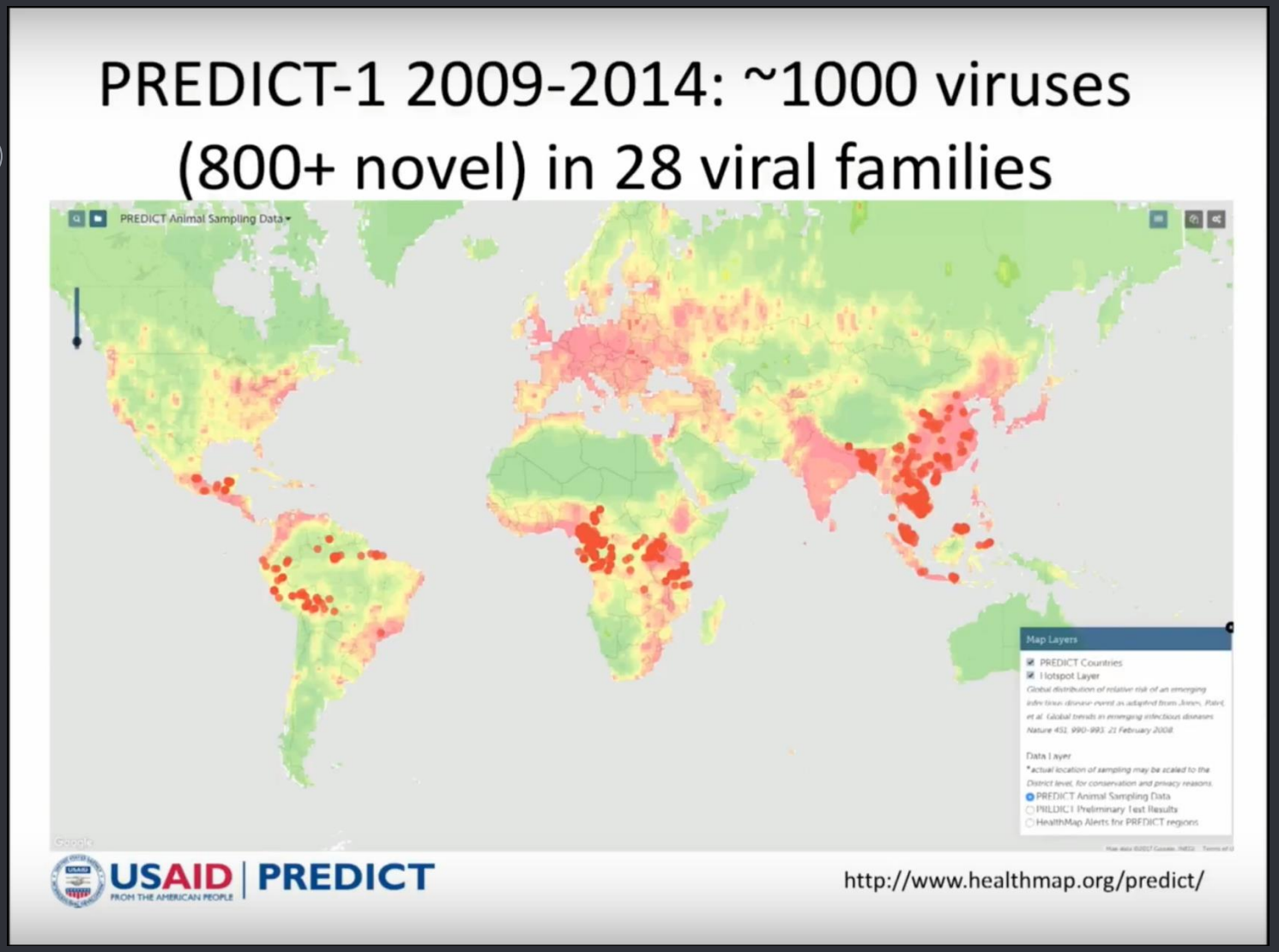
Where do they come from and how they evolve to infect human?

Mutation Rate V.S. Genome Size



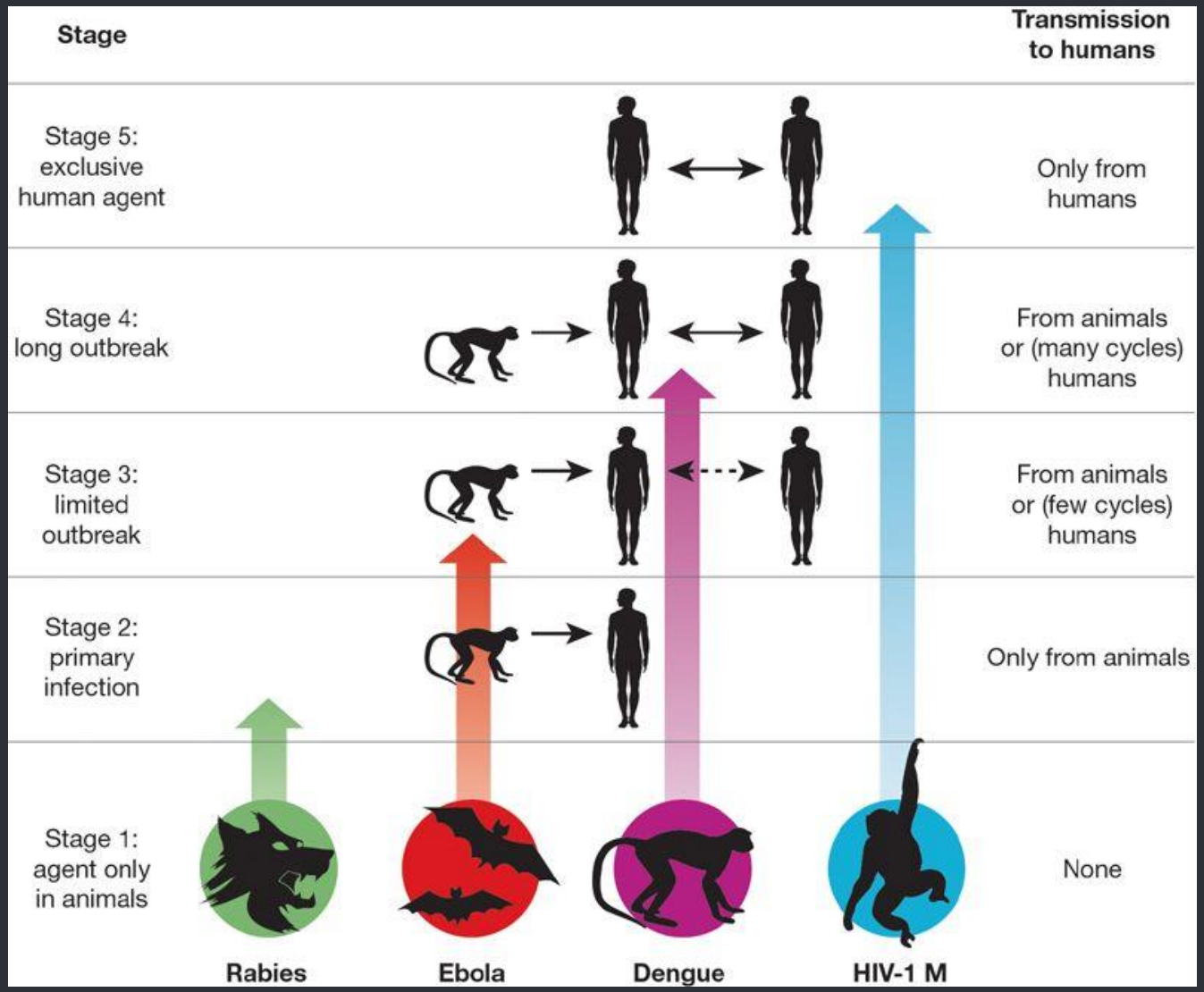
(Gago *et al.* Science, 2009)

Many of the viruses are UNKNOWN



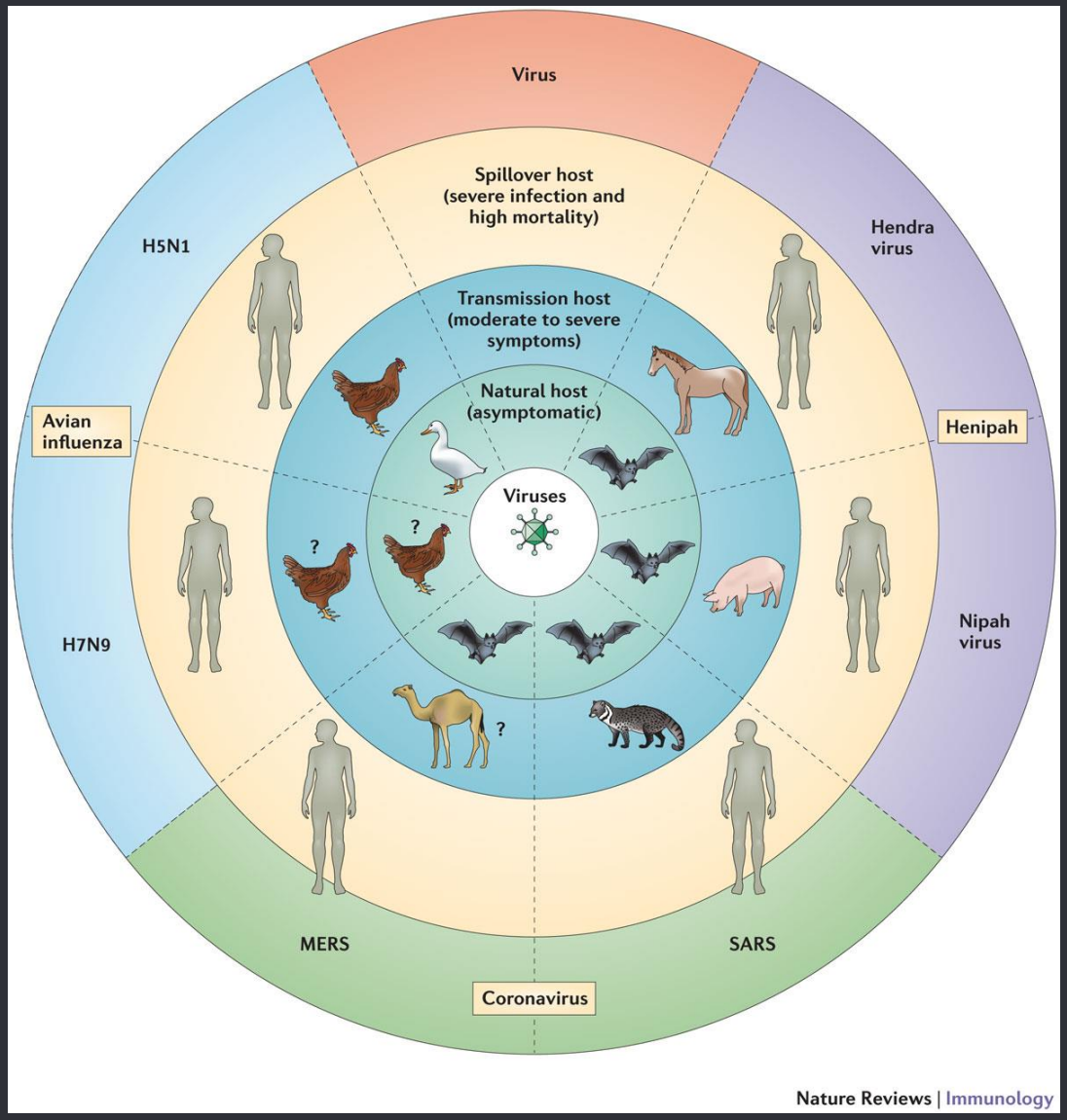
(Dr Peter Daszak's talk on "The beginning of an end to the Pandemic Era**",** Uppsala Health Summit, 2017)

Emergence of Zoonoses



(Wolfe, Dunavan and Diamond. Nature, 2007)

Multiple Species Barrier to become Zoonotic



(Bean *et al.* Nature Reviews Immunology, 2013)

2

Animals as Reservoir for EIDs

What favours viruses to jump from animals to human

List of Blueprint Priority Diseases 2018

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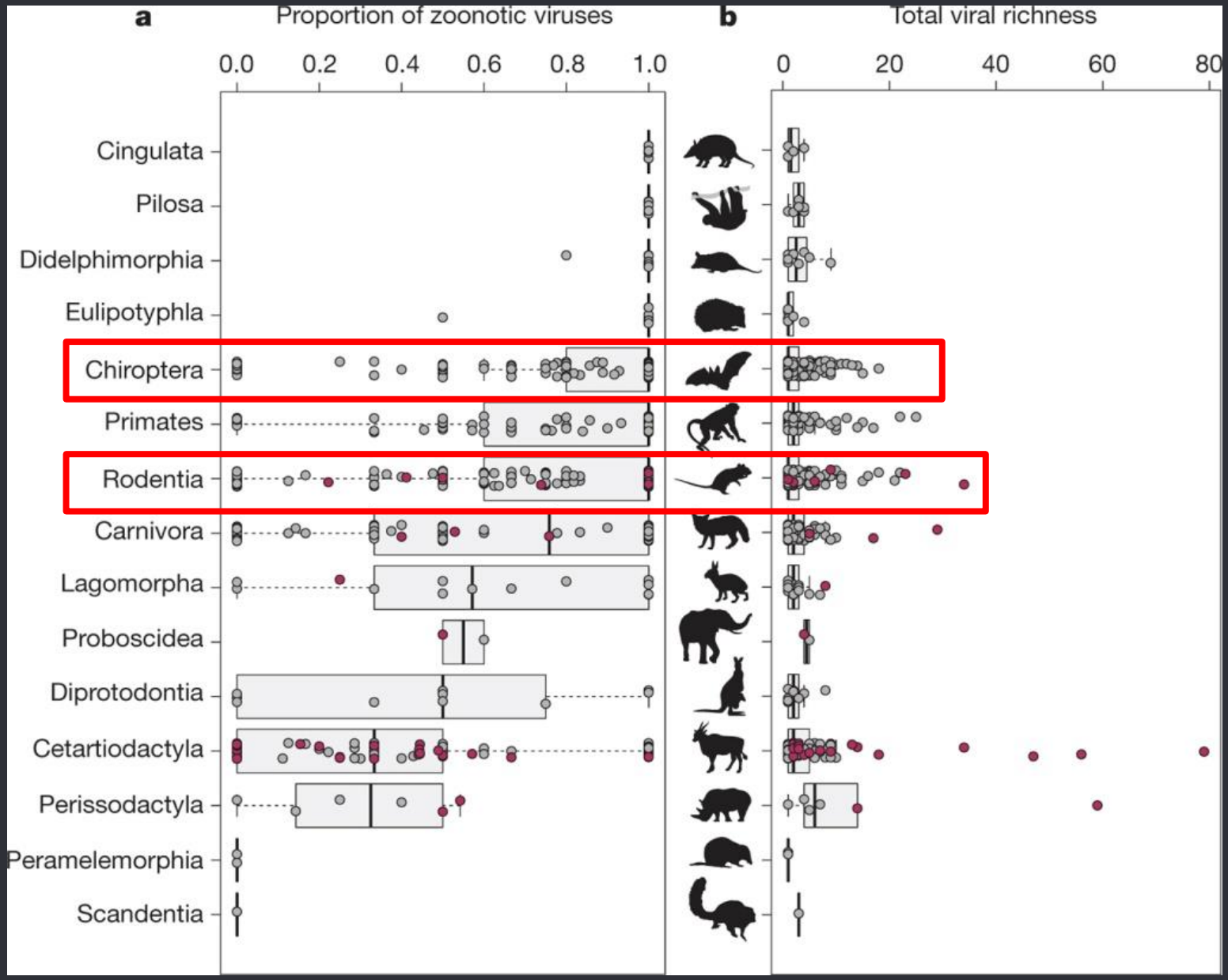
World Health Organization

Observed Viral Richness in mammals



(Olival *et al.* Nature, 2017)

Bats: a Good Reservoir of Deadly Viruses

- > 1200 species
- The only flying mammal
- Unique biological features

  - high metabolic and heart rate
  - Immune tolerance (“STING” pathway)
  - long-life span
- Anthropogenic activities ↑ interactions between bats, human and livestock

Asymptomatic carrier
+
Disseminator of highly pathogenic viruses

(Wynne and Wang, PLOS Pathogen, 2013; Xie *et al*, Cell Host & Microbe, 2018)




Disease X

VERY LIKELY TO BE A ZOONOTIC VIRAL DISEASE

A serious international epidemic could be caused by a pathogen currently unknown to cause human disease

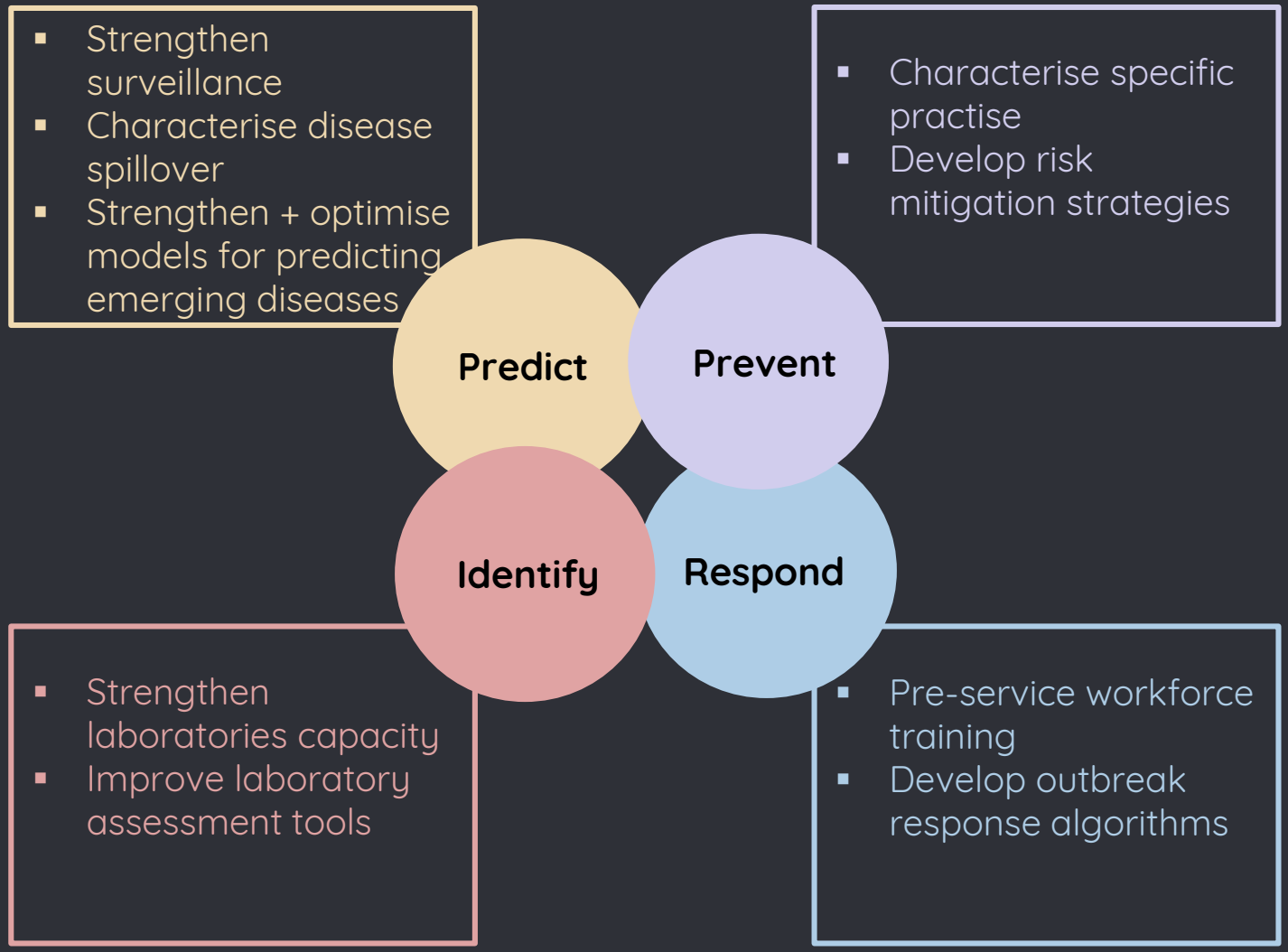



3

How are we going to tackle EIDs?

EPT programme - Advanced technologies - Challenges

Emerging Pandemic Threats (EPT) Programme



(USAID, 2017; OIE, 2017; WHO, 2017; FDA, 2017)

Advanced Technologies

- Event-based surveillance

- Web-based real-time surveillance

Google Trends

- Early warning and Alert response Networks

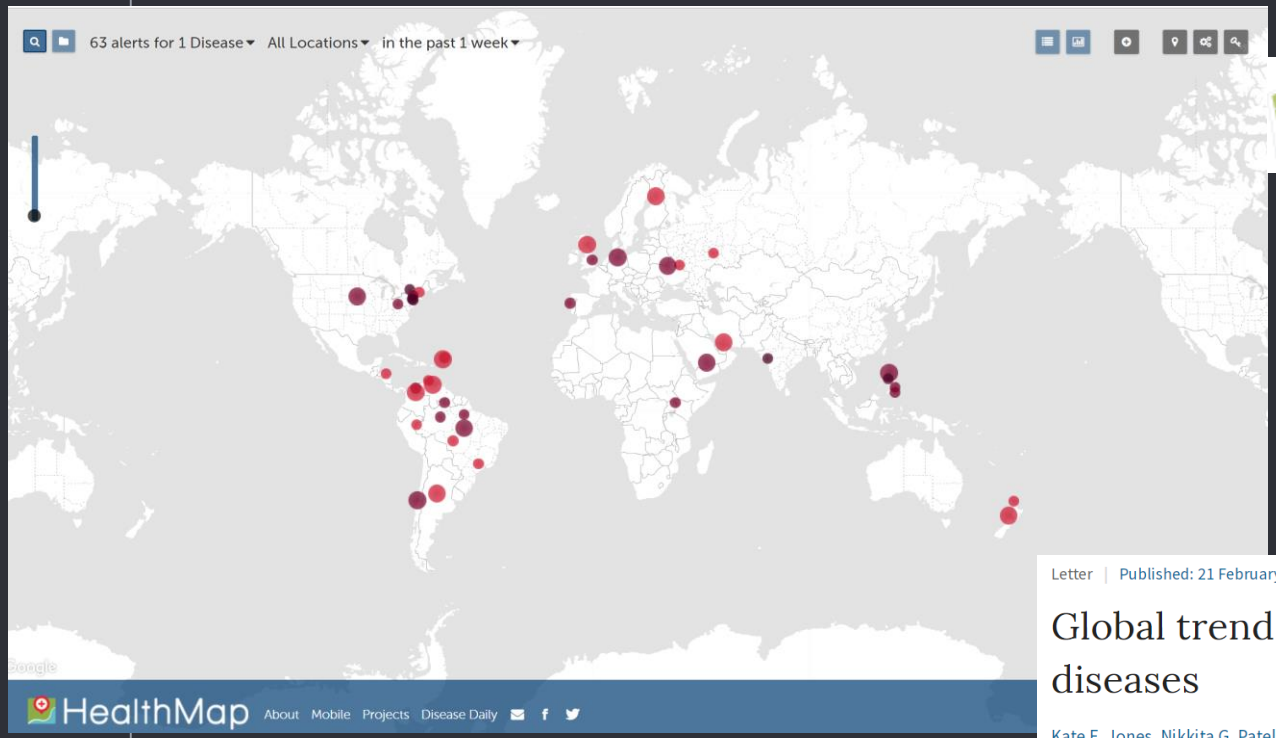
GOARN
Global Outbreak Alert and Response Network

- Infectious diseases modelling

- Mobile detection/sequencing devices

(Christaki, Virulence, 2015)

Advanced Technologies- Surveillance



HealthMap

Letter | Published: 21 February 2008

Global trends in emerging infectious diseases

Kate E. Jones, Nikkita G. Patel, Marc A. Levy, Adam Storeygard, Deborah Balk, John L. Gittleman & Peter Daszak

Nature **451**, 990–993 (21 February 2008) | Download Citation

Using Google Trends and ambient temperature to predict seasonal influenza outbreaks

Yuzhou Zhang[a], Hilary Bambrick[a], Kerrie Mengersen[b], Shilu Tong[a,c,d], Wenbiao Hu[a,*]

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[d] *Shanghai Children's Medical Centre, Shanghai Jiao-Tong University, Shanghai, China*

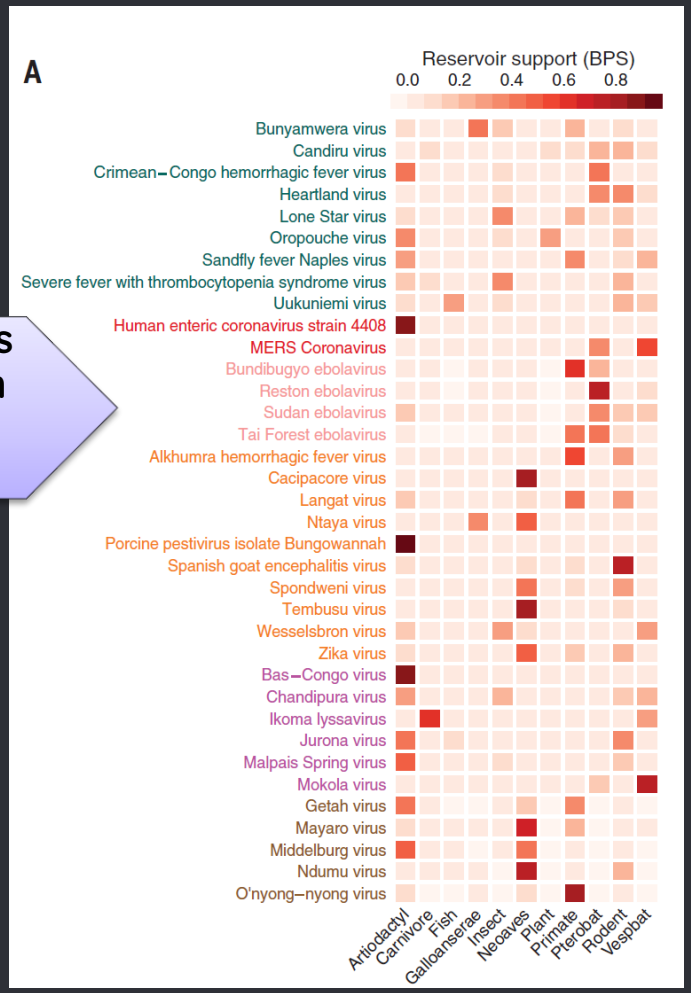
Advanced Technologies- Machine Learning

REPORT

Predicting reservoir hosts and arthropod vectors from evolutionary signatures in RNA virus genomes

Simon A. Babayan[1,2], Richard J. Orton[3], Daniel G. Streicker[1,3,*]

Develop algorithms → **Train with > 500 ssRNA viral sequences** → **Predict virus of unknown host and vector**

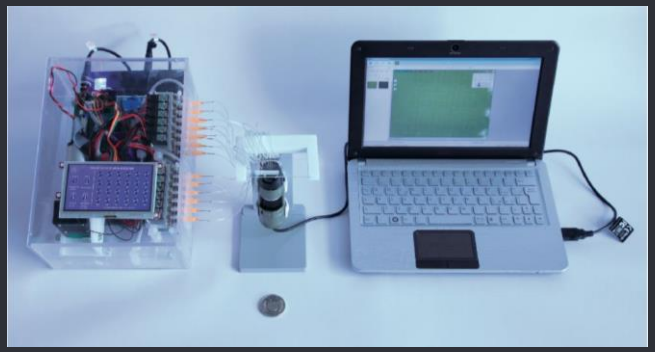


- Implement preventive measures
  - → vaccinating animal sources
  - → prevent contacts between species
- May prevent viruses from emerging

Advanced Technologies- Mobile Devices

(MinION by Nanopore)

(MIC personal q-PCR cycler)



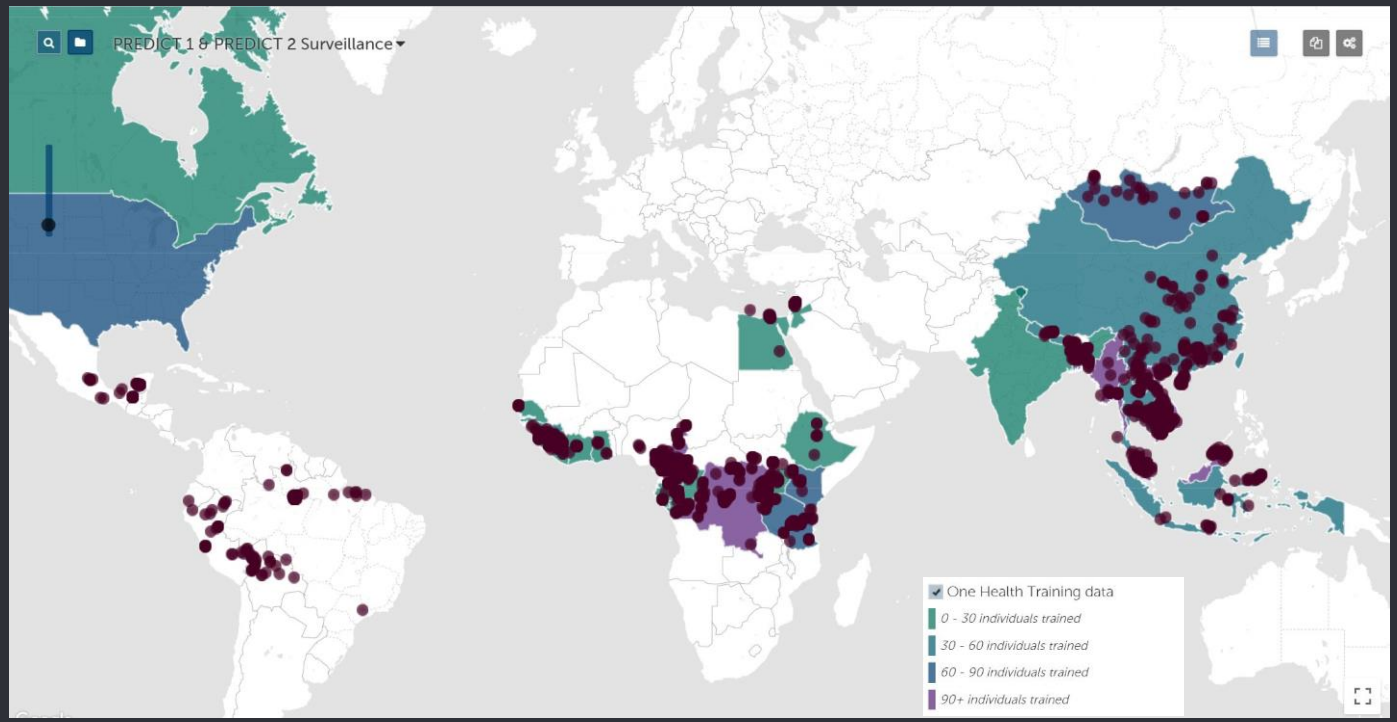
(Microfluidic platform by EPFL)

Challenges

1. Geographical surveillance gap

   - lack of equipment and diagnostic capability

   - shortage of trained personnel



(Halliday et al. Philos Trans R Soc Lond B Biol Sci, 2012; Morens and Fauci, PLOS Pathogens, 2013; Christaki, Virulence, 2015; Ribeiro, Koopmans and Haringhuizen, Science, 2018)

Challenges

1. Geographical surveillance gap
   - lack of equipment and diagnostic capability
   - shortage of trained personnel
2. Under-reporting of zoonoses
3. Availability of real time surveillance data
   - excessive ownership over genetic resources
   - sharing relevant data before publication?
   - simplified sharing agreements
4. International collaborations
   - political interest/ national trade priorities

(Halliday et al. Philos Trans R Soc Lond B Biol Sci, 2012; Morens and Fauci, PLOS Pathogens, 2013; Christaki, Virulence, 2015; Ribeiro, Koopmans and Haringhuizen, Science, 2018)

4

Conclusion

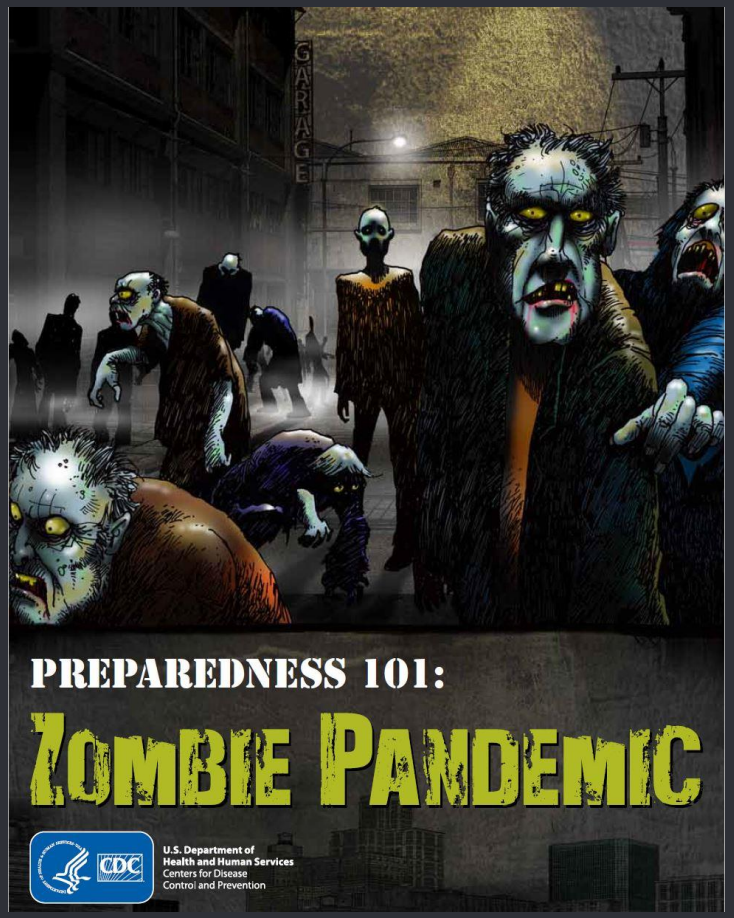
Are we ready for the next pandemic?

Are we ready for the Next Pandemic?

- Better understanding on emerging infectious diseases
- WHO list blueprint priority diseases → narrow down the range
- Able to recognise/predict potential animal reservoir
- Advanced technologies for detection and diagnostic
- Stockpiles of drugs and vaccines

- Insufficient trainings in “hot spots” of emerging infectious diseases
- Global collaborations

- Thank you!
  Any Questions?



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