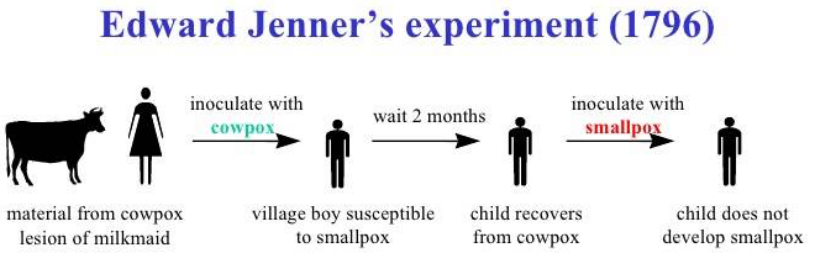
Preparedness, research and response when epidemics and news go viral

Gagandeep Kang

thsti
Translational Health Science and Technology Institute

We know the value of prevention

- In the 1700s, in Europe alone 400,000 people died every year of small pox



By 1800, vaccines administered across Europe and North America

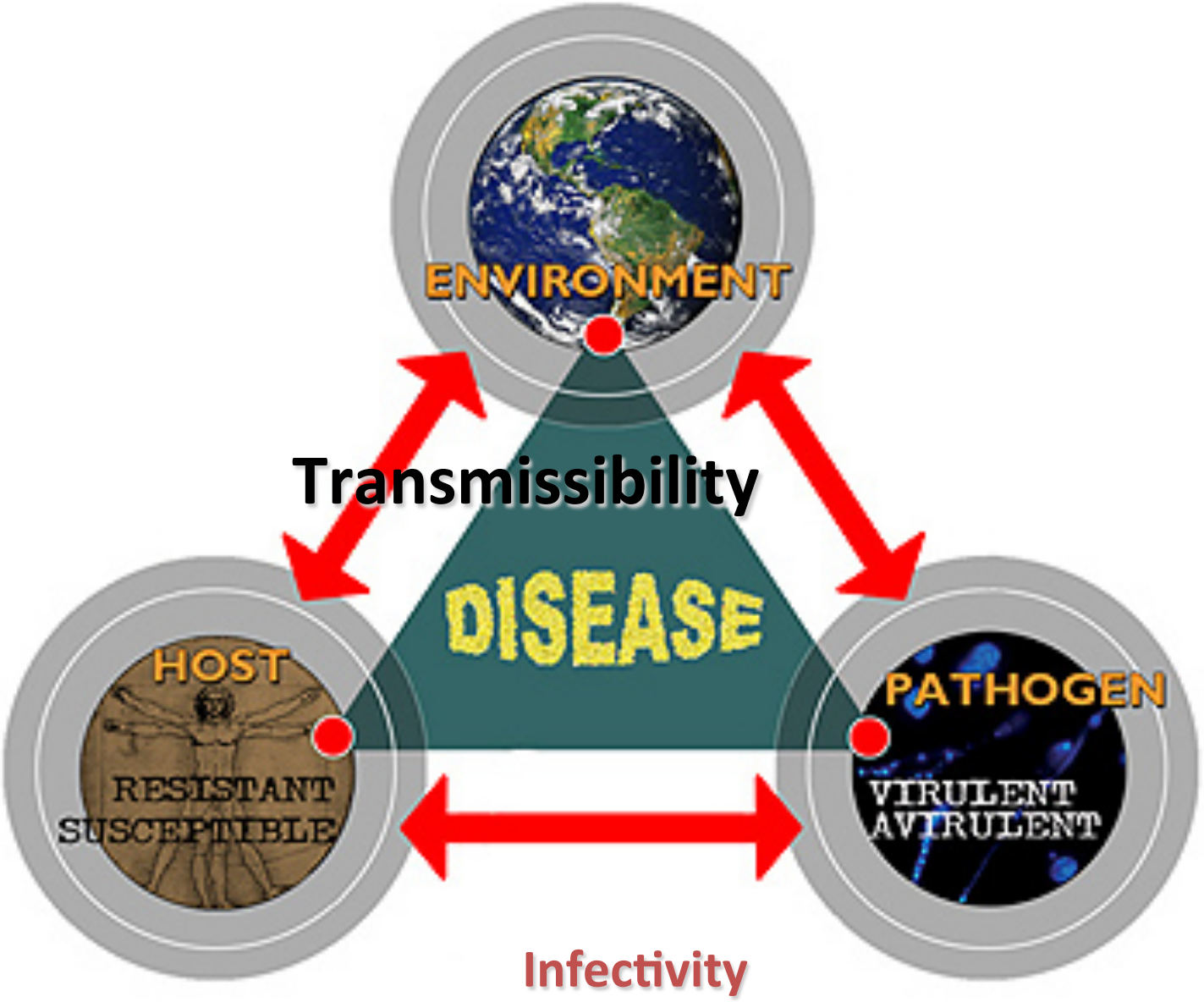
By 1900: smallpox eliminated from much of industrialized world

1950: Pan Am Health Org - eradication program throughout Americas

1959: Beginning of global smallpox eradication program

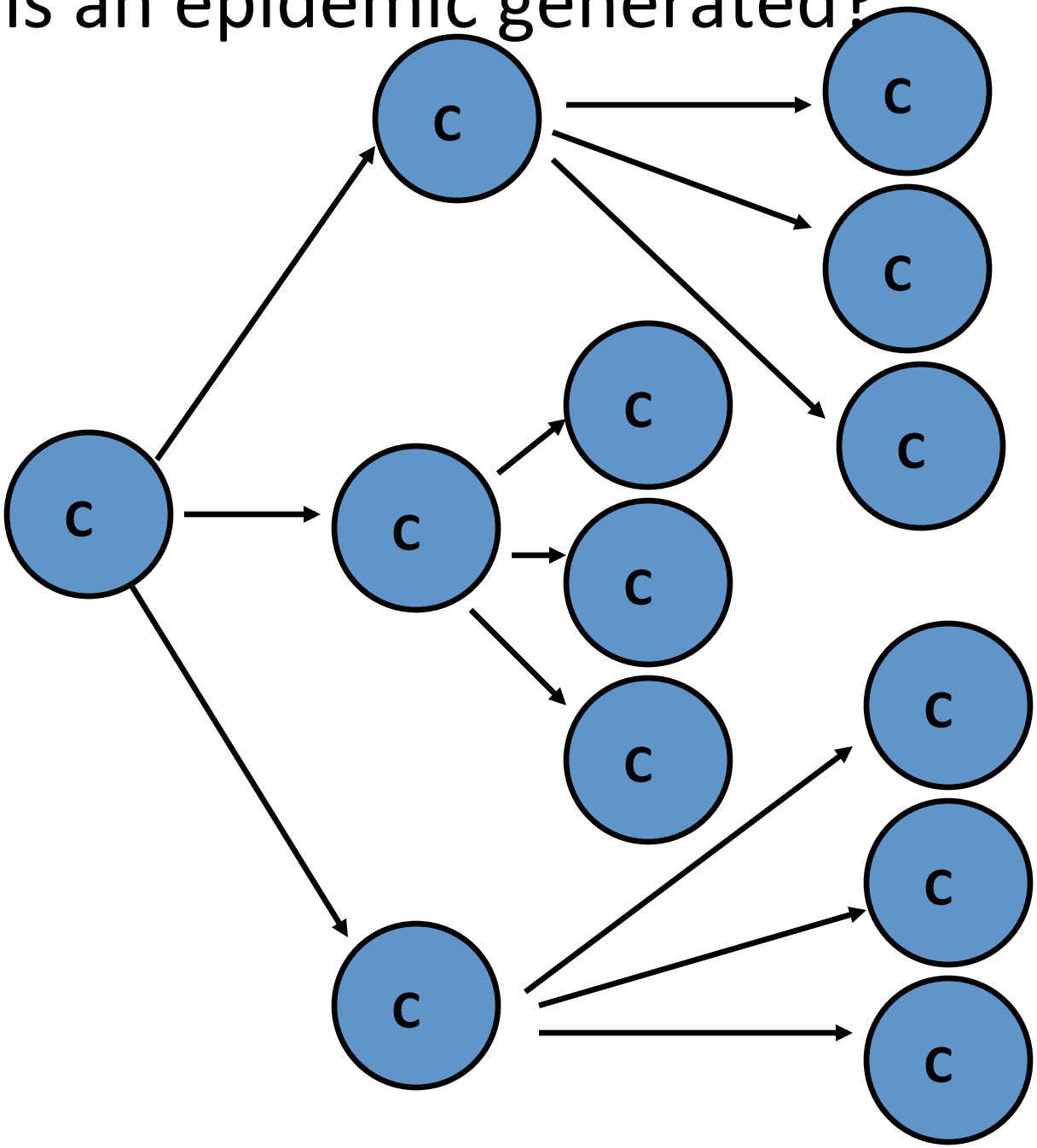
1975: Rahima Banu, one of the last people naturally infected by smallpox

12/9/1979: WHO declared smallpox eradicated


ENVIRONMENT
Transmissibility
DISEASE
HOST
RESISTANT
SUSCEPTIBLE
PATHOGEN
VIRULENT
AVIRULENT
Infectivity

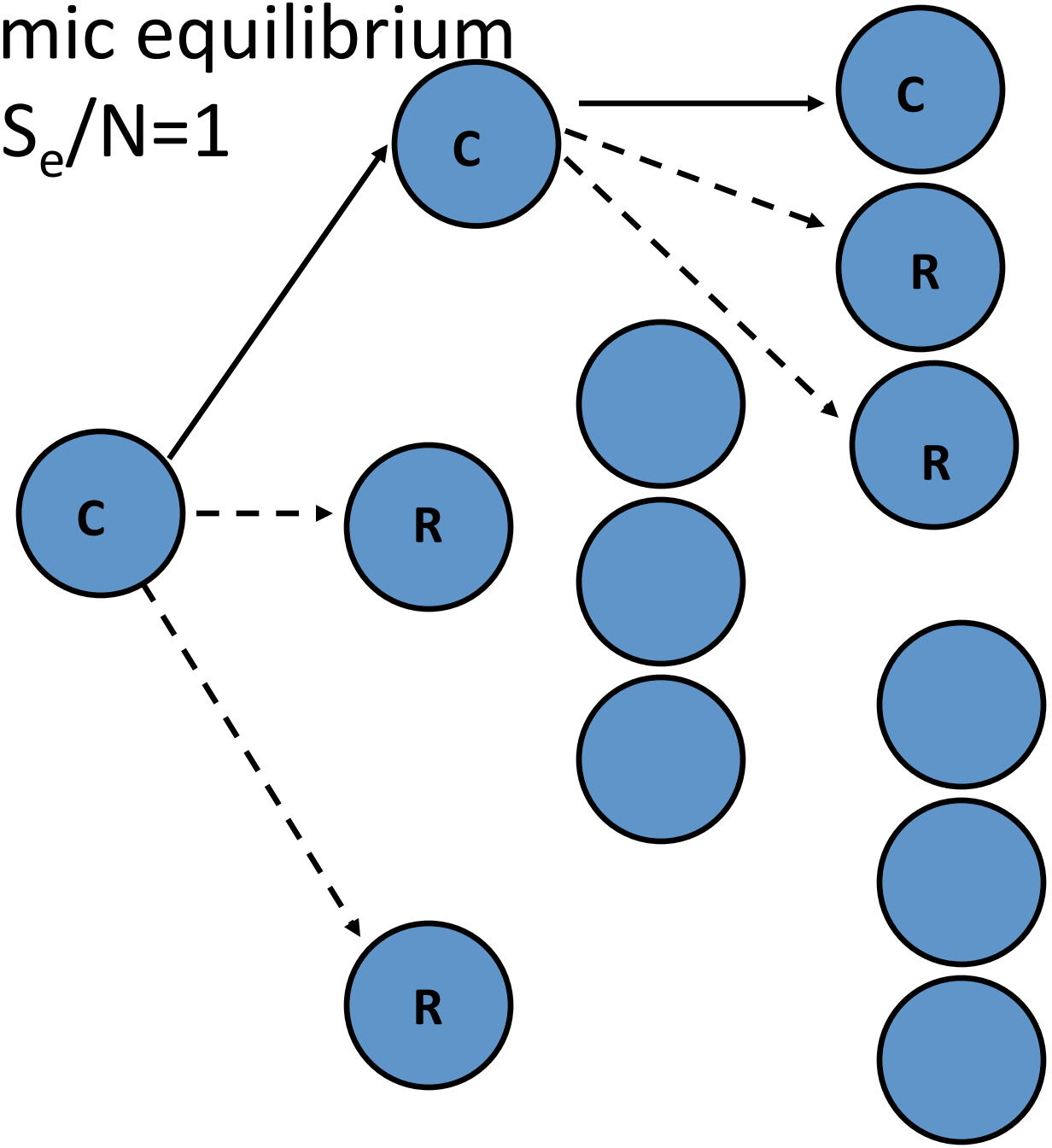
How is an epidemic generated?

$R_0=3$



Endemic equilibrium

$R_0 \times S_e/N=1$

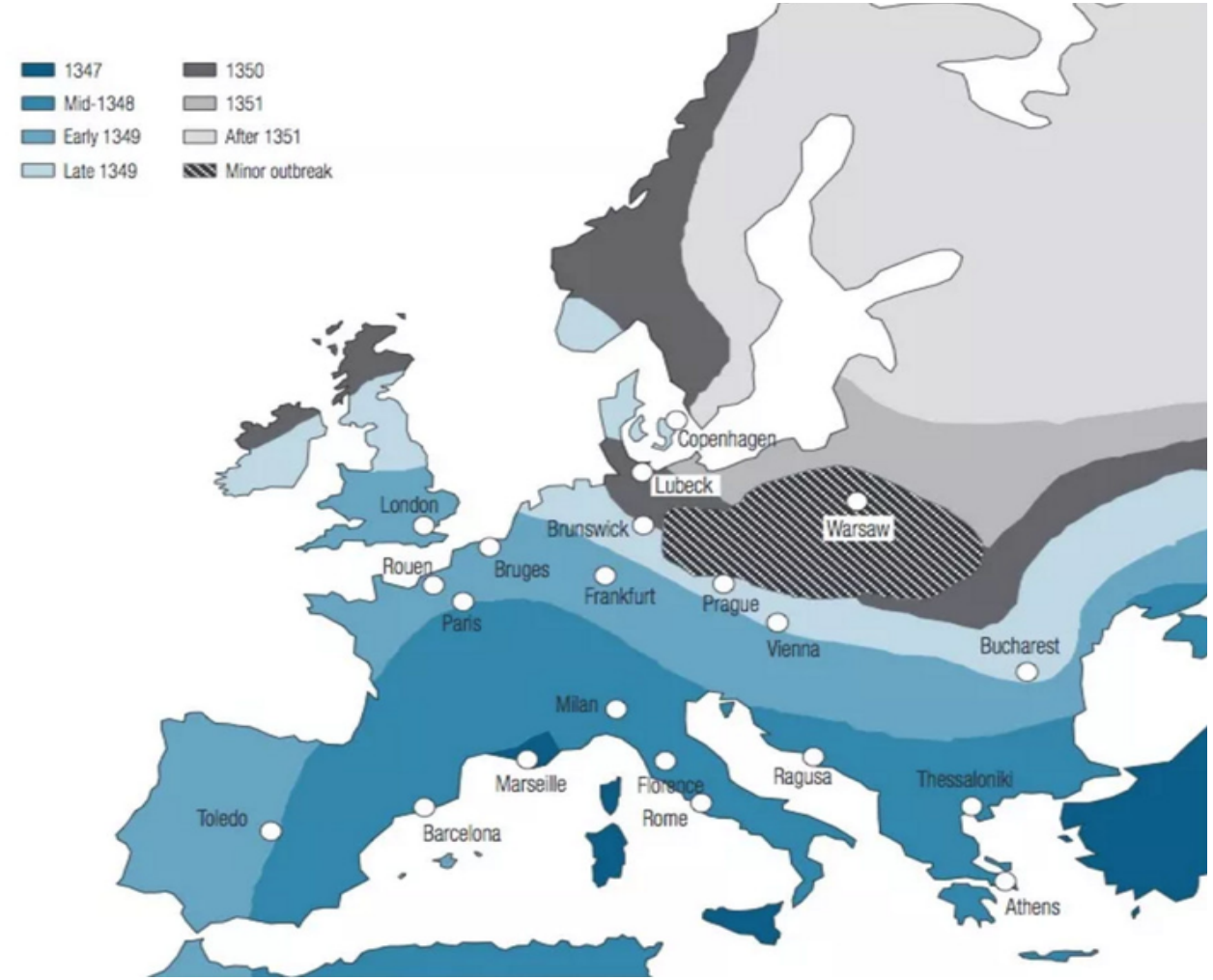


Factors affecting transmission and natural history of disease

- Who gets infected?
- Who develops immunity? How broad is immunity?
- What processes generate direct or indirect contacts that can transmit infection?
- What factors affect transmission given a contact?
- What environments allow survival and growth of an agent?
- What is the pattern of disease in infected individuals?

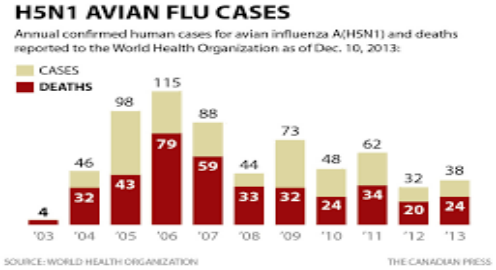
We have understood and had the ability to track diseases for a long time

- Bubonic plague in Europe from 1340 to 1350



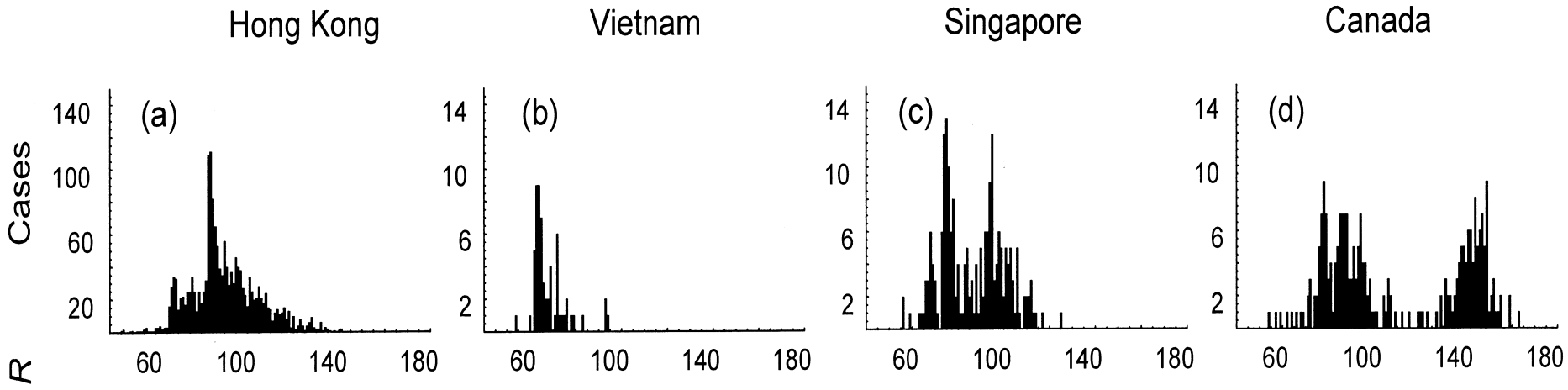
But today's world is very different and the timelines for spread have changed

The challenge of epidemics



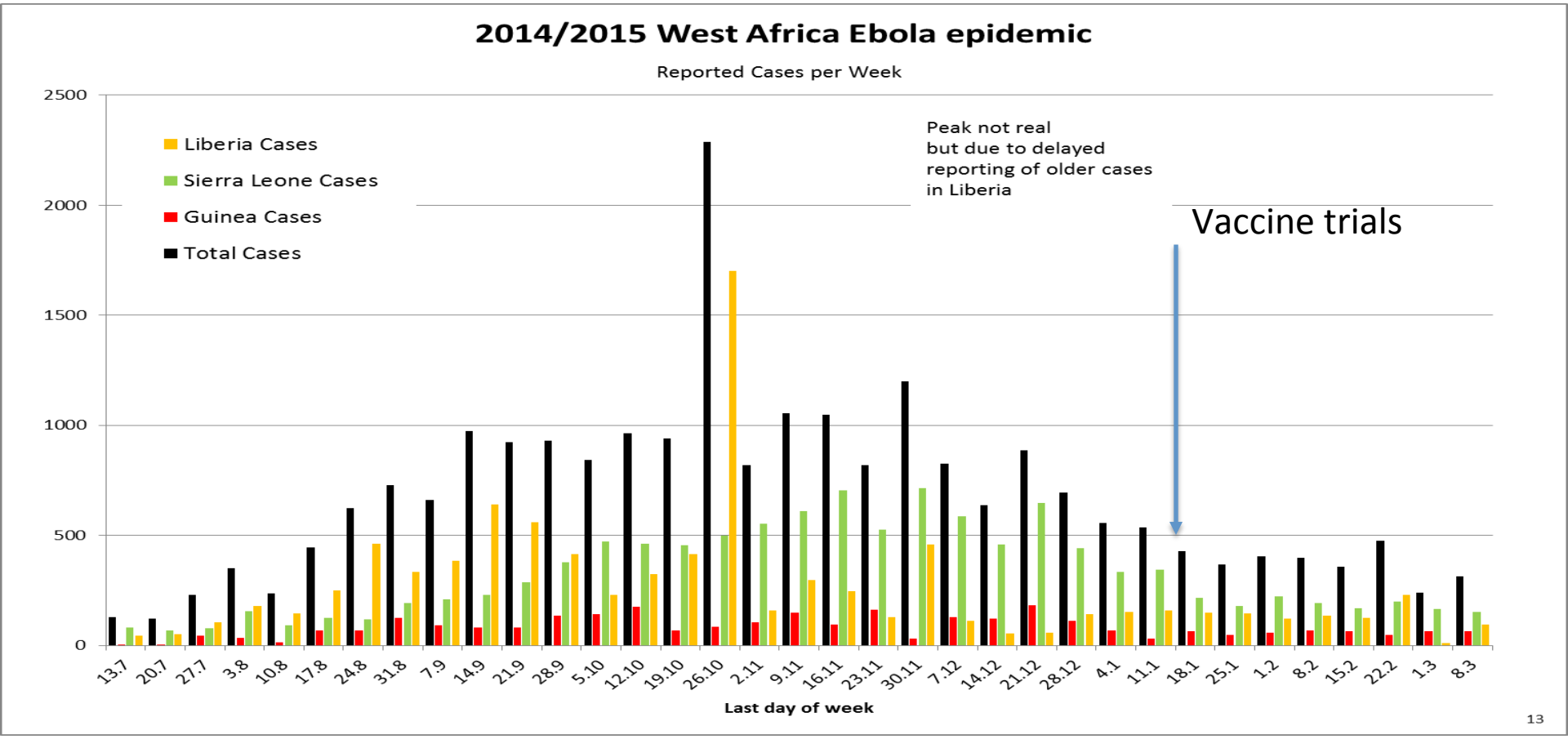
Approaches to control of epidemics

- SARS epidemic curves
  - Screening and quarantine
  - Barrier nursing



Wallinga and Teunis, Am J Epidemiol 2004

Ebola in West Africa 2014/2015

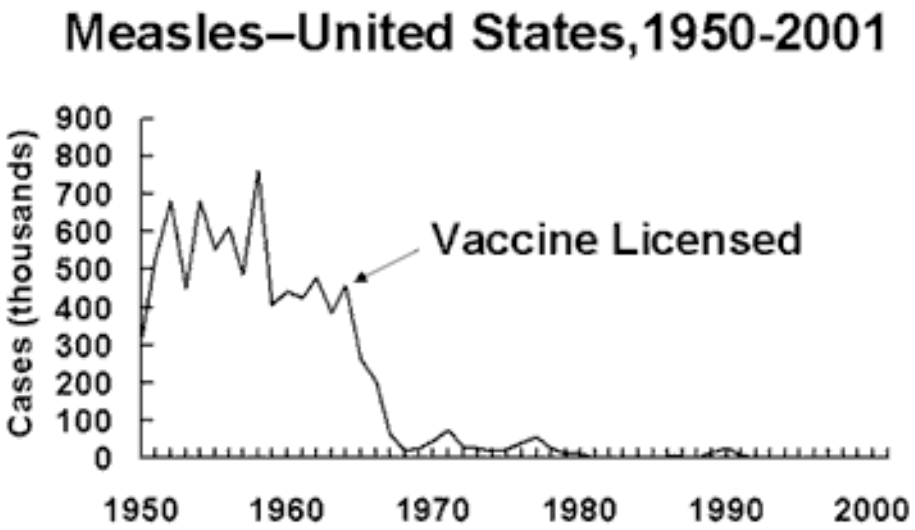


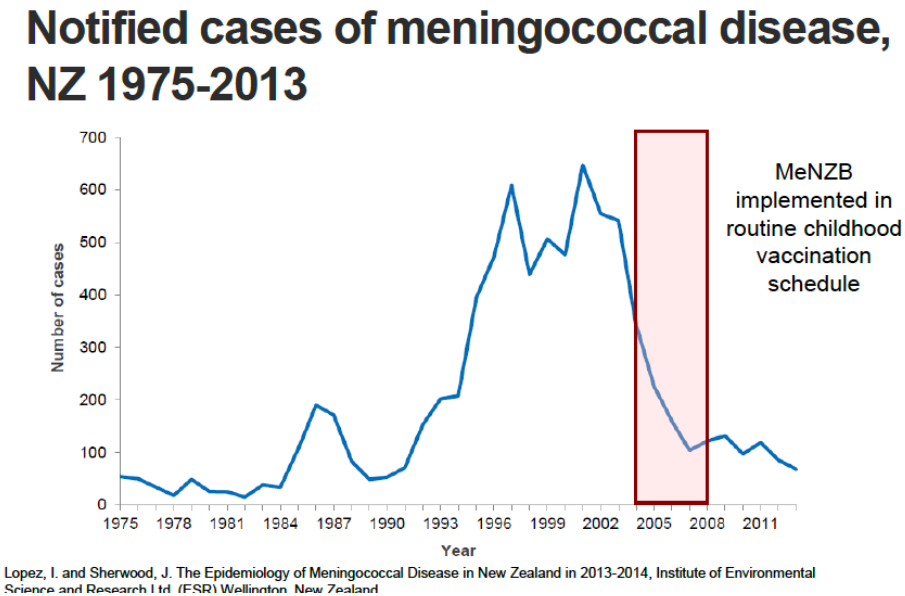
Why think of vaccines when other approaches work?

- Prevention is better than cure
- Preparation compared to uncertain scale of response

- Challenges in epidemics
  - Screening needs
  - Trained staff
  - Surge capacity in hospitals, people/resources
  - Impact on other programs

What can vaccines do to disease?





Lopez, I. and Sherwood, J. The Epidemiology of Meningococcal Disease in New Zealand in 2013-2014, Institute of Environmental Science and Research Ltd. (ESR) Wellington, New Zealand

Vaccines prevent 2-3 million deaths a year

7000 deaths a day

300 deaths an hour

5 deaths every minute

And this is only counting deaths, not all sickness prevented

A pandemic could cost up to 570 Billion US$ in a year

Indirect costs

- Death of healthcare professionals
- Quarantine necessitates expensive, rigorous screening and closure of borders
- Reduces trade and travel
- Affects food supply (<30,000 cases but >1000,000s affected)

The World Bank estimates that Ebola cost 4 billion US dollars in direct costs. **54 billion US dollars total costs**

Rebuilding is expensive.

Calls for global action

ADVANCE UNEDITED COPY

Protecting Humanity from Future Health Crises

Report of the

High-level Panel on the Global Response to Health Crises

25 January 2016

Report of the

Ebola Interim Assessment Panel

World Health Organization

AN R&D BLUEPRINT FOR ACTION TO PREVENT EPIDEMICS

PLAN OF ACTION

MAY 2016

World Health Organization

Outcome document
Financing of R&D Preparedness and Response to Epidemic Emergencies
October 29-30, 2015
Oslo, Norway

Background

This Outcome document summarizes discussions that took place during the Oslo consultation on *Financing of R&D Preparedness and Response to Epidemic Emergencies* (October 29-30, 2015). It reflects views expressed and the discussion that took place, but does not necessarily reflect all interventions. Names of representatives of countries and organizations participating in the Oslo consultation on Financing can be found on the webpage of the Norwegian Institute of Public Health. Stakeholders represented included government, industry, NGOs and academia as well as charitable foundations and other relevant actors. The consultation was jointly organized by WHO and the Norwegian Institute of Public Health and hosted by the Norwegian Institute of Public Health.

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Health Policy

Will Ebola change the game? Ten essential reforms before the next pandemic. The report of the Harvard-LSHTM Independent Panel on the Global Response to Ebola

Dr Suerie Moon, PhD, DPhil, Sophie Delaunay, MA, Prof Eric Goosby, MD, Prof Leung, MD, J Stephen Morr, Benjamin Hawkins, PhD, Li

Published Online: 22 Novemb

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Global Health Risk Framework

The Neglected Dimension of Global Security: A Framework to Counter Infectious Disease Crises

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Perspective

Establishing a Global Vaccine-Development Fund

Stanley A. Plotkin, M.D., Adel A.F. Mahmoud, M.D., Ph.D., and Jeremy Farrar, M.D., Ph.D.
N Engl J Med 2015; 373:297-300 | July 23, 2015 | DOI: 10.1056/NEJMp1506820

Comments open through July 29, 2015

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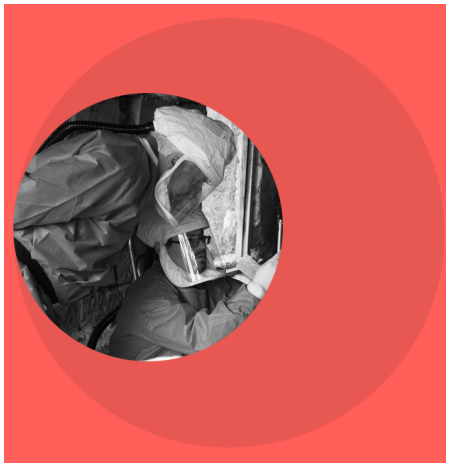
Article | References | Citing Articles (8) | Comments (2) | Metrics

In response to Ebola-a new initiative

Preparedness

Advance access to safe and effective vaccines against emerging infectious diseases



Response

Accelerate the research, development and use of vaccines during outbreaks

Sustainability

Create durable and equitable solutions for outbreak response capacity

Coalition for Epidemic Preparedness Innovations

CEPI

The CEPI response

Rationalize & accelerate

Rationalize and **accelerate** research and development responses to new outbreaks

Coordinate

Coordinate resources of industry, academia, governments, philanthropies, and NGOs

Prioritize & facilitate

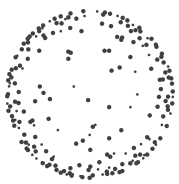
Prioritize platform technology and vaccine targets and **facilitate** the advanced development of vaccines for emerging infectious diseases

Rationalize and accelerate

- WHO R and D Blueprint
- Updated for top ten threats every year

- And disease X

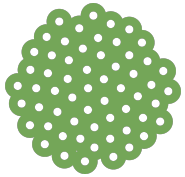
CEPI's strategic portfolio targets



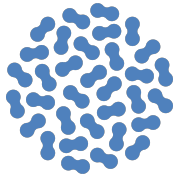
Lassa

MERS-CoV

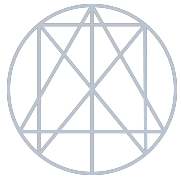
Nipah



Rift Valley Fever



Chikungunya



Disease X

Advance at least one vaccine for each pathogen through phase IIa and stockpile within five years of funding

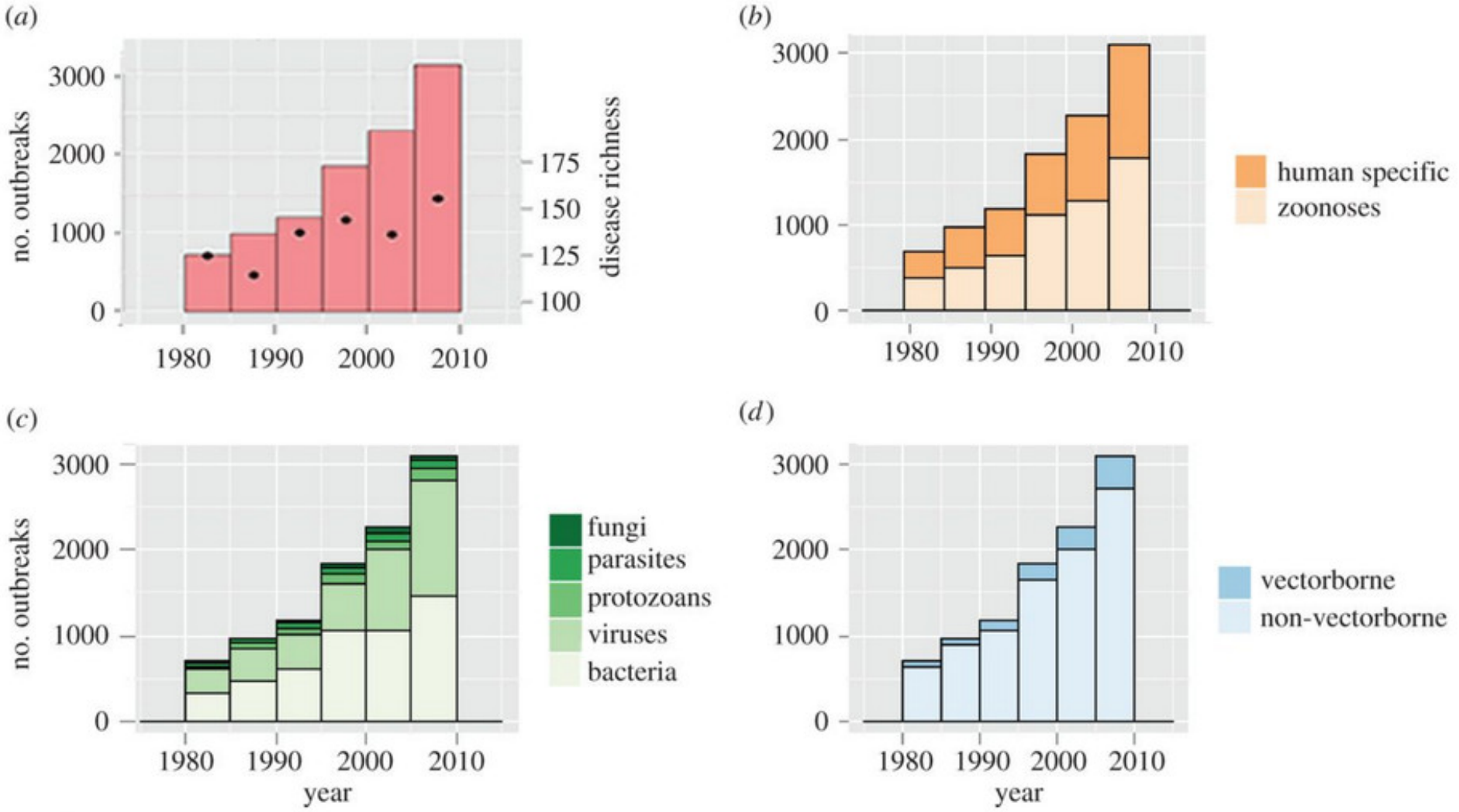
Support activities enabling late stage development, prequalification and access

Advance through phase I multiple rapid response platforms with potential to significantly improve speed of vaccine development against multiple pathogens

CEPI

Dec 2019-Jan 2020 Pathogen X

Not unexpected, zoonotic diseases from AIDS to Zika



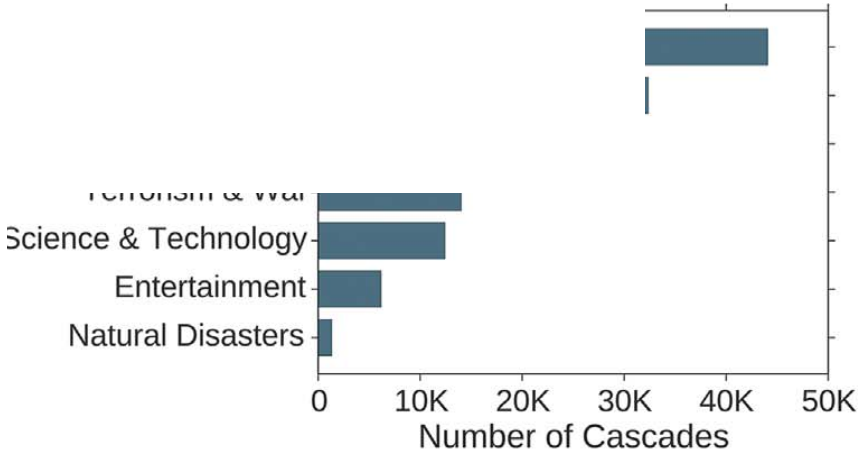
Coronavirus has sparked an infodemic

- Manmade bioweapon
- No evidence based on sequencing data
- More than 100,000 have died
- Just over 2800 as of yesterday

SOCIAL SCIENCE

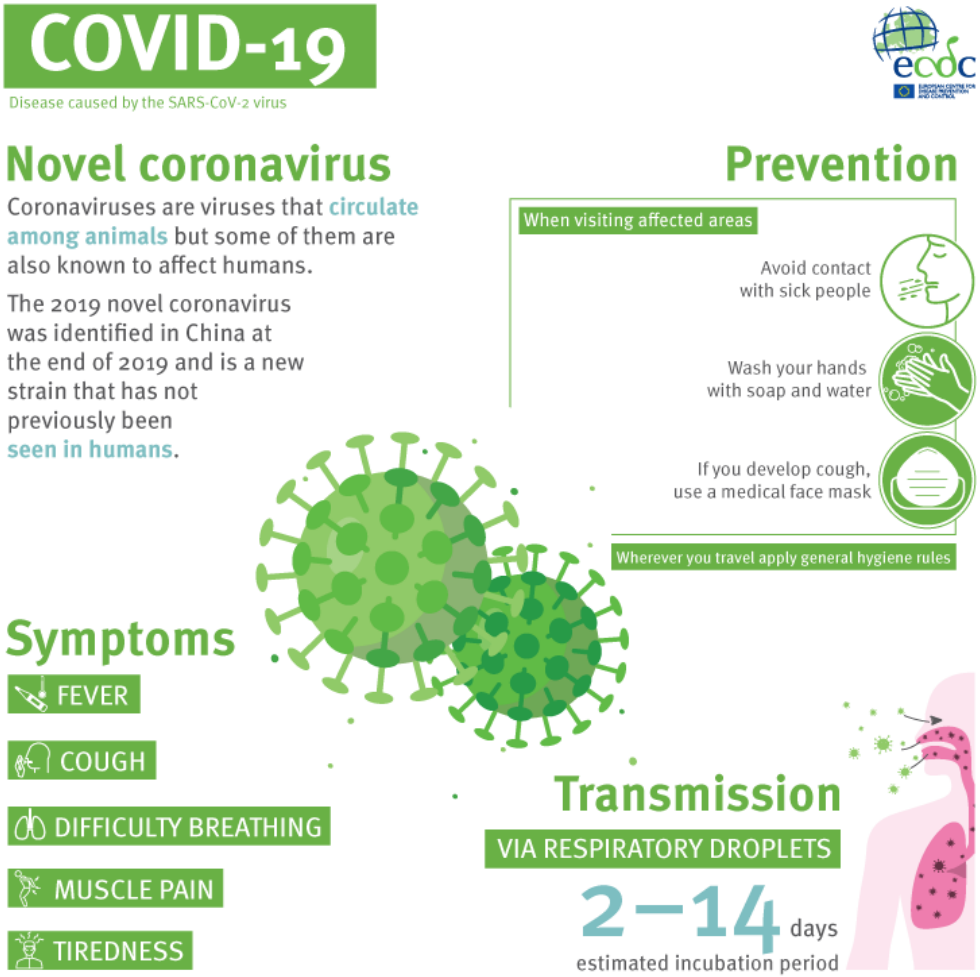
The spread of true and false news online

Soroush Vosoughi,[1] Deb Roy,[1] Sinan Aral[2]*



- Falsehood diffused significantly farther, faster, deeper, and more broadly than the truth in all categories of information
- False stories inspired fear, disgust, and surprise
- False news spreads more than the truth because humans, not robots, are more likely to spread it

In today's world we access information easily



Too easily……and inaccurately

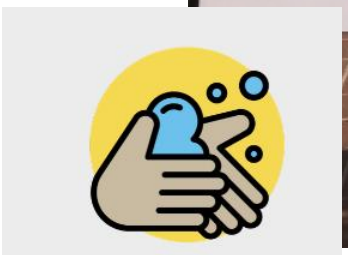
Ugly battles erupt as residents fight housing coronavirus patients in their cities

Los Angeles Times

LOG IN

IFRC unicef for every child World Health Organization

Social Stigma associated with COVID-19



A guide to preventing and addressing social stigma[1]

Target audience: Government, media and local organisations working on the new coronavirus disease (COVID-19).

Coordination for public protection

Internal preparedness

- Who responds?
  - Disaster/Emergency/Outbreak

WEEKLY OUTBREAK REPORT

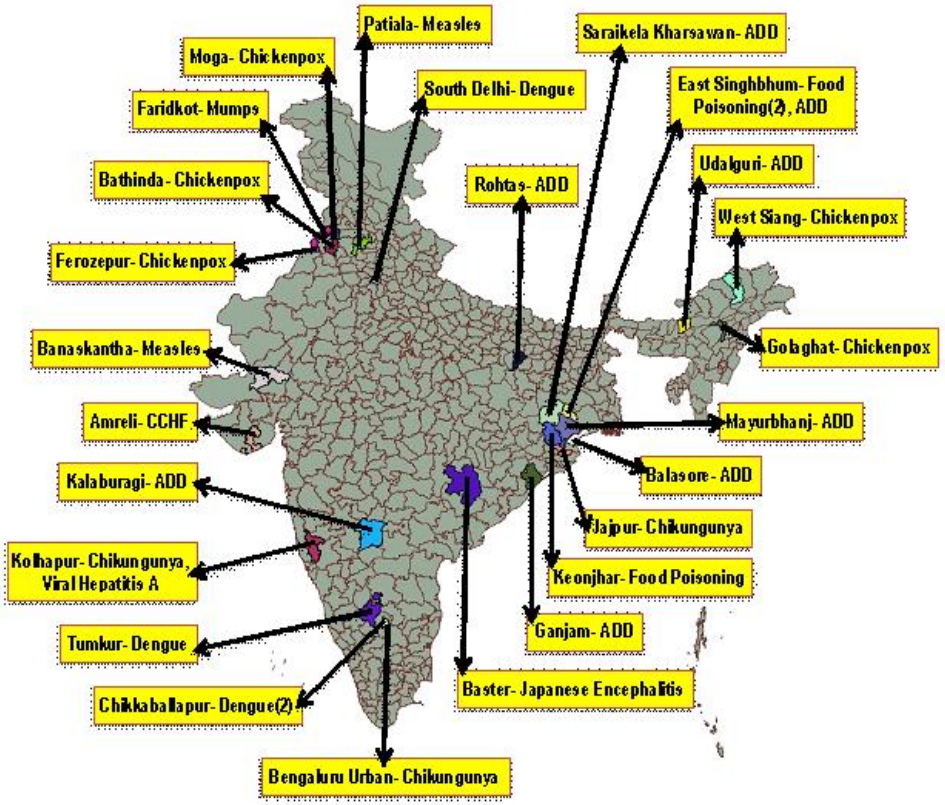
Disease Alerts/Outbreaks reported and responded to by States/UTs through Integrated Disease Surveillance Program (IDSP)

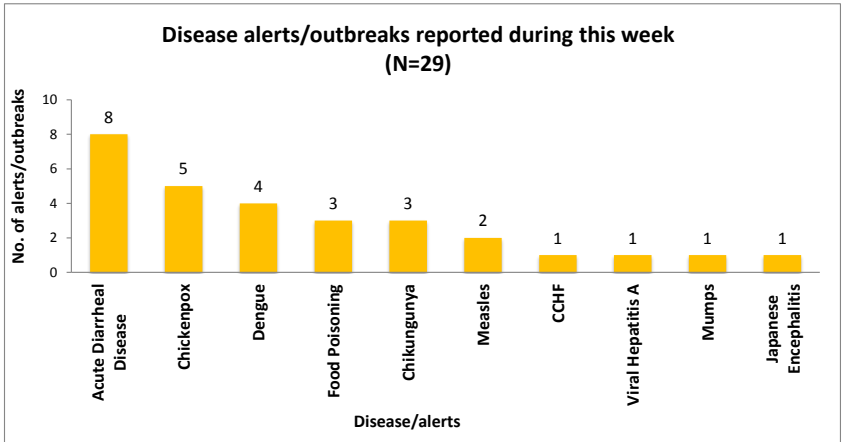
(25th November to 1st December 2019)

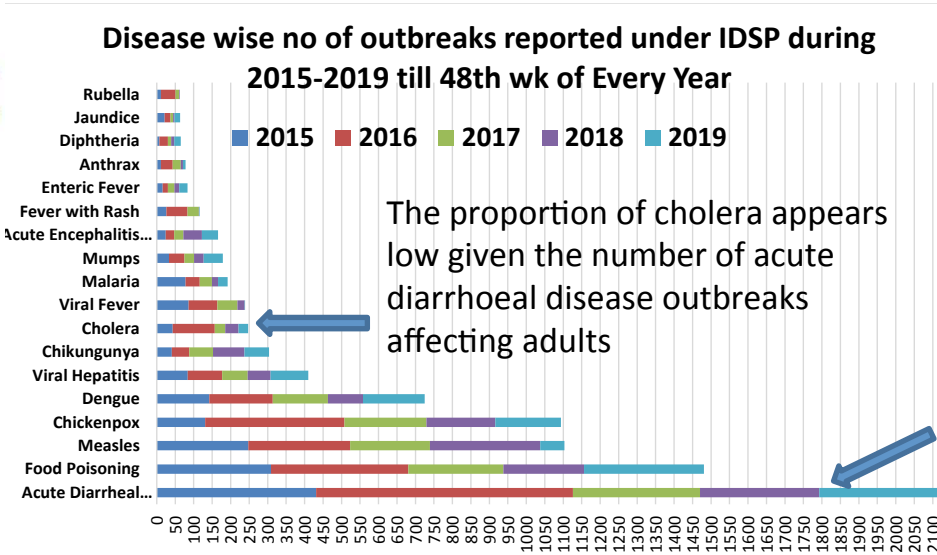
48th Week

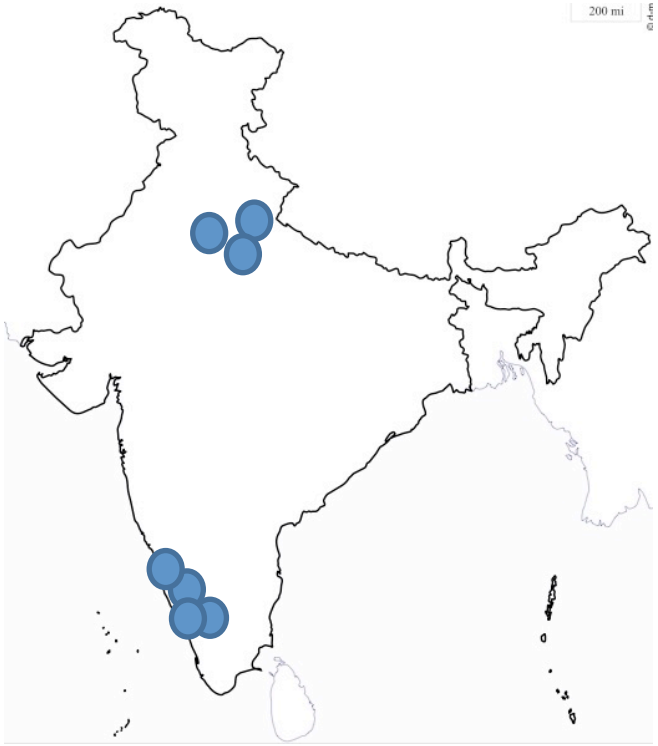
District wise disease alerts/outbreaks reported in the 48th week 2019

48th Week Map

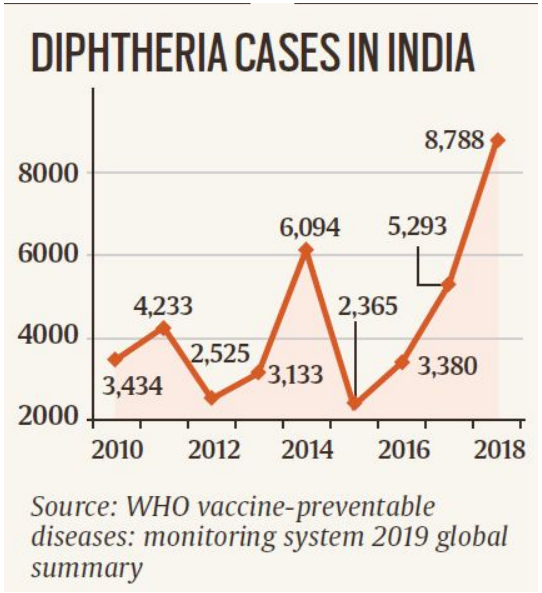


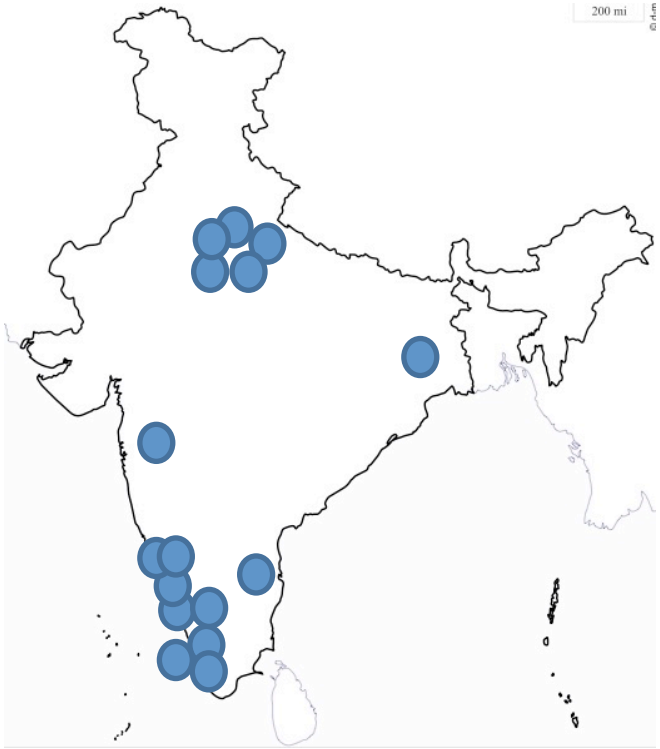






Two sets of investigations into diphtheria outbreaks in India in 2014





Preparedness for research

- Ability to diagnose
- Ability to treat
- Ability to measure
- Ability to prevent

CDC distributes tests 3 weeks after sequence

A traveler wearing a protective facemask at Changi Airport in Singapore. The city has not seen COIVD-19 cases exploding yet. ROSLAN RAHMAN/AFP VIA GETTY IMAGES

Singapore claims first use of antibody test to track coronavirus infections

By Dennis Normile | Feb. 27, 2020 , 4:30 PM

Surge capacity in hospitals

- Pre-hospital
- Outpatients
- Healthcare facilities
- Public health
- Mental health
- Mortuary

Ability to measure

Coronavirus disease 2019 (COVID-19)
Situation Report – 37

World Health Organization

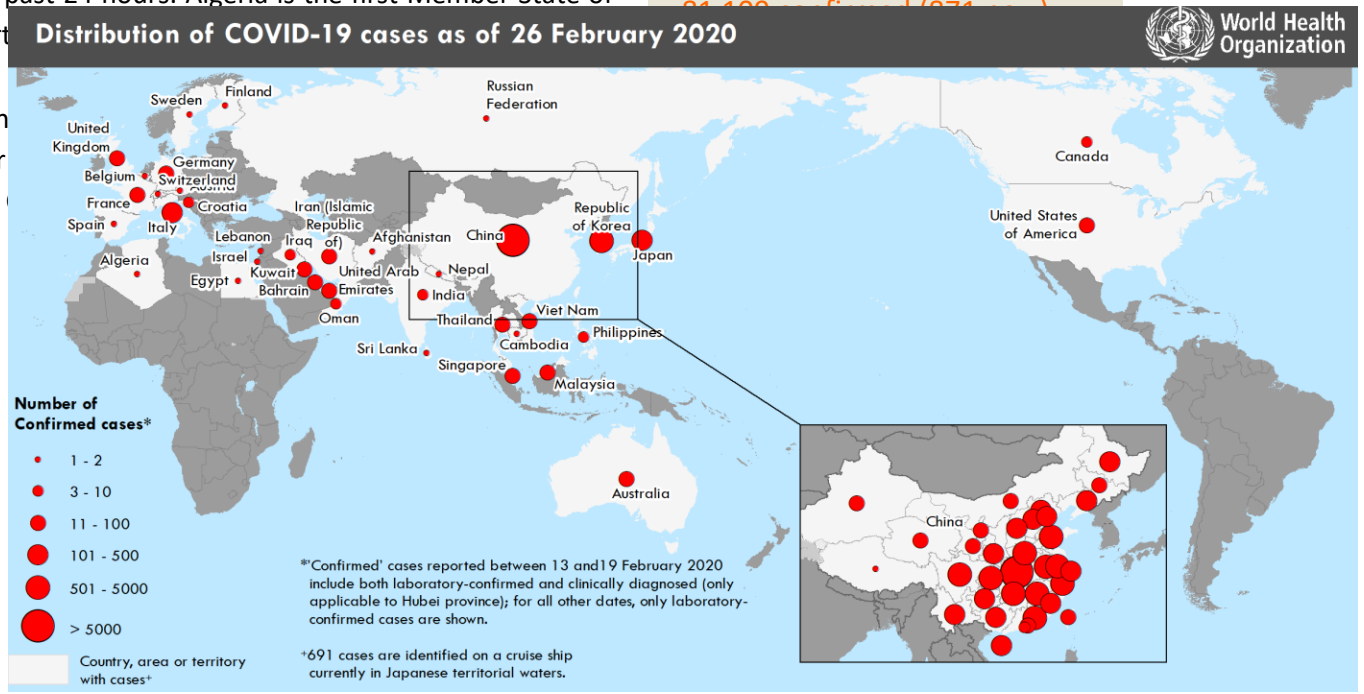
Data as reported by 10AM CET 25 February 2020*

HIGHLIGHTS

- Four new Member States (Algeria, Austria, Croatia, and Switzerland) reported cases of COVID-19 in the past 24 hours. Algeria is the first Member State of the AFRO Region to report
- For the first time, since th
COVID-19 on 8 December
from countries outside of

SITUATION IN NUMBERS
total and new cases in last 24 hours

Globally



Ability to do research

How many? The coronavirus is prompting a burst of clinical trials in search of a treatment

By Ed Silverman[3] @Pharmalot[4]

February 19, 2020

Medical staff members work at an exhibition centre converted into a hospital in Wuhan. *STR/AFP via Getty Images*

What can we do and what does it take?

- Diagnostics
- Repurposing drugs
- New antivirals
- Monoclonal antibodies
- Vaccines
- Personal protective equipment

- Linking all stakeholders- national and international
- Sharing
  - Data
  - Reagents
  - Protocols
  - Patients
- Supporting
  - Preparedness planning
  - Research in peace time and in war

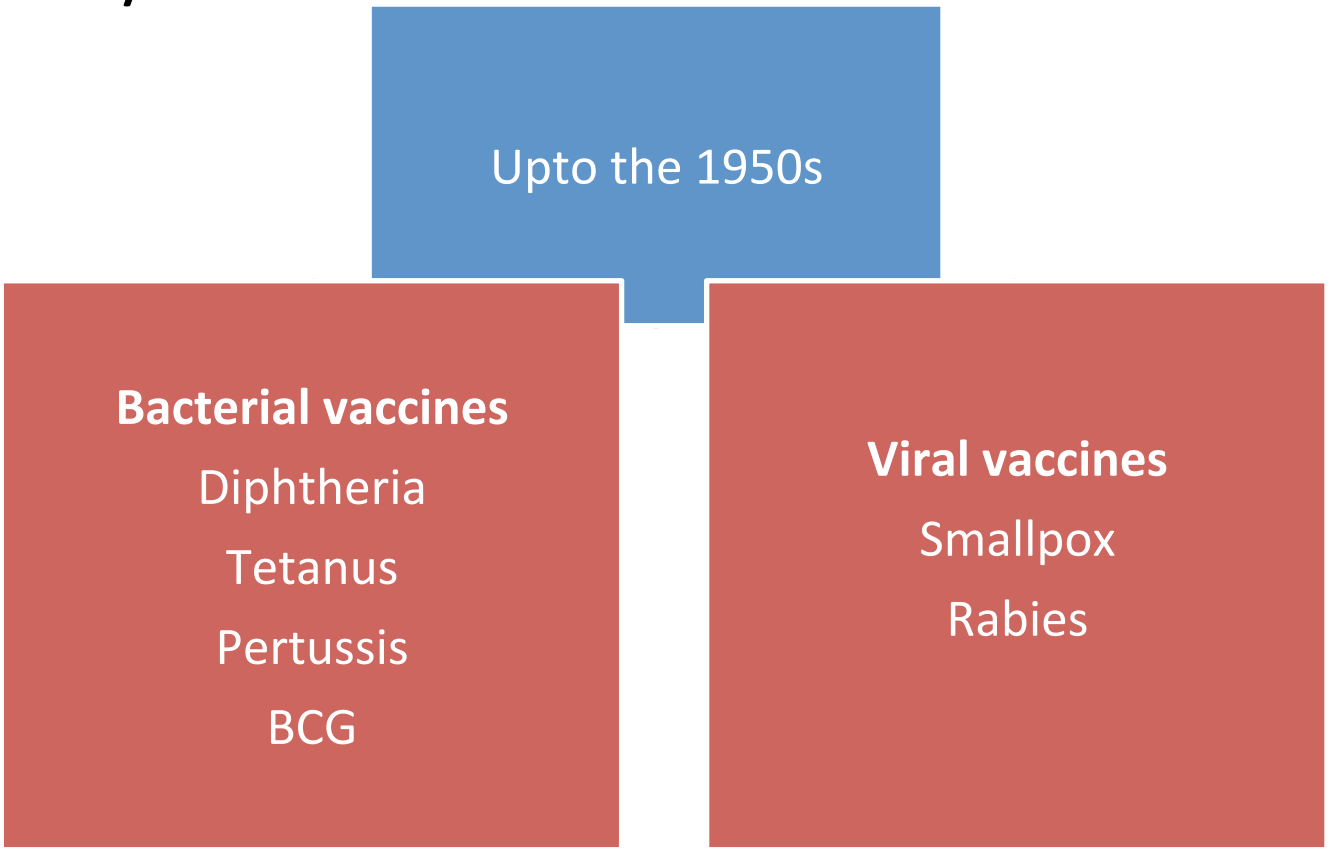
The example of CEPI

CEPI accelerates development of vaccines against emerging infectious diseases and enables equitable access to these vaccines for affected populations during outbreaks

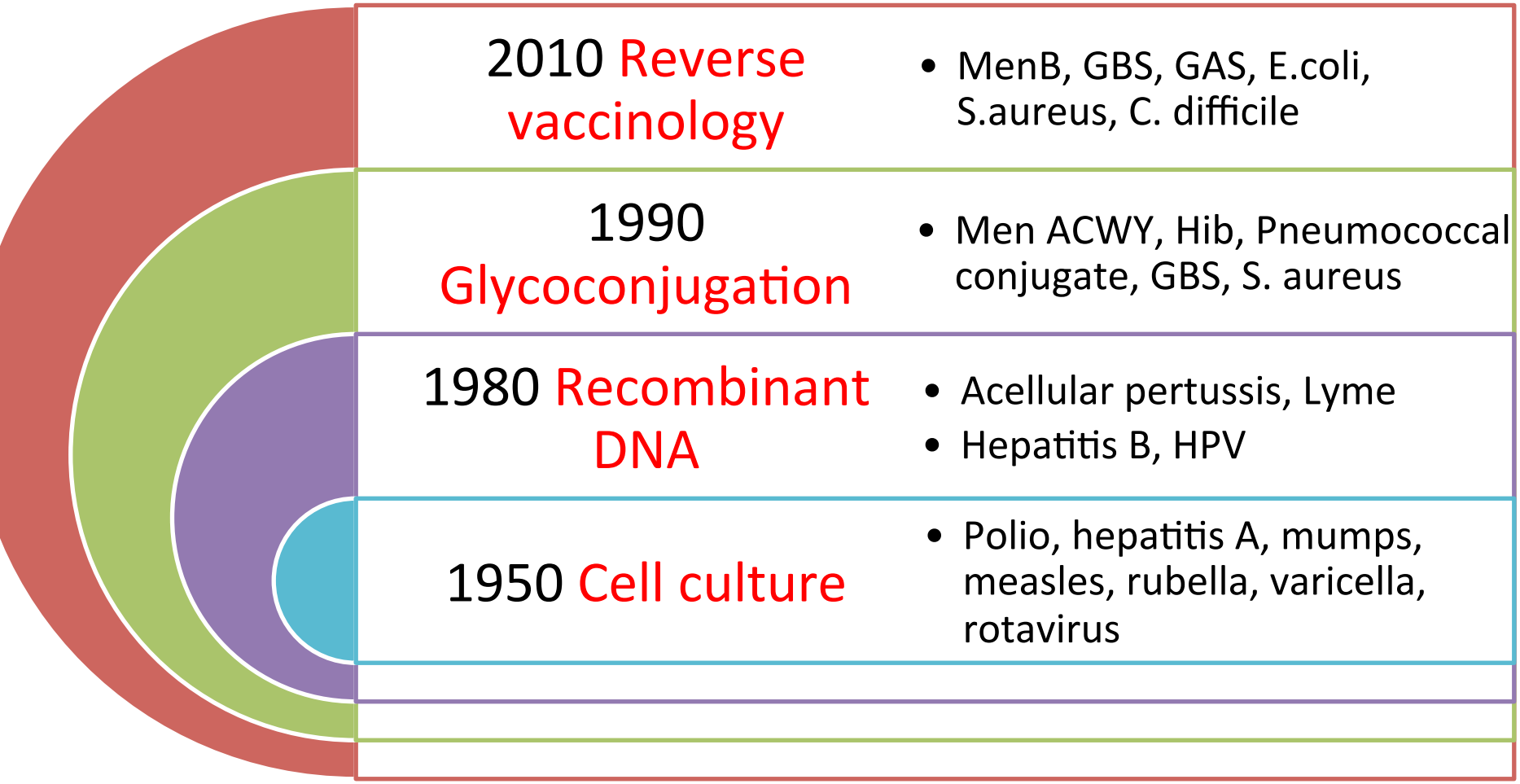
New vaccines for a safer world

From Jenner to Pasteur to Hilleman

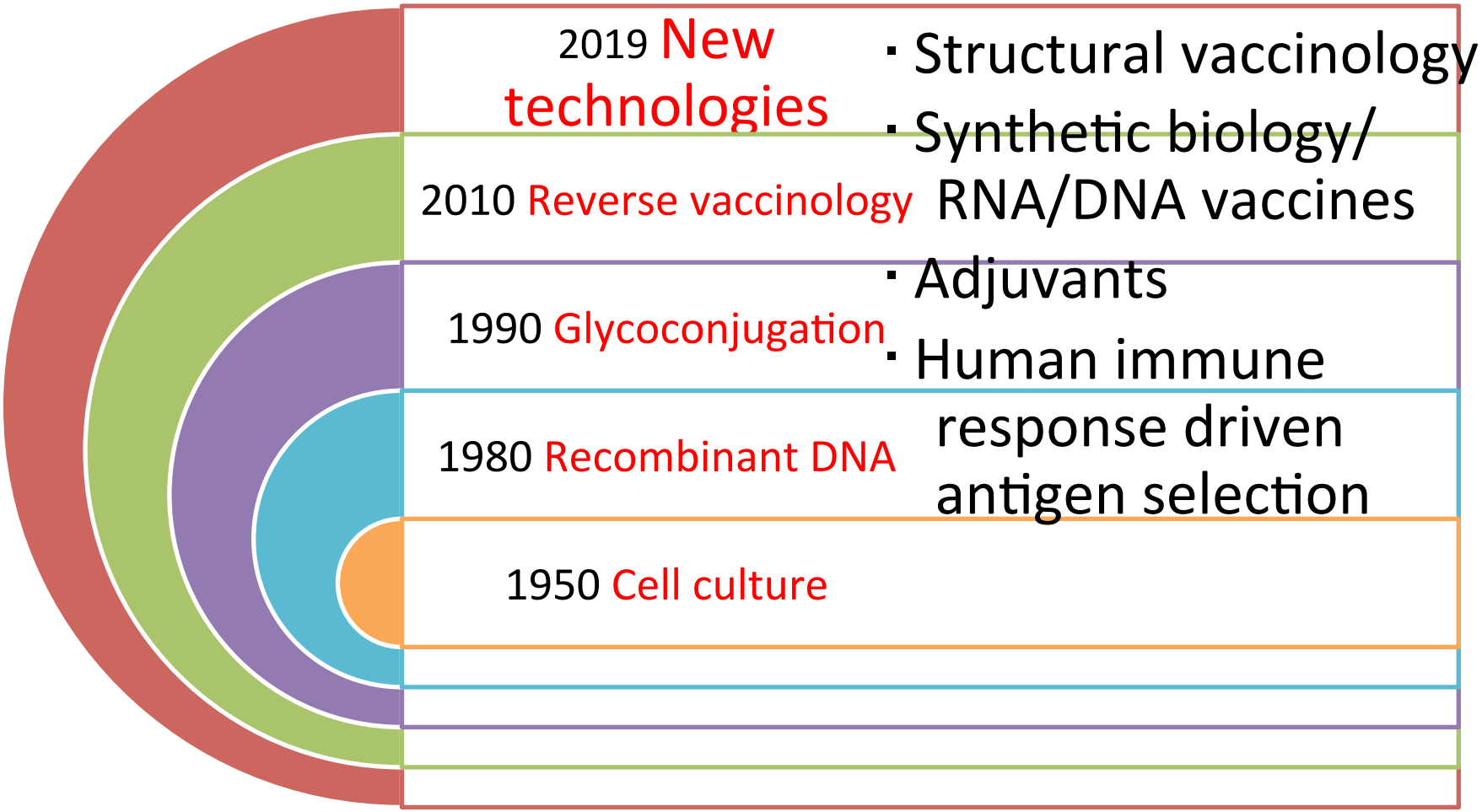
- Isolate
- Inactivate/Attenuate
- Inject



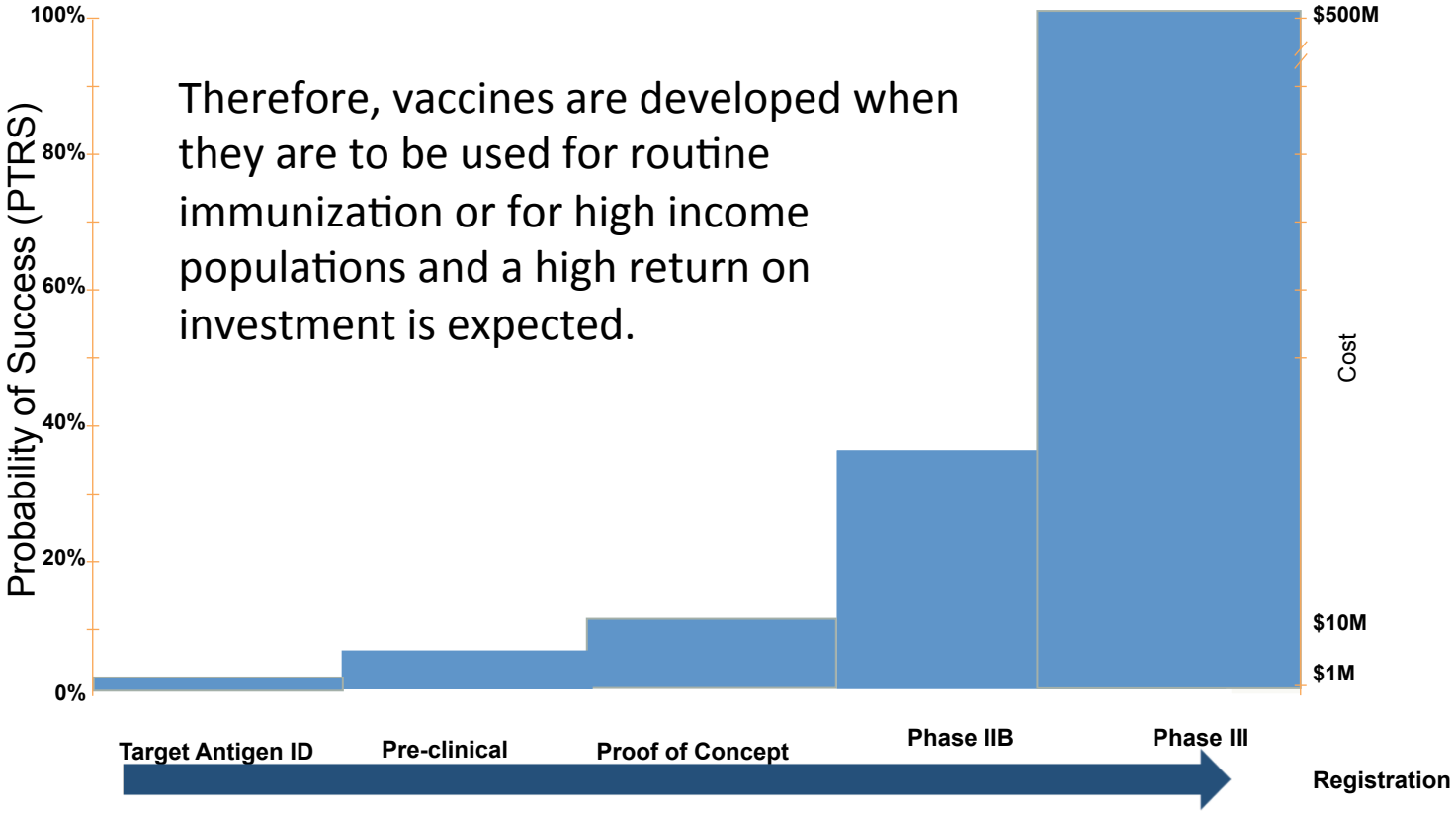
After 1950, new technologies have advanced vaccines beyond the older empirical approaches



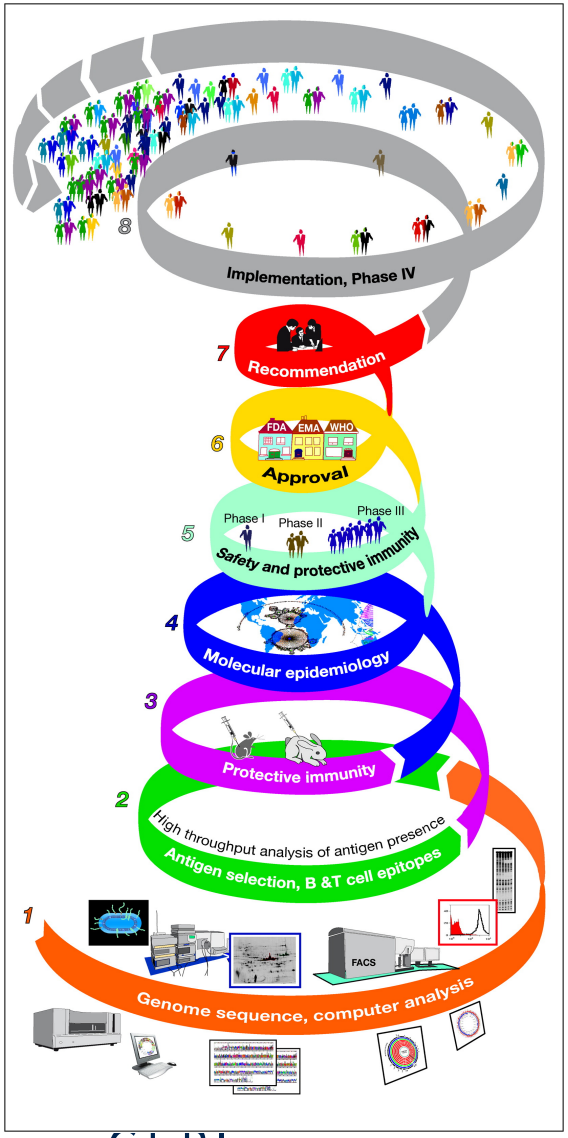
During the past 20 years, new technologies have exploded vaccine design

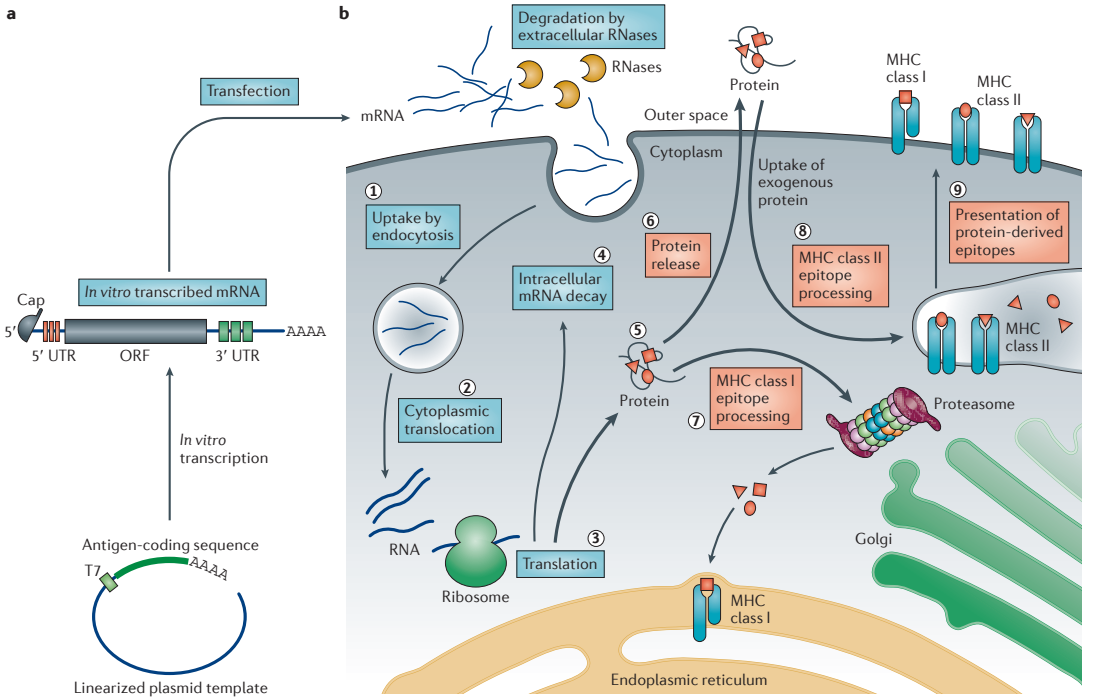


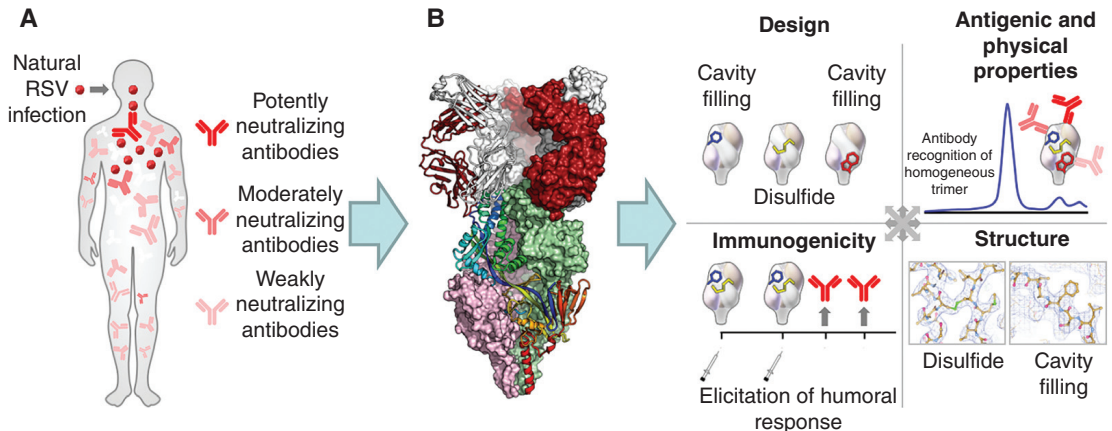
The cost of making vaccines



CEPI SARS-CoV2 platform technologies



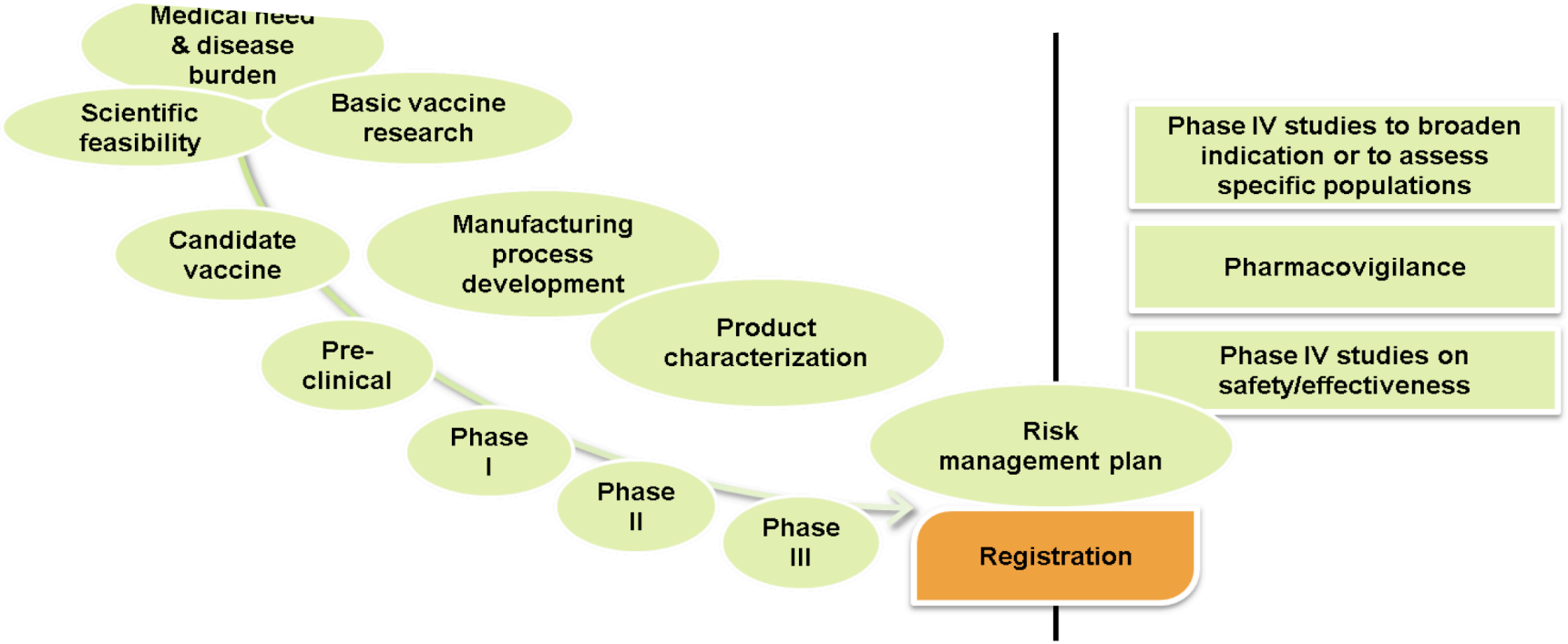




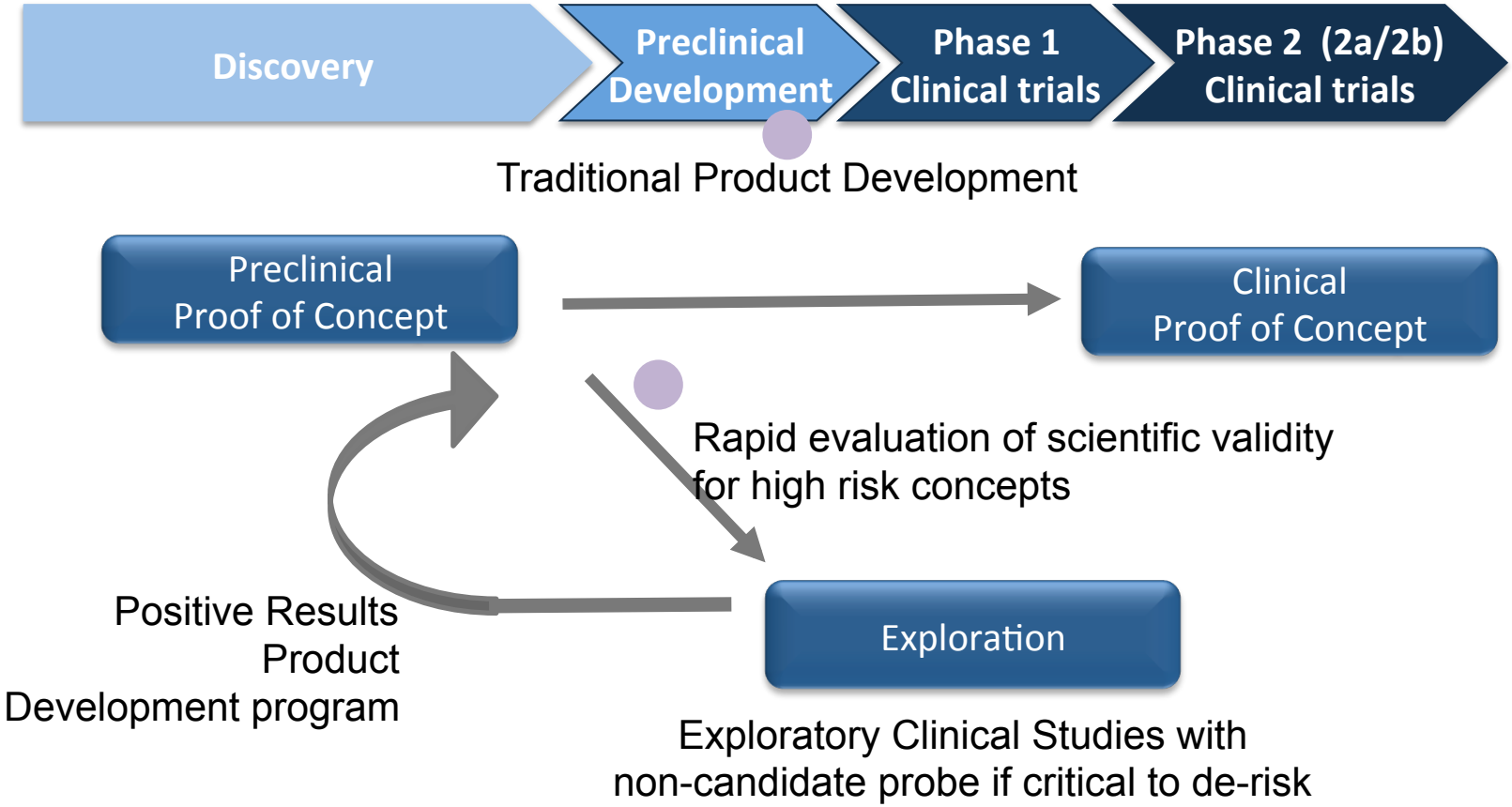
Vaccine development in the 21st Century

- Time it takes to develop and deliver a new vaccine to market remains too slow.
- A number of issues contribute to the delay:
  - Limitation of animal models to predict and mimic vaccine-induced immunity
  - Limited ability to generate novel, but physiologically relevant and testable hypotheses about the mechanisms of vaccine-induced protection
  - Difficulties in defining correlates of protection
  - Poor strategies to rationally up and down select different vaccine candidates in an affordable and timely manner
- **Exploratory clinical studies could circumvent many of these problems BUT there are major logistical barriers to this approach**

Current pathways



Product development through experimental medicine approaches



Vaccines have potential for prevention beyond epidemics-for all of society

Poverty

Cholera
Dengue
ETEC
HAV
HBV
HEV
Flu
JEV
Malaria
Men B
Parasitic infections
Paratyphoid
Rabies
Rotavirus
Salmonella
S. enterica
S. typhimurium
Shigella
TB
Typhoid fever

Emerging infections

AIDS
Anthrax
Avian influenza
Cholera
Diphtheria
Dengue
Ebola
EV71
Malaria
SARS
TB
Smallpox
West Nile
Yersinia

Travelers

Cholera
Dengue
ETEC
Flu
HAV
HBV
JEV
Malaria
Men
Paratyphoid
Rabies
Shigella
TB
Typhoid fever
Yellow Fever

Patients with Chronic diseases

CMV
Flu
Fungal infections
P. aeruginosa
Parainfluenza
RSV
Staph
TB

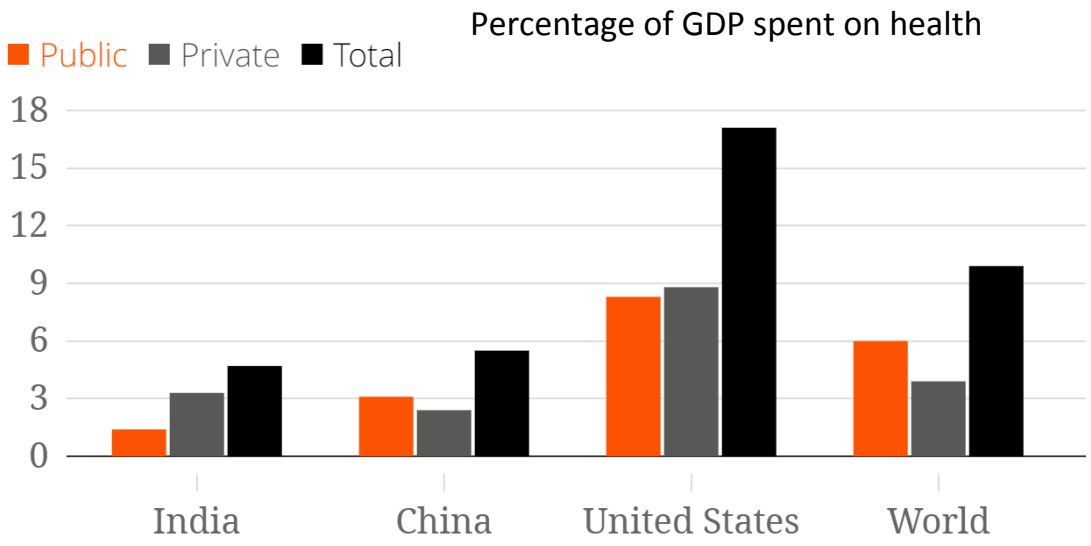
Immunotherapy/therapeutic vaccines?

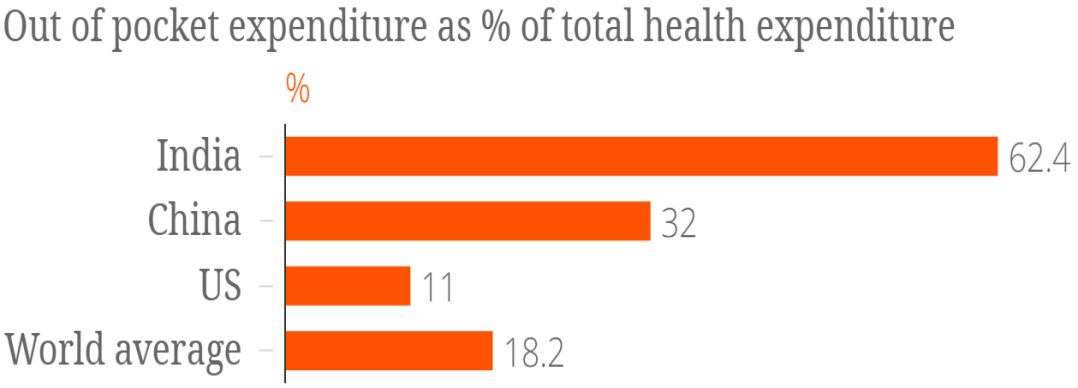
Cancer
Antoimmune diseases
Alzheimer
Chronic infections
(HCV, HBV, HPV, HIV, ...)
Metabolic diseases
Allergy
Drug addiction

Vaccines are one tool of public health
always useful in peace time, and sometimes in war

Protection, planning and policy

63 million have catastrophic health spending annually!
Without outbreaks





Vaccines transformed public health in the 20th century and in the 21st century we will see them not just for prevention of infectious diseases and outbreaks but in the prevention and treatment of non-communicable disease

60% of vaccines used in public immunization programs for children use a vaccine made in India

But we can do more

The MenAfriVac story

- Meningitis Vaccine Project (PATH, Synco Biopartners, CBER and Serum Institute)
- <10 years, 70 million US$
- Freeze-dried polysaccharide of Neisseria meningitidis group A conjugated to tetanus toxoid at a price of 0.50 US$ (other vaccines 50-80 US$)

103 million
people immunised

Impact:

Number of MenA cases:

	2009	2012
Niger	1,460	0
Burkina Faso	36	0
Mali	16	0

GAVI ALLIANCE

EMA approval for Ebola vaccine-first rVSV vaccine licensed for human use

CEPI