UNIMAS
UNIVERSITI MALAYSIA SARAWAK

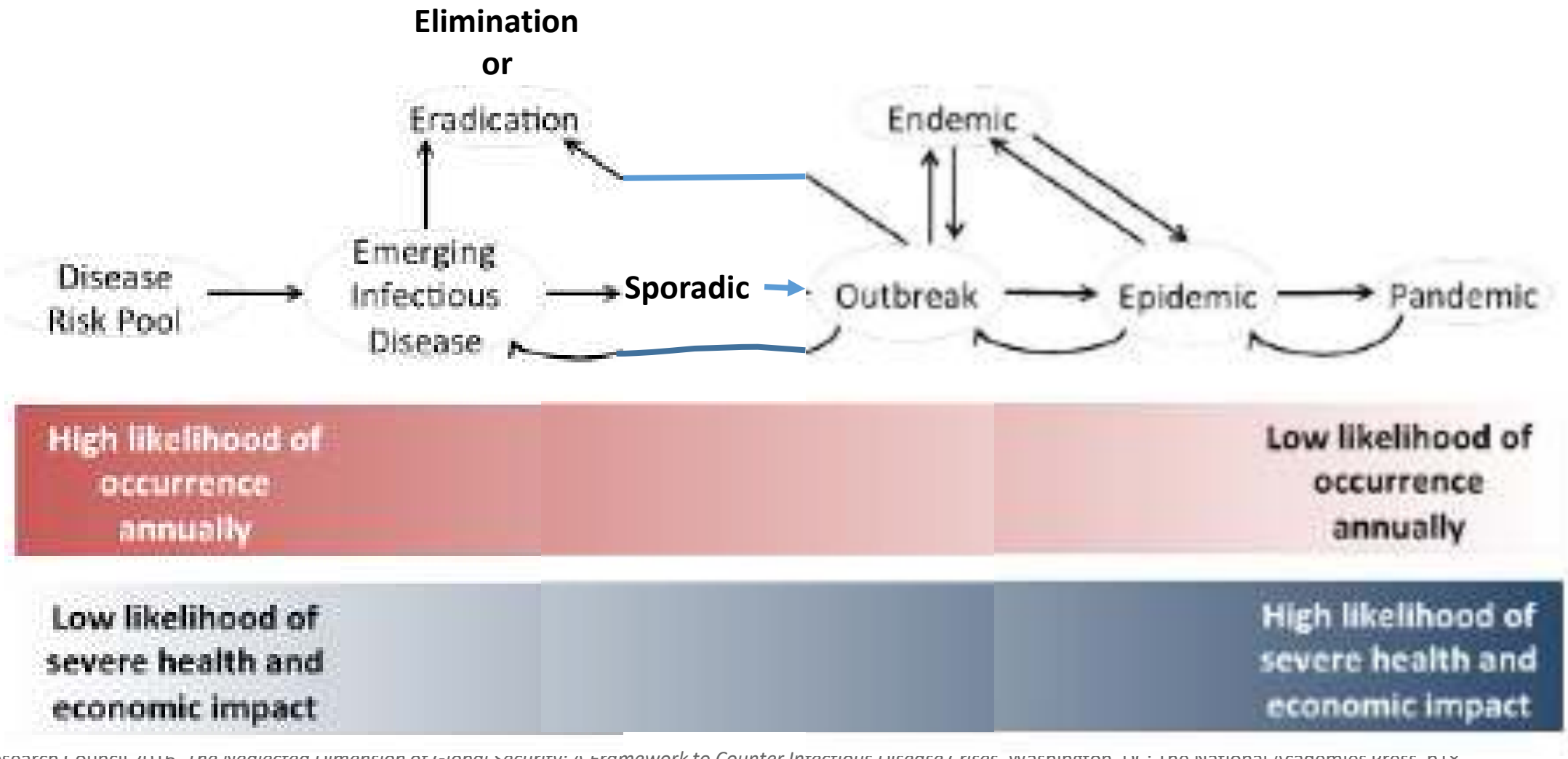
7th UNIMAS PUBLIC HEALTH WEBINAR 2021
"Impact of COVID-19 pandemic"

Global Preparation for Future Pandemics: Lessons from the Covid-19 Pandemic

Prof Andrew Kiyu
(kiyu.andrew@gmail.com)
Department of Community Medicine and Public Health
Faculty of Medicine and Health Sciences,
UNIMAS

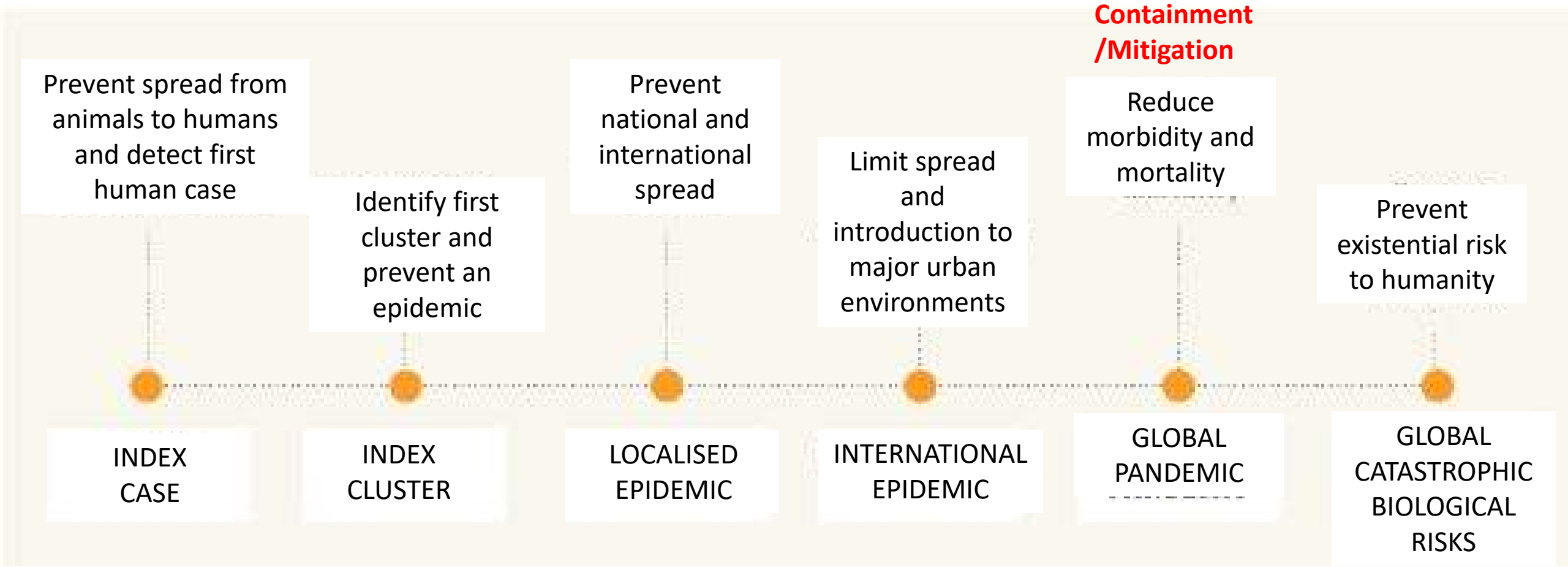
Presented at the 7 th UNIMAS Public Health Seminar
23 February 2021

Progression From Zero Case to Pandemic: Spectrum of Disease Risk



National Research Council 2016. *The Neglected Dimension of Global Security: A Framework to Counter Infectious Disease Crises*. Washington, DC: The National Academies Press. p18 https://doi.org/10.17226/21891.

Points of Intervention to Prevent a Pandemic



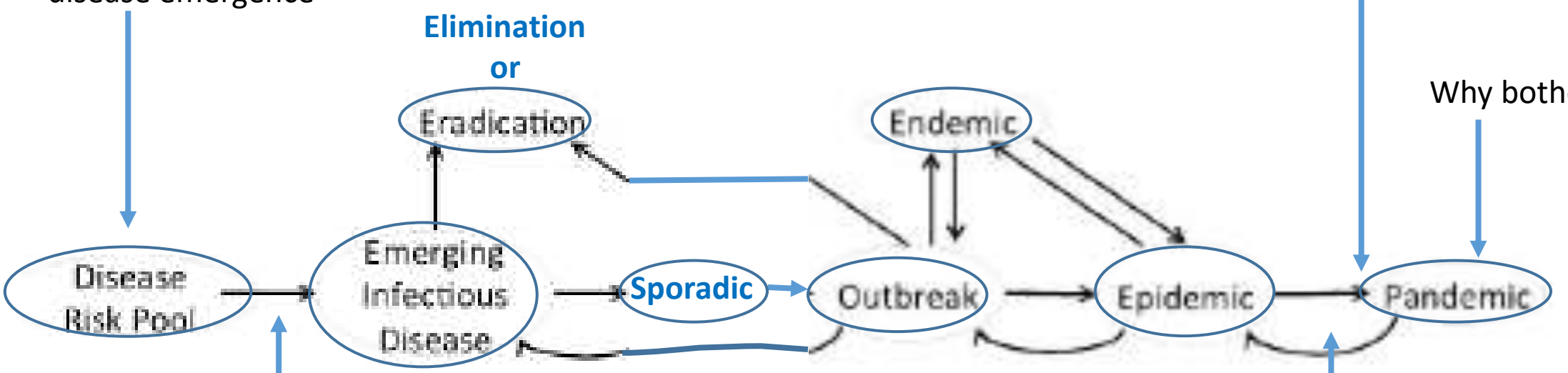
Johns Hopkins Center for Health Security (2017). **Technologies to address global catastrophic biological risks**

Scope of Topics to be Covered

The Environment
- Viruses
- Global virome project
- Characteristics likely to emerge
- Factors relating to disease emergence

- Pandemic Preparedness Plan
- Global health security
- Prerequisites for successful response

- Improving global response
- Improving national response



Can disease emergence be prevented?

Can pandemics be predicted?

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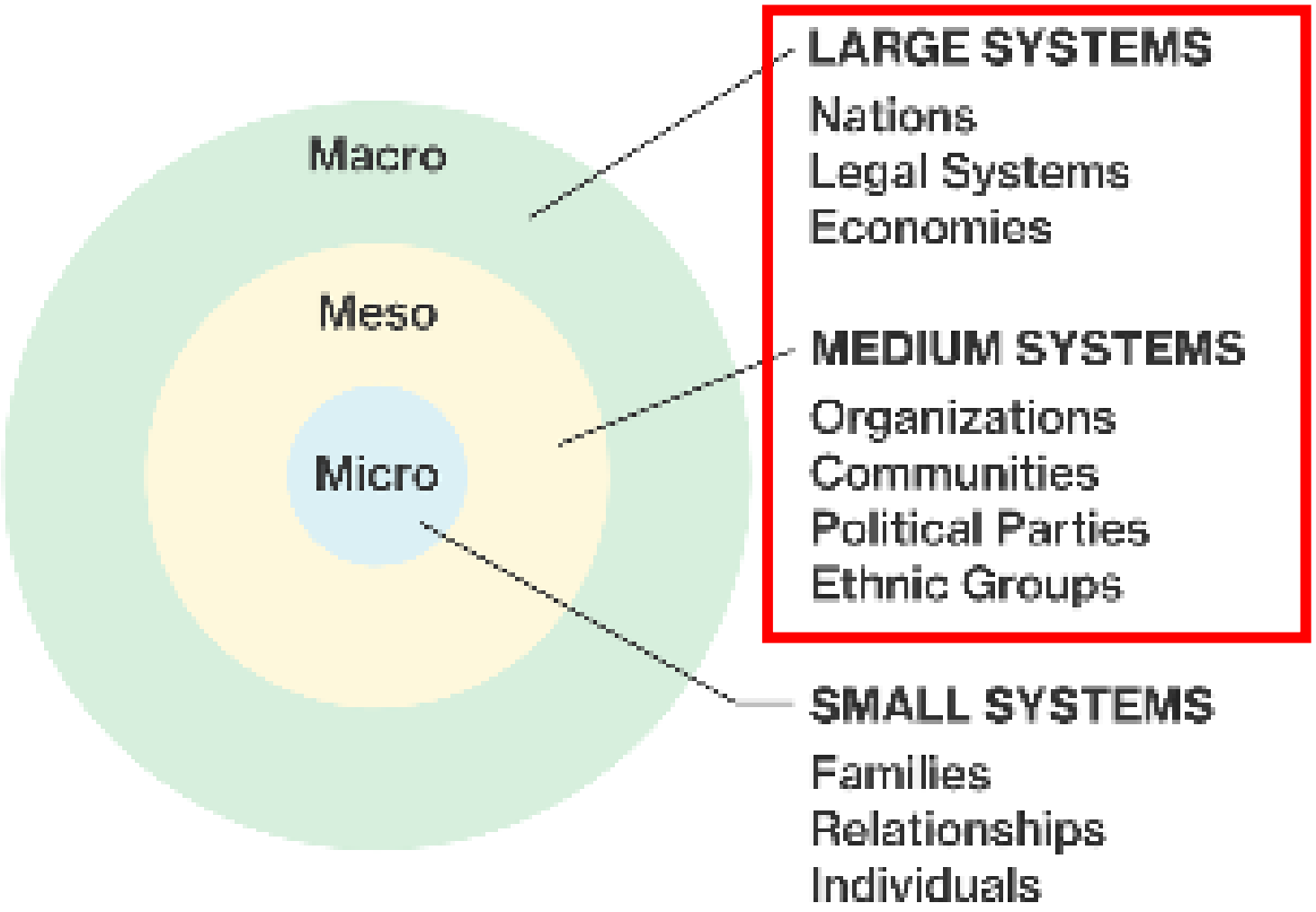
Level of Analysis



https://www.coursehero.com/sg/introduction-to-sociology/macro-level-meso-level-and-micro-level-analysis/

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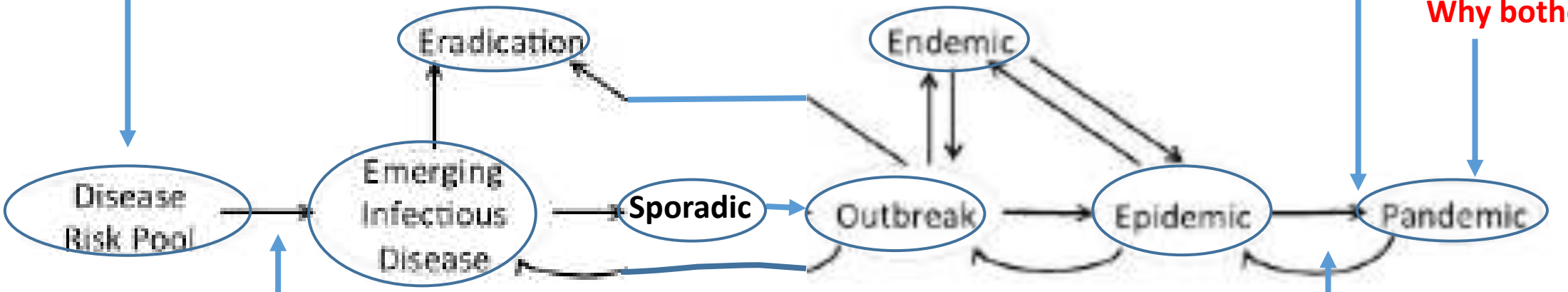

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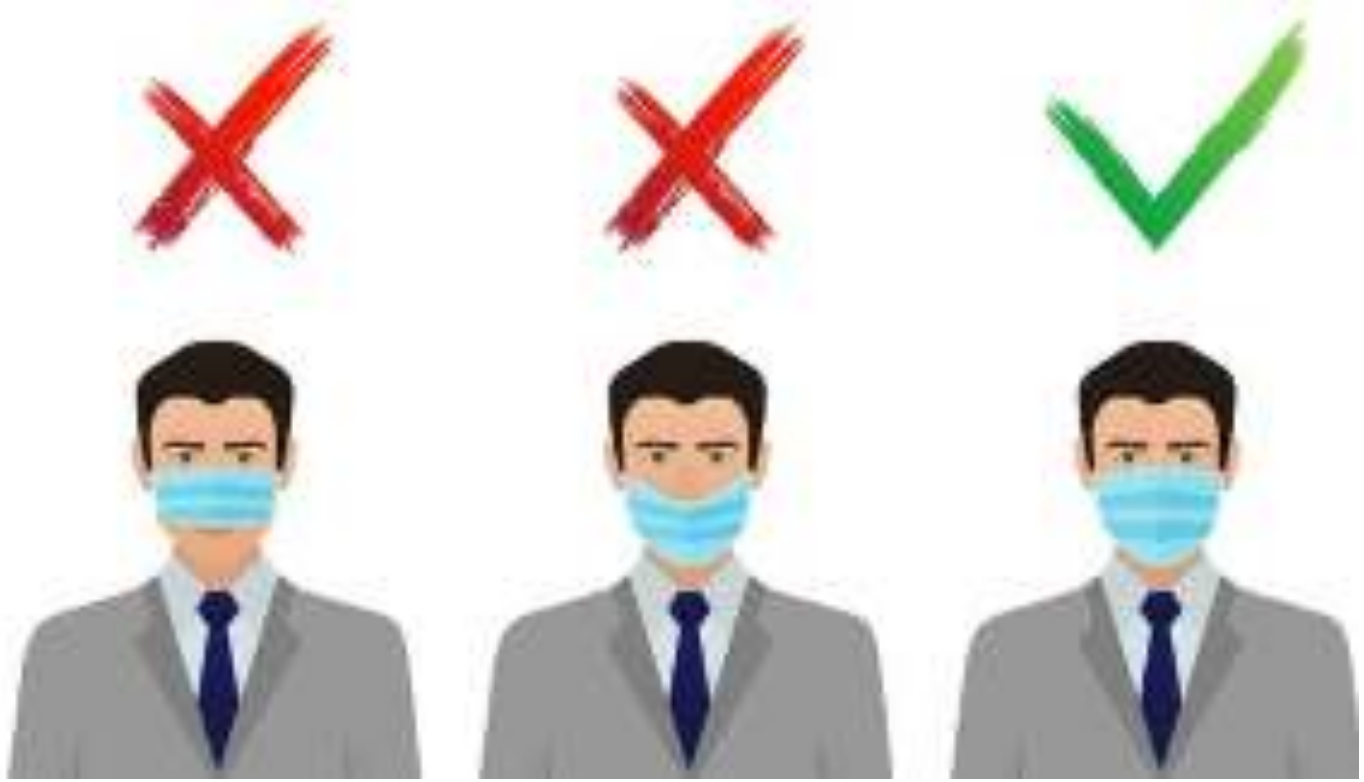


Why Pandemics Should be Prevented / Managed Properly?

Forbes

Bill Gates: Future Pandemics Must Be Taken As Seriously As 'The Threat Of War'

SARS-CoV-2 virus

Colorized scanning electron micrograph of an apoptotic cell (greenish brown) heavily infected with SARS-COV-2 virus particles (pink), also known as novel coronavirus, isolated from a patient sample. Image captured and color-enhanced at the NIAID Integrated Research Facility (IRF) in Fort Detrick, Maryland. National Institute of Allergy and Infectious Diseases, NIH/Handout via REUTERS.

https://www.forbes.com/sites/rachelsandler/2021/01/27/bill-gates-future-pandemics-must-be-taken-as-seriously-as-the-threat-of-war/?sh=5c126ad73871

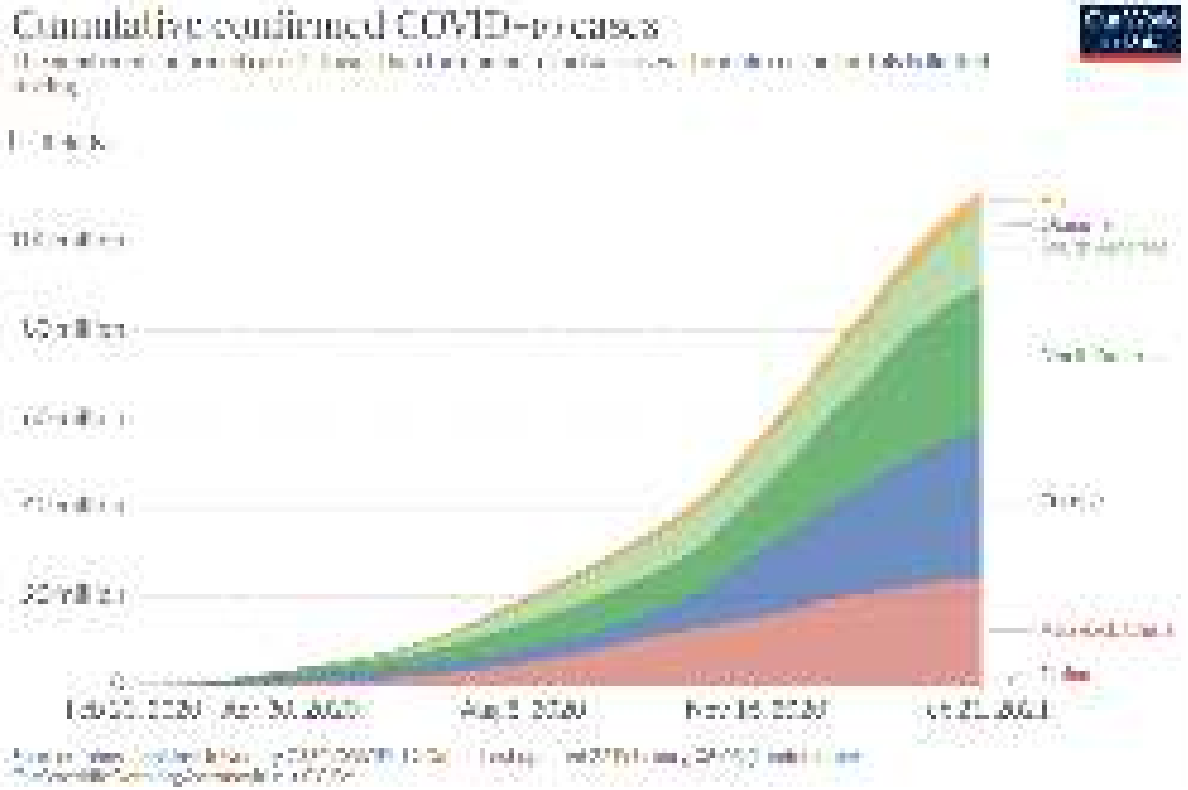
Aircraft carrier

https://nationalinterest.org/blog/the-buzz/chinas-carrier-killer-really-threat-the-us-navy-13765

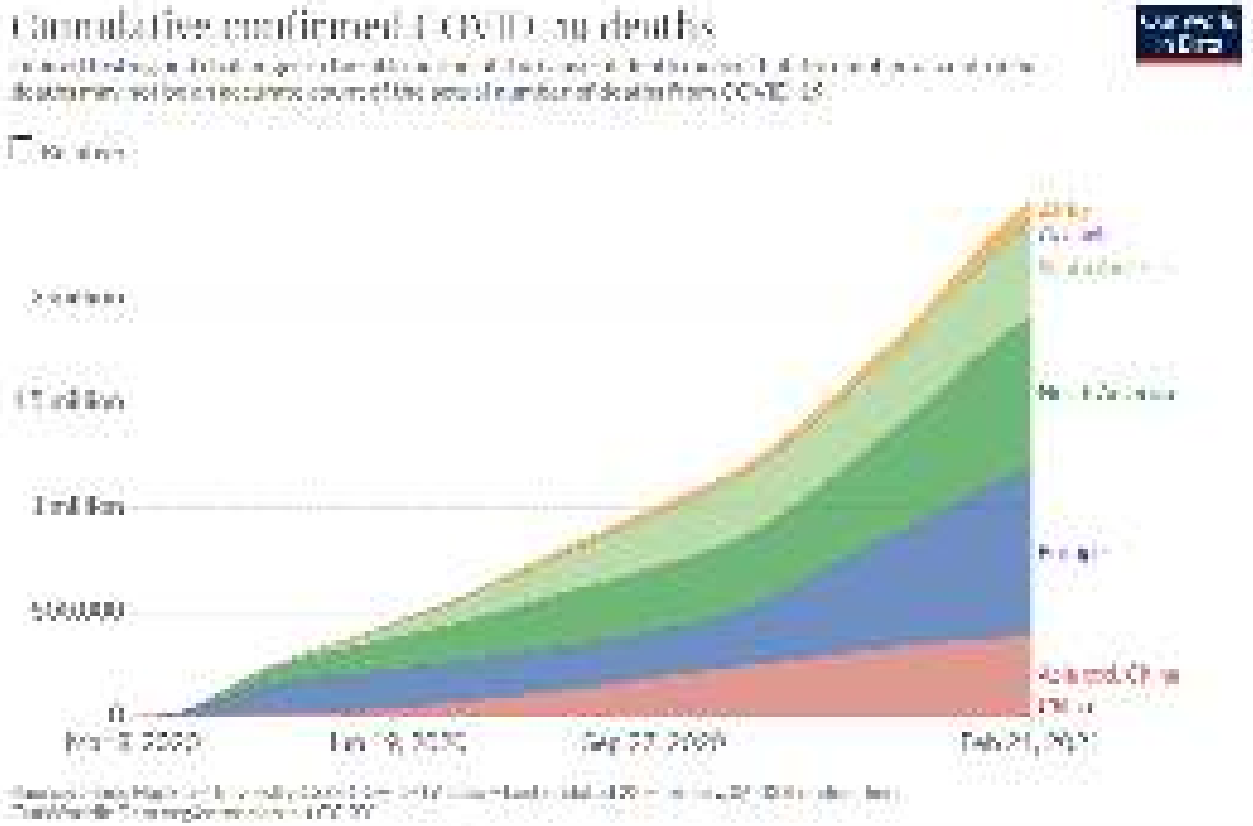
Morbidity and Mortality due to Covid -19 as of 21 Feb 2021

111 Million cases;

2.46 Million deaths as of 22 Feb 2021



https://ourworldindata.org/grapher/cumulative-covid-cases-region?tab=chart&stackMode=absolute&time=2020-01-05..latest&region=World



https://ourworldindata.org/grapher/cumulative-covid-deaths-region?tab=chart&stackMode=absolute&time=2020-01-11..latest&region=World

Economic Impact of EID

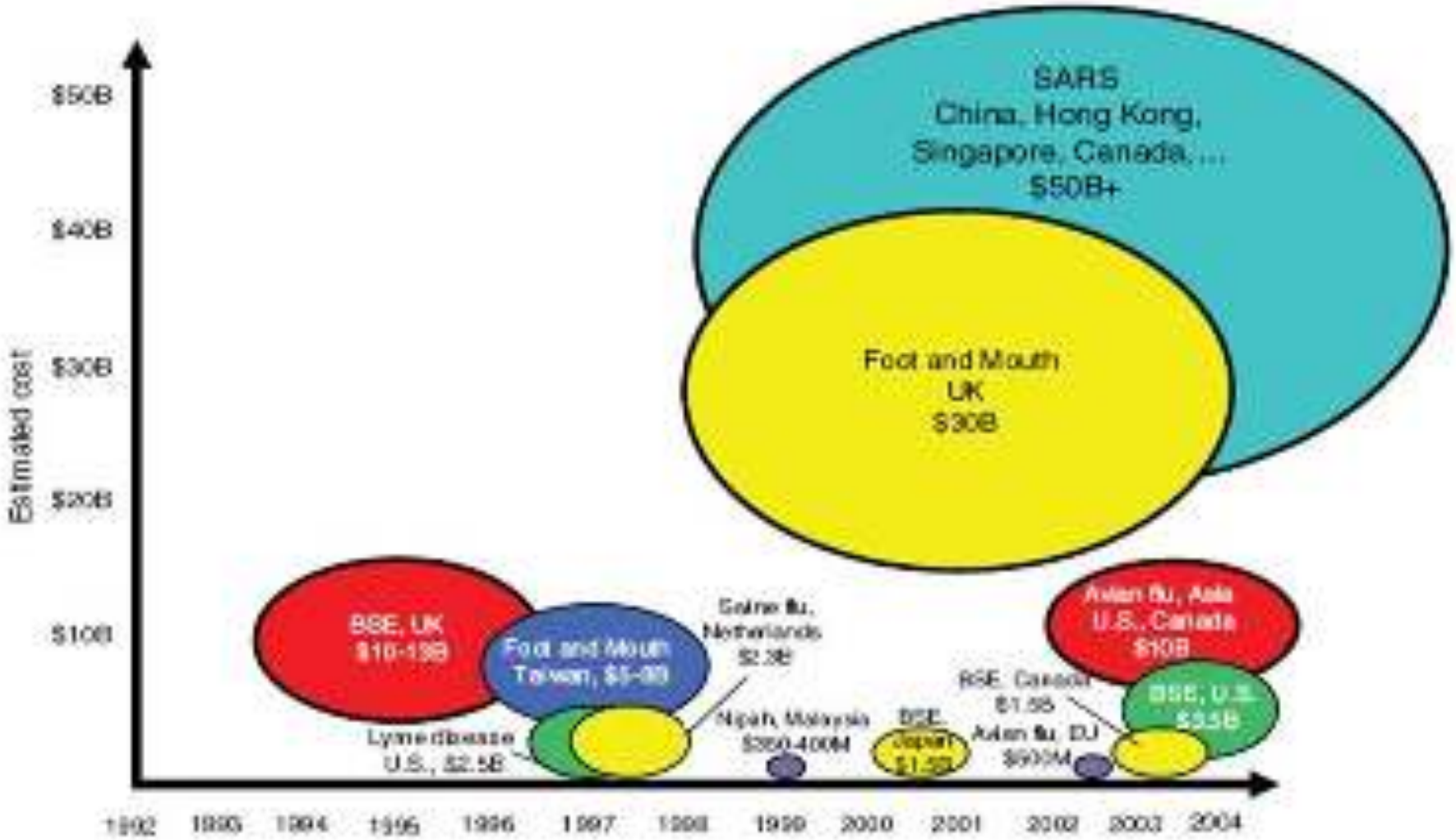


FIGURE SA-1 The economic impact of selected infectious diseases.
SOURCE: Kaniah (2006). Reprinted with permission from Bio-era. Copyright 2007.

Institute of Medicine 2007. *Global Infectious Disease Surveillance and Detection: Assessing the Challenges Finding Solutions: Workshop Summary*. Washington, DC: The National Academies Press. https://doi.org/10.17226/11996.

Economic Impact of Covid-19 Pandemic

- The International Monetary Fund projects that,
  - the global economy will lose US$12 trillion, or more, by the end of 2021.
  - even with the US$18 trillion that has already been spent to stimulate economies around the world,
- That amount of money is impossible to fathom.

Historical comparisons help:

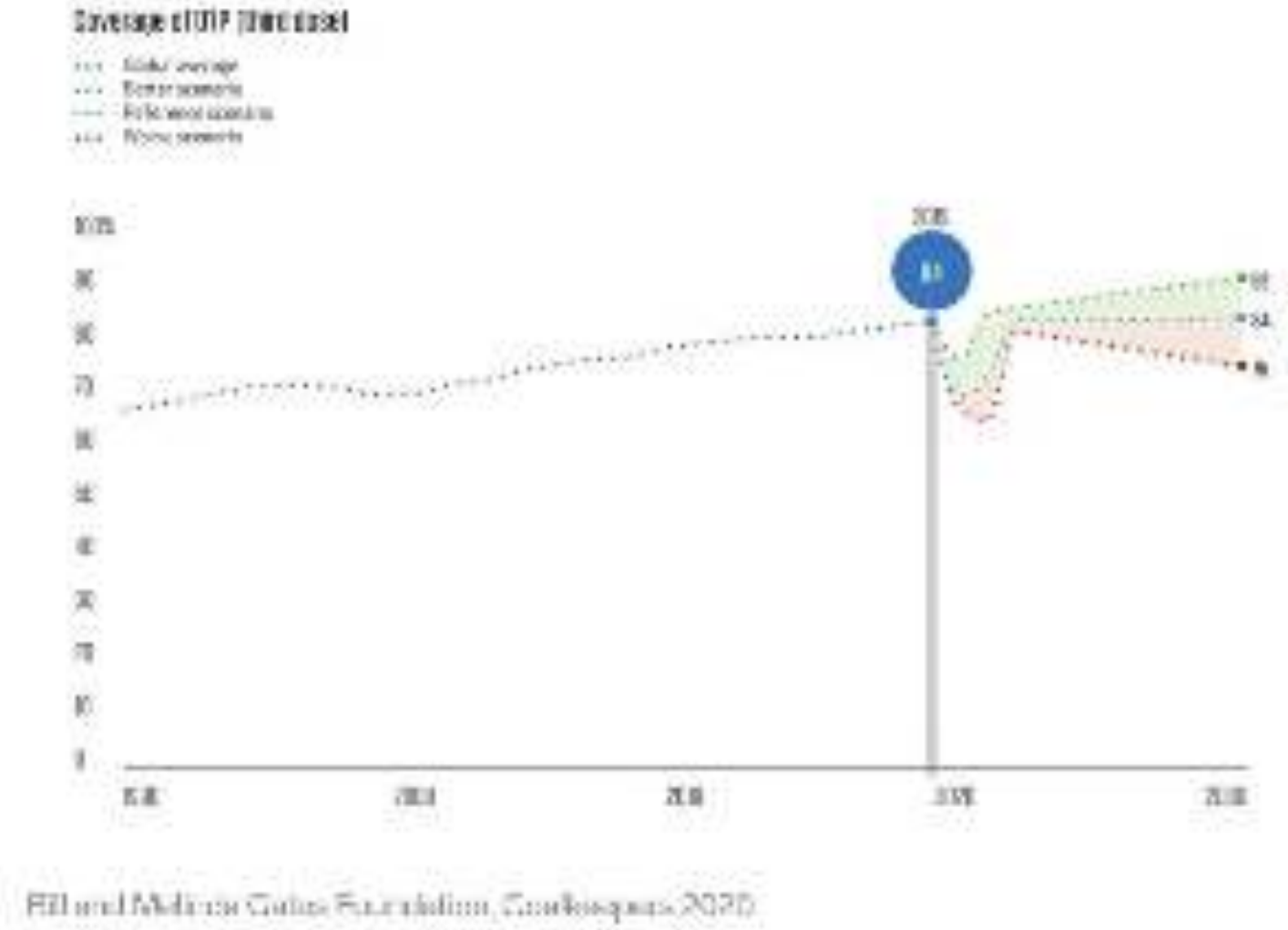
- For example, in terms of global gross domestic product (GDP) loss,
  - this is the worst recession since the end of World War II,
    - when war production stopped in an instant,
    - one entire continent and parts of another were destroyed, and
    - 3 percent of the world's pre-war population was dead.
- The last time this many countries were in recession at once was in 1870, literally two lifetimes ago.

25 years of Progress in Global Health Wiped Out in 25 weeks

According to the Institute for Health Metrics and Evaluation (the Gates Foundation's data partner),

- 25 years of progress to get the world vaccinated against deadly diseases
- was just swiftly wiped out in 25 weeks.

Here's one example of how vaccine coverage has dropped to levels that haven't been seen since the 1990s, showing diphtheria, tetanus, pertussis, or DTP, vaccination coverage worldwide:



https://ww2.gatesfoundation.org/goalkeepers/report/2020-report/progress-indicators/vaccines

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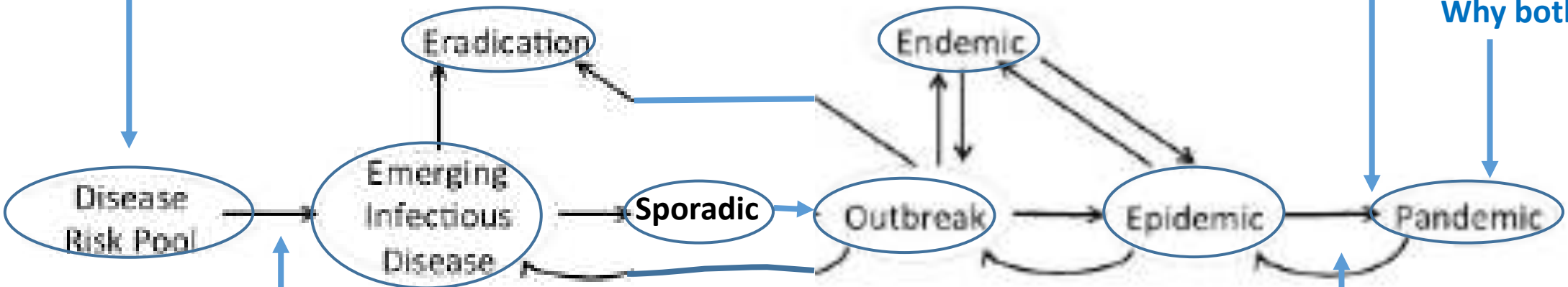

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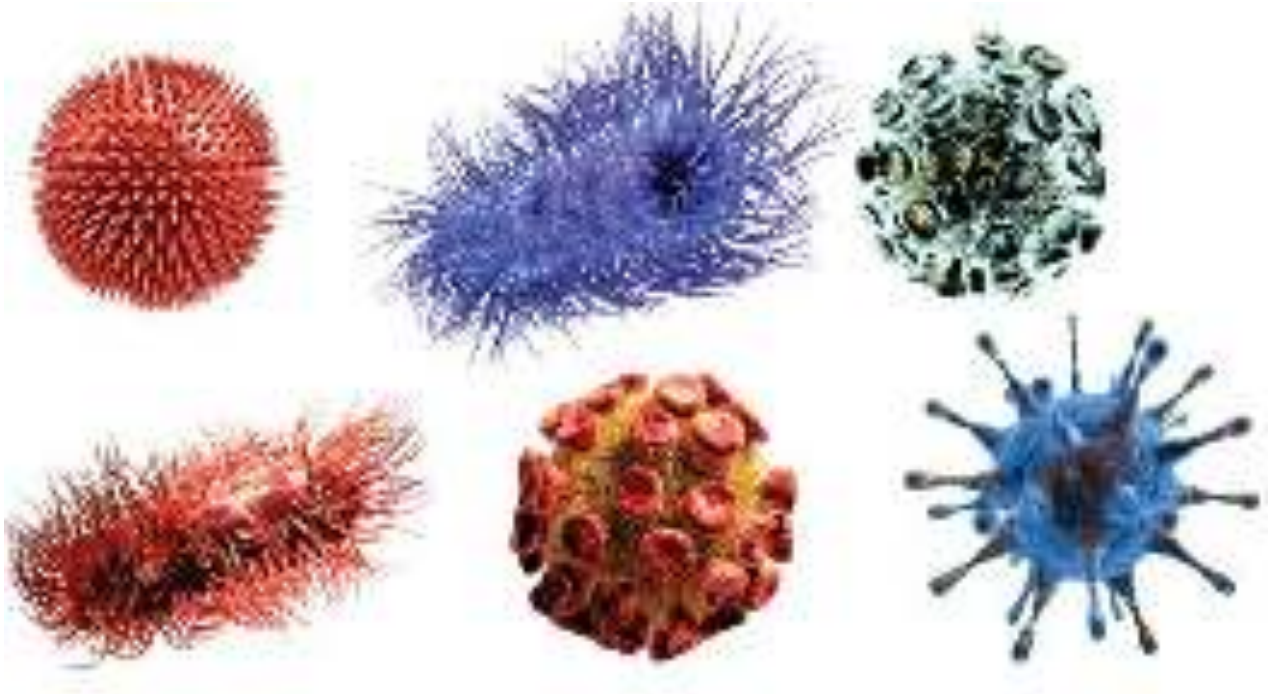
The Environment: Natural/Disturbed and Built



How many viruses are out there?

SARS-CoV2 and Bats

Bats are thought to host a large plethora of viruses. These include, amongst the others, lyssaviruses, filoviruses, henipaviruses, and reoviruses.

Before SARS-CoV epidemic, bats were not known to host CoVs. Indeed, the first evidence of a bat CoV was published in 2005.

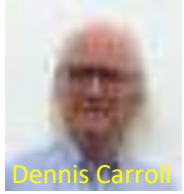
After the SARS epidemic, there was a boost in interest regarding searching for novel CoVs in various animals, including bats.

To date, over 200 novel CoVs have been identified in bats and approximately 35 % of the bat virome sequenced to date is composed of CoVs.

GOING VIRAL Genetic studies of viruses from horseshoe bats (shown) in one cave in China suggest the animals are reservoirs of SARS coronaviruses. Bats harbor many viruses that can sometimes infect people, including Ebola and Marburg.
Libiao Zhang/Guangdong Institute of Applied Biological Resource, China

https://www.sciencenews.org/article/bats-china-carry-all-ingredients-make-new-sars-virus

Nicola Decaro and Alessio Lorusso (2020.05). **Novel human coronavirus (SARS-CoV-2): A lesson from animal coronaviruses. Veterinary Microbiology**
Volume 244, May 2020, 108693. https://doi.org/10.1016/j.vetmic.2020.108693

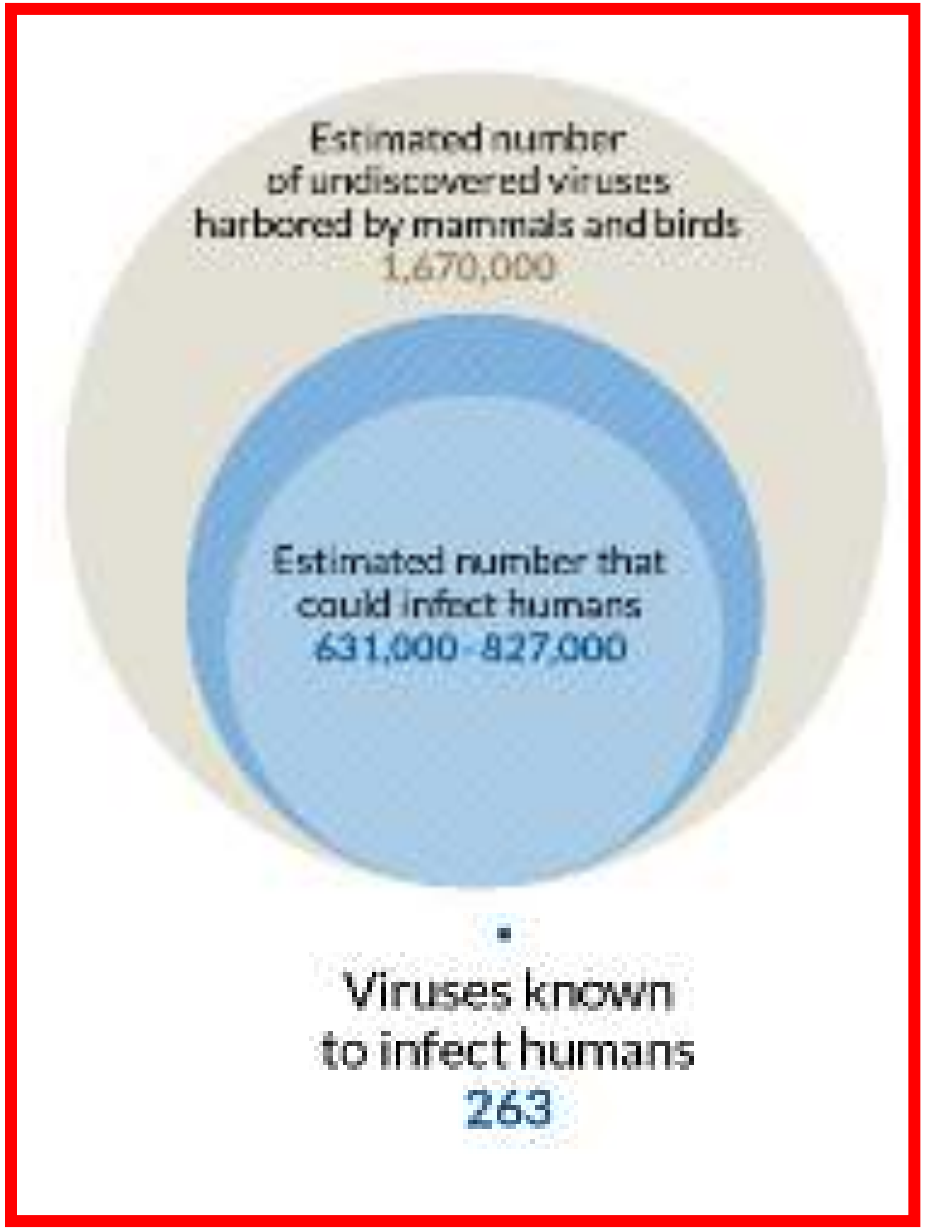


Global Virome Project (GVP)

The Human Genome Project in the 1980s catalyzed technological innovation that dramatically shortened the time and cost for its completion, and ushered in the era of personalized genomics and precision medicine.

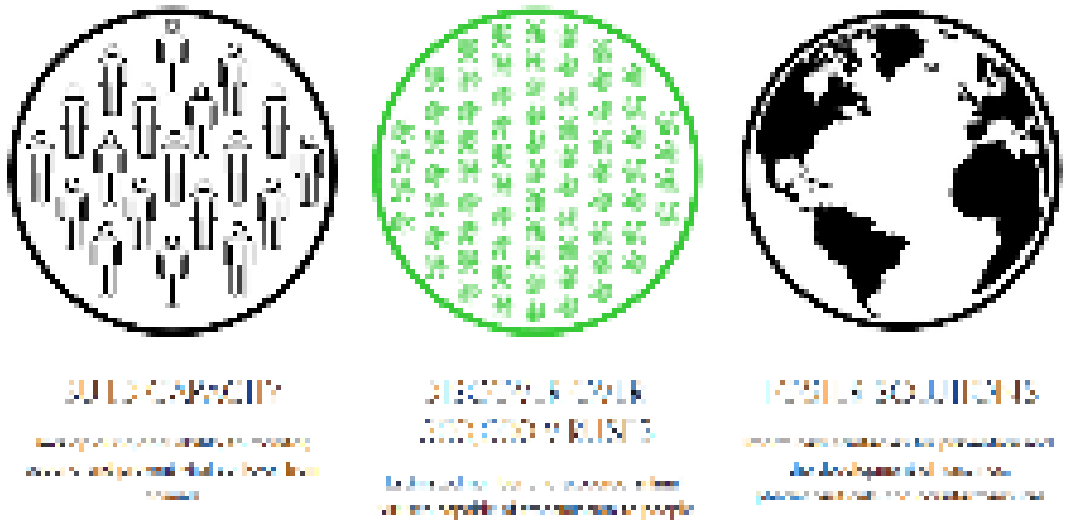
The GVP will likely accelerate:

- development of pathogen discovery technology,
- diagnostic tests, and
- science-based mitigation strategies,
  - which may also provide unexpected benefits



Carroll, D., Daszak, P., et al (2018). The Global Virome Project. https://science.sciencemag.org/content/359/6378/872

The Global Virome Project (GVP) is a 10-year collaborative scientific initiative to discover unknown zoonotic viral threats and stop future pandemics



The Global Virome Project will cost US $ 1.2 billion, which is less than 0.2% of the 10 and 50 billion United States dollars losses caused by the Severe Acute Respiratory Syndrome (SARS) outbreak in 2003

Source: Carroll, D, et al (2018). Building a global atlas of zoonotic viruses. Bull World Health Organ 2018;96:292–294 doi:http://dx.doi.org/10.2471/BLT.17.205005

http://www.globalviromeproject.org/

(The aircraft carrier USS Gerald R. Ford, cost USD 13 billion)

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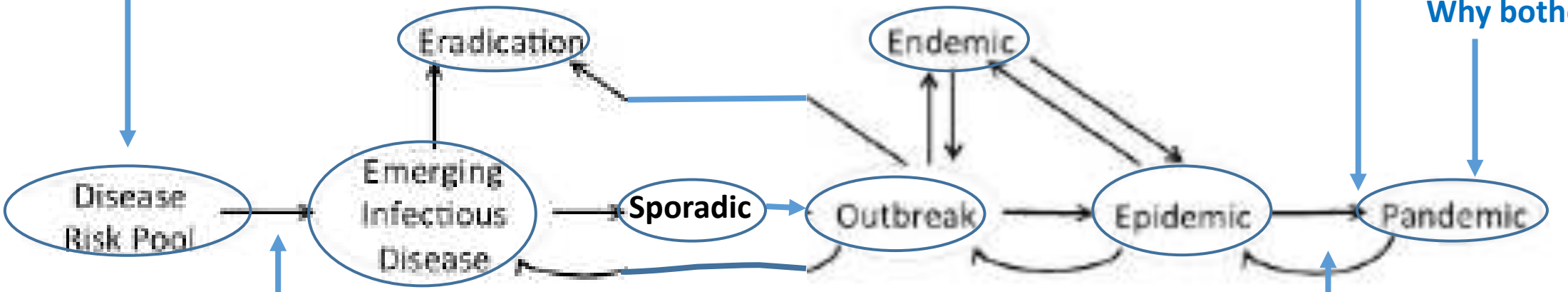

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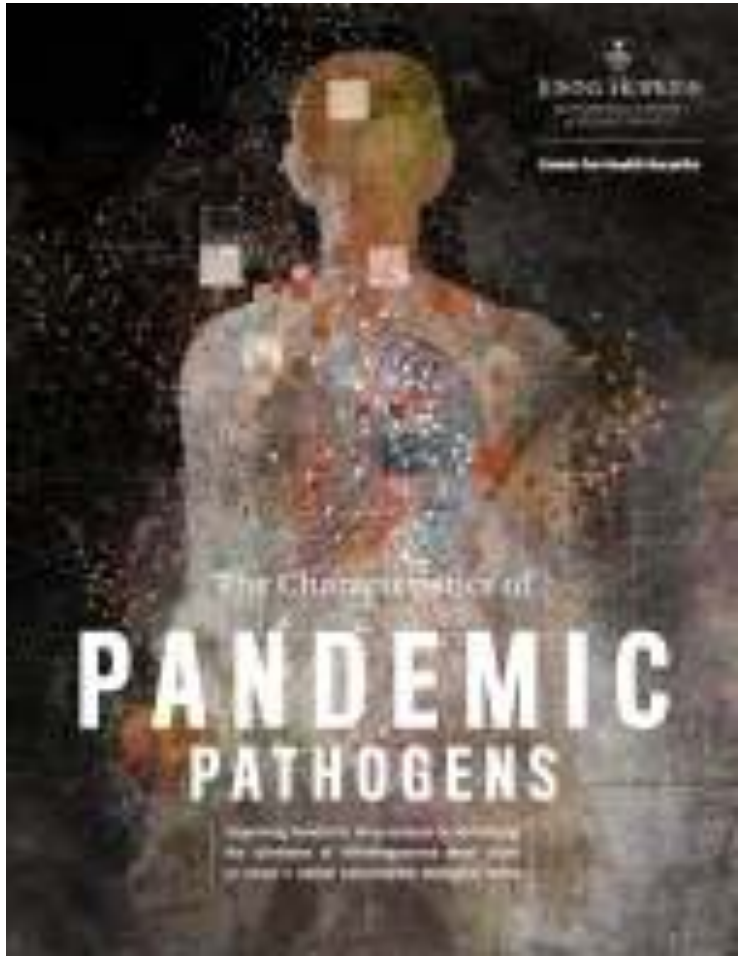
Characteristics of viruses that are like to emerge

Characteristics of Pandemic Pathogens (2018)

A potential global catastrophic risk-level pandemic pathogen will most likely:

- have a respiratory mode of transmission;
- be contagious during the incubation period, prior to symptom development, or when infected individuals show only mild symptoms;
- need specific host population factors (e.g., immunologically naïve persons)
- have additional intrinsic microbial pathogenicity characteristics (e.g., a low but significant case fatality rate)
    - that together substantially increase disease spread and infection.
- RNA viruses are the biggest threat.



Johns Hopkins Center for Health Security (2018.05.29). **Characteristics of microorganisms most likely to cause a global pandemic**
https://www.centerforhealthsecurity.org/our-work/pubs_archive/pubs-pdfs/2018/180510-pandemic-pathogens-report.pdf

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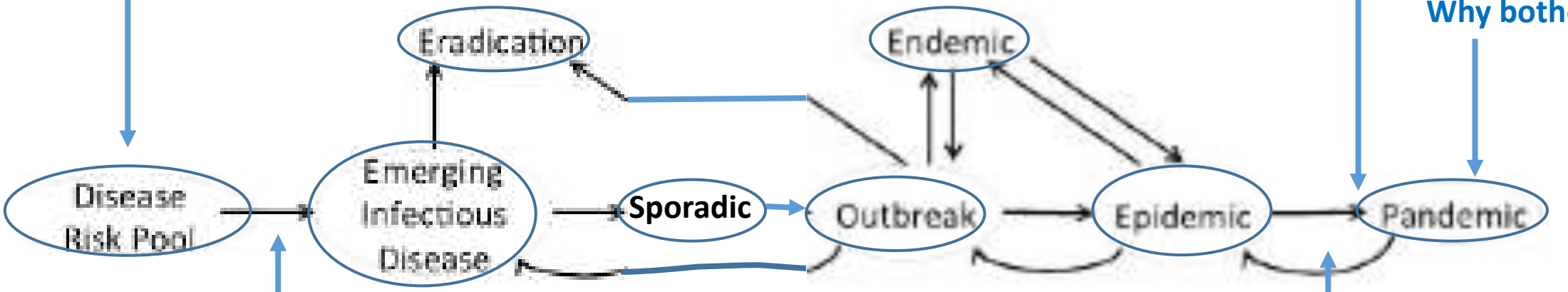

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http://www.thegraphicrecorder.com/2012/01/09/word-sketch-emergence/

Factors Related to Disease Emergence

Origins and Emergence of Pandemics

Pandemics

- have their origins in diverse microbes carried by animal reservoirs,
- but their emergence is entirely driven by human activities.

The underlying causes of pandemics are the same global environmental changes that drive biodiversity loss and climate change. These include:

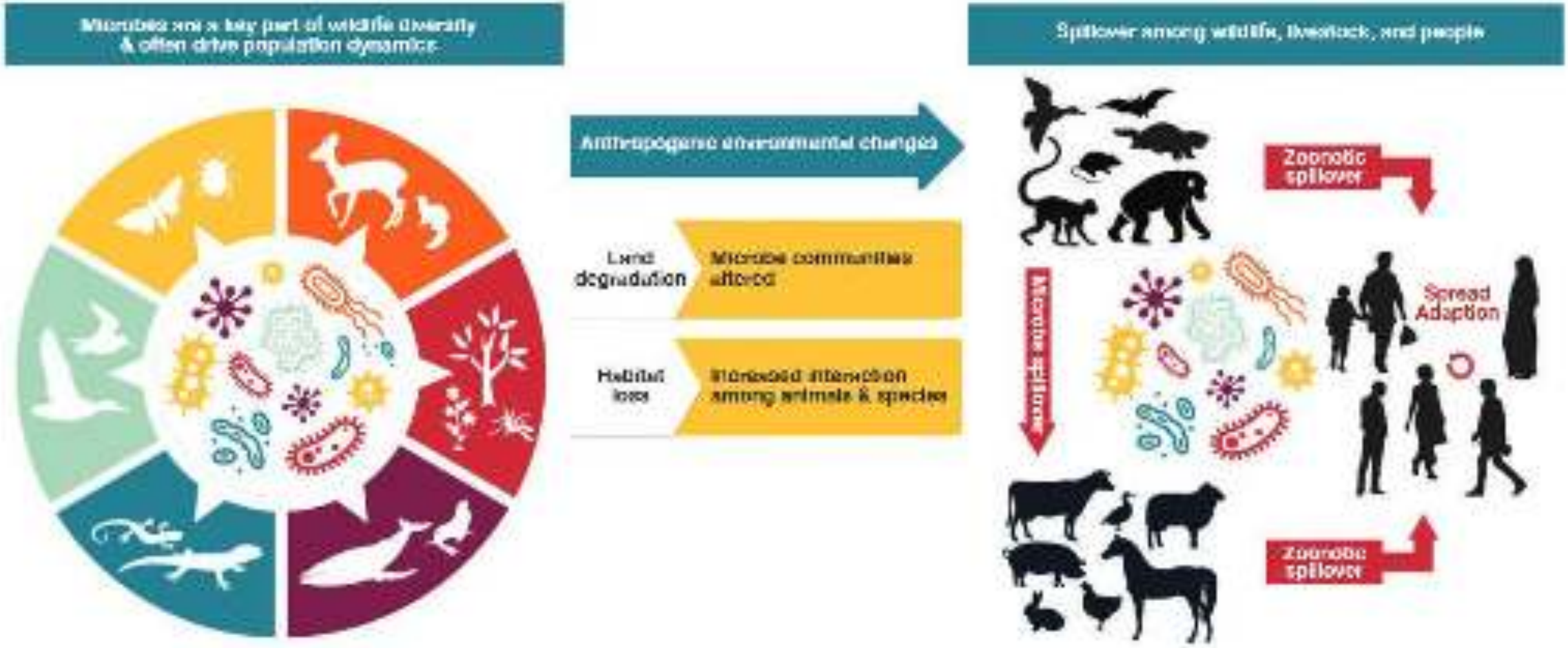
- land-use change,
- agricultural expansion and intensification, and
- wildlife trade and consumption.

These drivers of change

- bring wildlife, livestock, and people into closer contact,
- allowing animal microbes to move into people and lead to infections, sometimes outbreaks, and
- more rarely into true pandemics
    - that spread through road networks, urban centres and global travel and trade route

IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://ipbes.net/sites/default/files/2020-12/IPBES%20Workshop%20on%20Biodiversity%20and%20Pandemics%20Report_0.pdf

The Origins and Drivers of Emerging Zoonotic Diseases and Pandemics.



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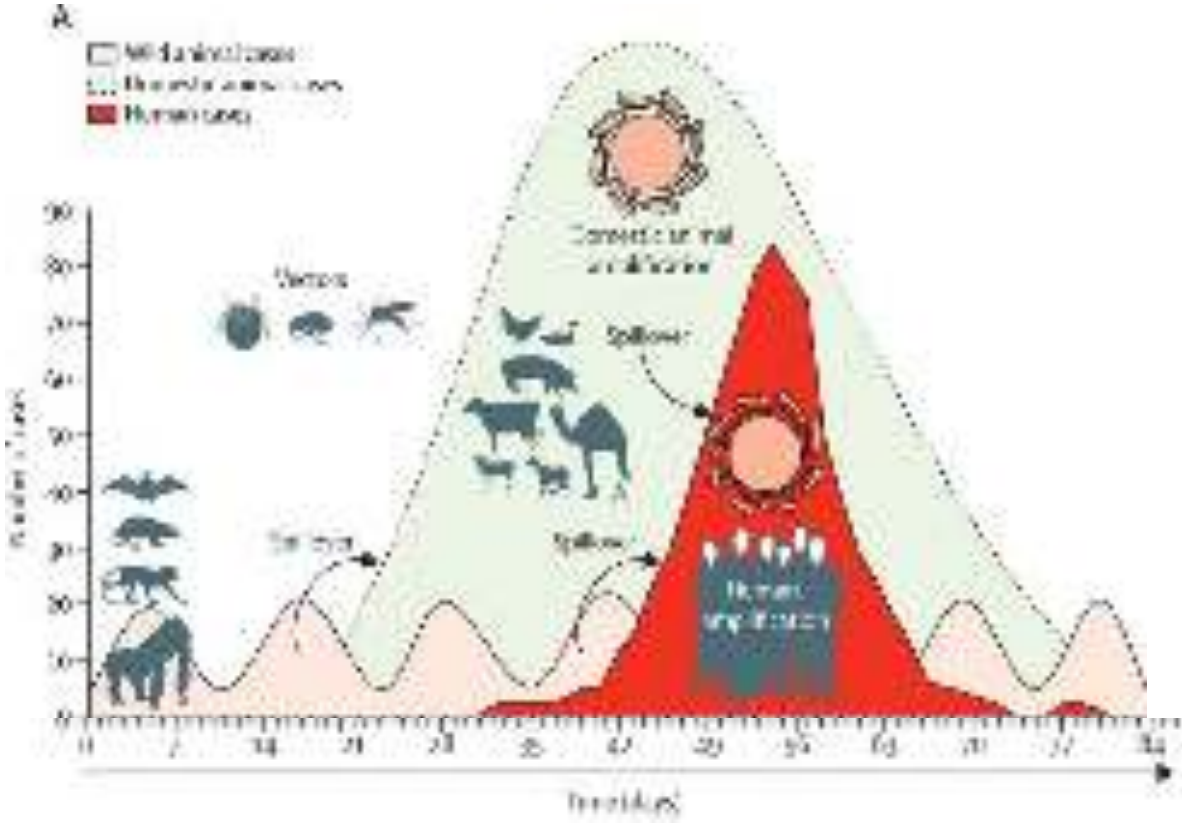
Pandemics and Emerging Infectious Diseases (EIDs)

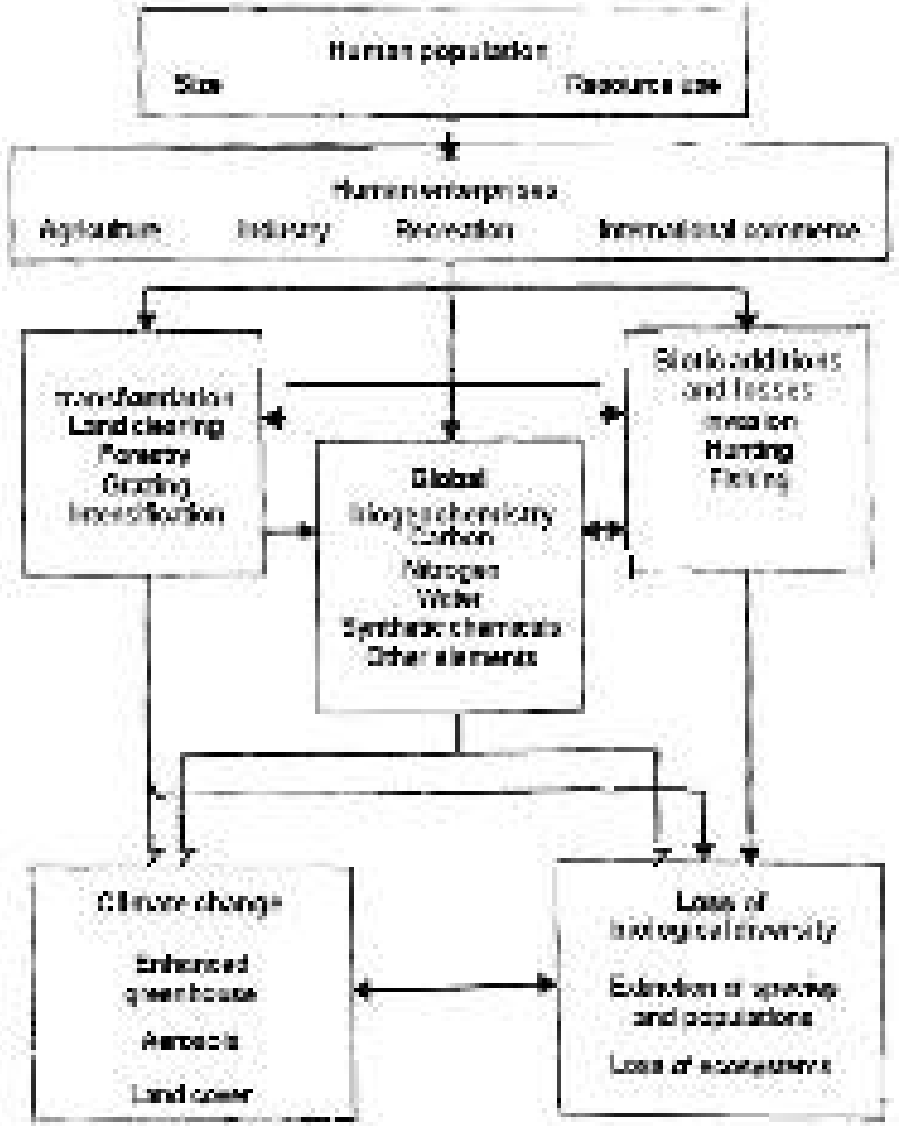
- Pandemics emerge from the microbial diversity found in nature
- Zoonoses account for
  - 70% of emerging diseases (e.g. Ebola, Zika, Nipah encephalitis),
  - almost all known pandemics (e.g. influenza, HIV/AIDS, COVID-19), are zoonoses.
- These microbes ‘spill over’ due to contact among wildlife, livestock, and people.



William B Karesh, et al/ (2012). **Ecology of zoonoses: natural and unnatural histories** The Lancet. Volume 380, ISSUE 9857, P1936-1945, December 01, 2012. DOI:https://doi.org/10.1016/S0140-6736(12)61678-X

IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://ipbes.net/sites/default/files/2020-12/IPBES%20Workshop%20on%20Biodiversity%20and%20Pandemics%20Report_0.pdf

A conceptual model illustrating humanity's direct and indirect effects on the arth system

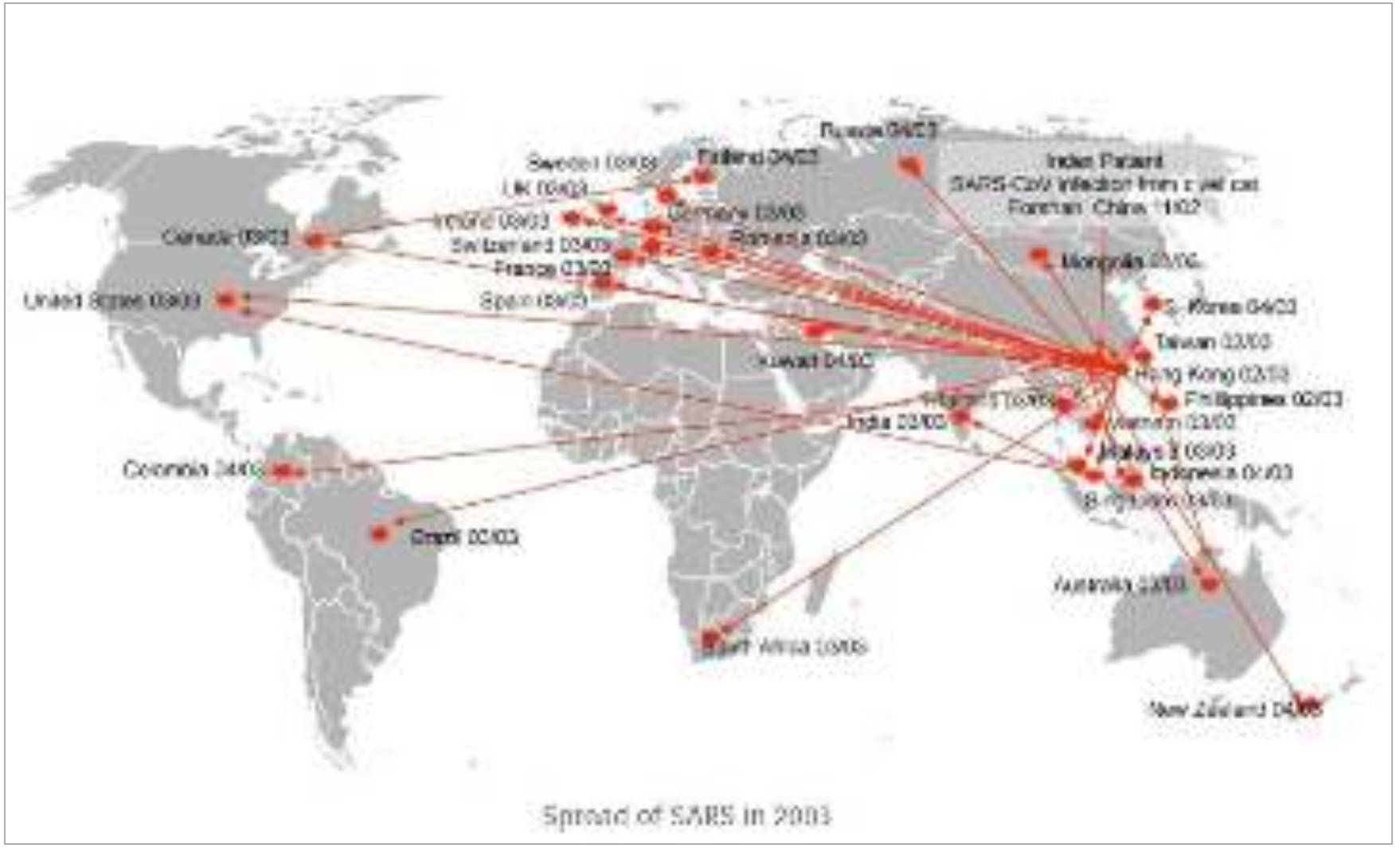


- **Source:** Peter M. Vitousek, Harold A. Mooney, Jane Lubchenco, Jerry M. Melillo. Human Domination of Earth's Ecosystems. SCIENCE VOL. 277 25 JULY 1997 http://www.sciencemag.org/

1. Global travel
2. Urbanisation
3. Climate change
4. Increased human animal contact
5. Health worker shortage

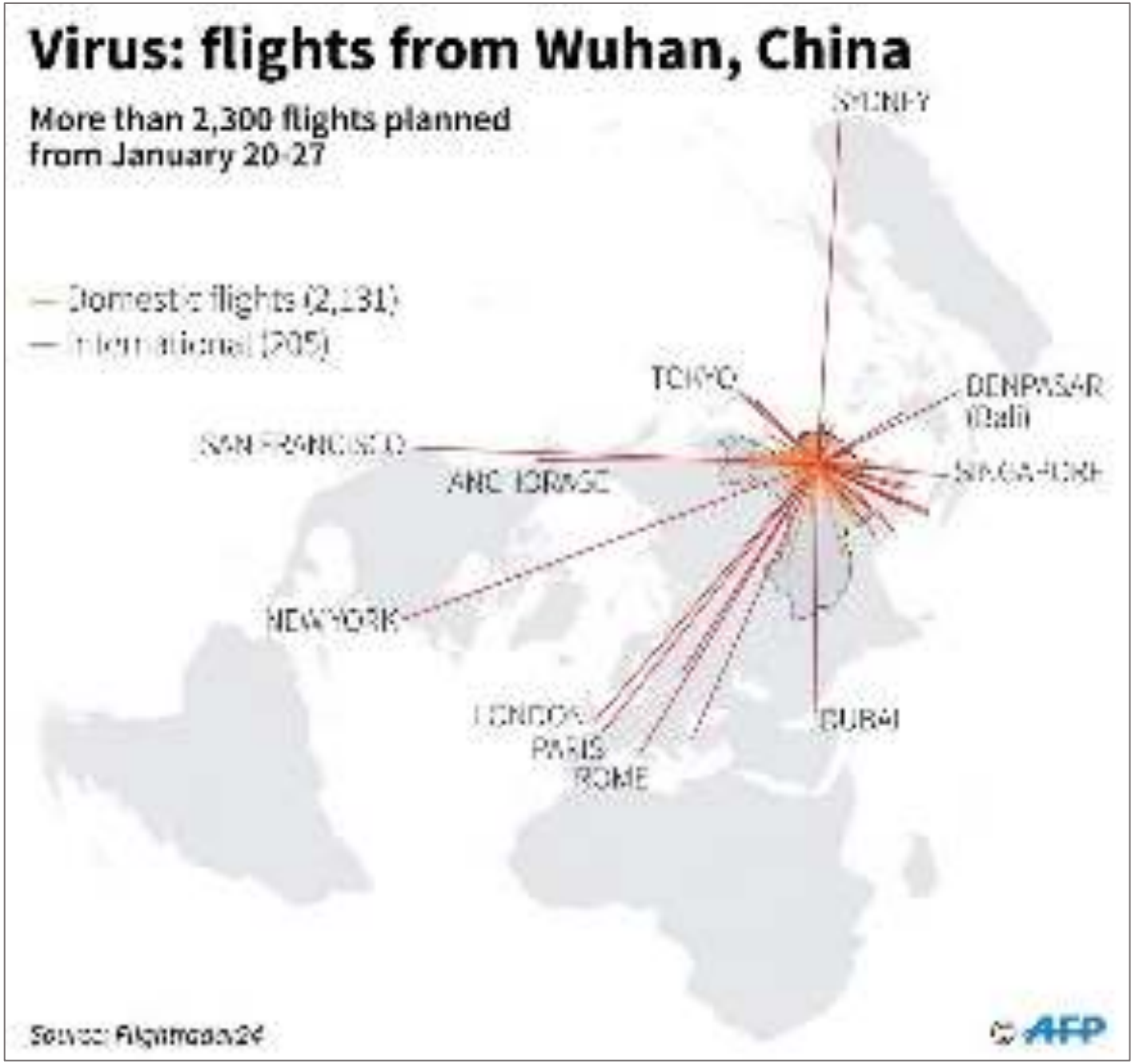
https://www.gavi.org/vaccineswork/5-reasons-why-pandemics-like-covid-19-are-becoming-more-likely

Spread of SARS in 2003



International travel allowed SARS to reach 26 countries and create over 8000 cases with 774 deaths.

https://medium.com/@kfila1/all-you-need-to-know-about-the-covid-19-a-master-guide-e86f78031d4



Roxburgh, H., and Thomet, L. (2020-01-21).
Asia steps up checks as China virus kills six, infects more than 300.
https://medicalxpress.com/news/2020-01-china-virus-cases.html

Global Flight Map (? Date)

https://www.iom.int/outbreak-preparedness-and-response

Preventing pandemics cost 100 times less than the cost of responding to pandemics

- Relying on responses to diseases after their emergence,
  - such as public health measures and technological solutions,
    - in particular the rapid design and distribution of new vaccines and therapeutics,
  - is a "slow and uncertain path",
    - underscoring both the widespread human suffering and
    - the tens of billions of dollars in annual economic damage to the global economy of reacting to pandemics
- It is estimated that the cost of reducing risks to prevent pandemics to be 100 times less than the cost of responding to such pandemics,
  - "providing strong economic incentives for transformative change."

IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://ipbes.net/sites/default/files/2020-12/IPBES%20Workshop%20on%20Biodiversity%20and%20Pandemics%20Report_0.pdf

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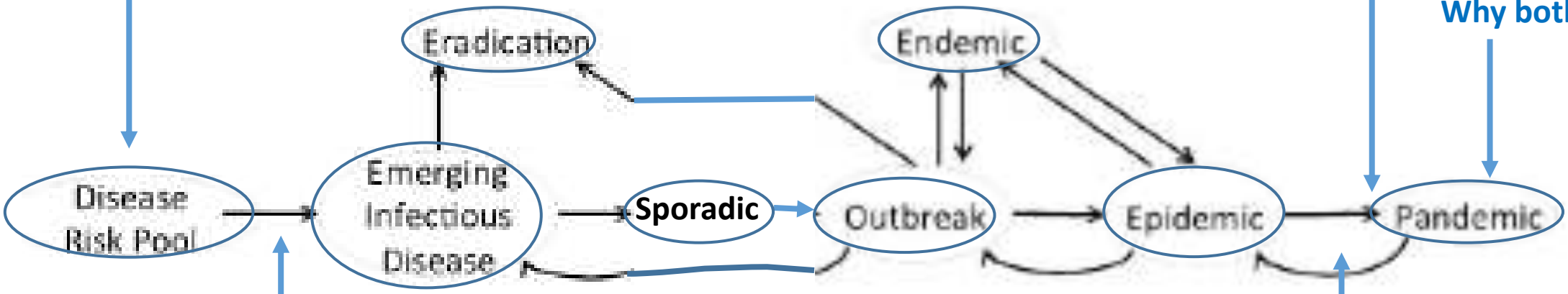

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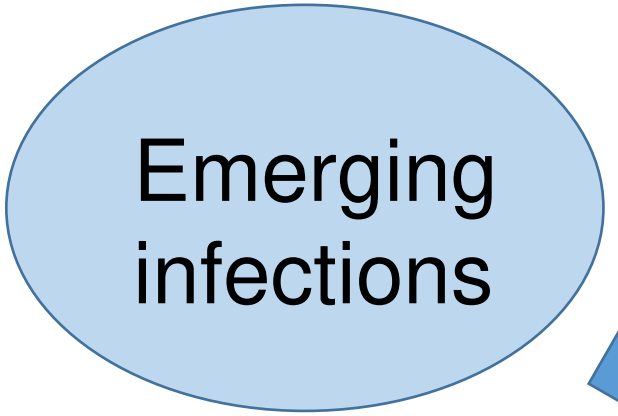
https://phys.org/news/2020-05-relationships-forests-deforestation-infectious-disease.html

Disease Emergence

Definition and concept



Newly emerging
diseases that are recognized in the human host for the first time
e.g. SARS, Pandemic H1N1 2009, Nipah Virus, MERS-CoV

Re-emerging infectious diseases
diseases that historically have infected humans, but continue to appear in new locations or in drug-resistant forms, or that reappear after apparent control or elimination e.g. dengue, TB, Ebola

"Deliberately emerging"
diseases that are intentionally introduced e.g. anthrax for bioterrorism

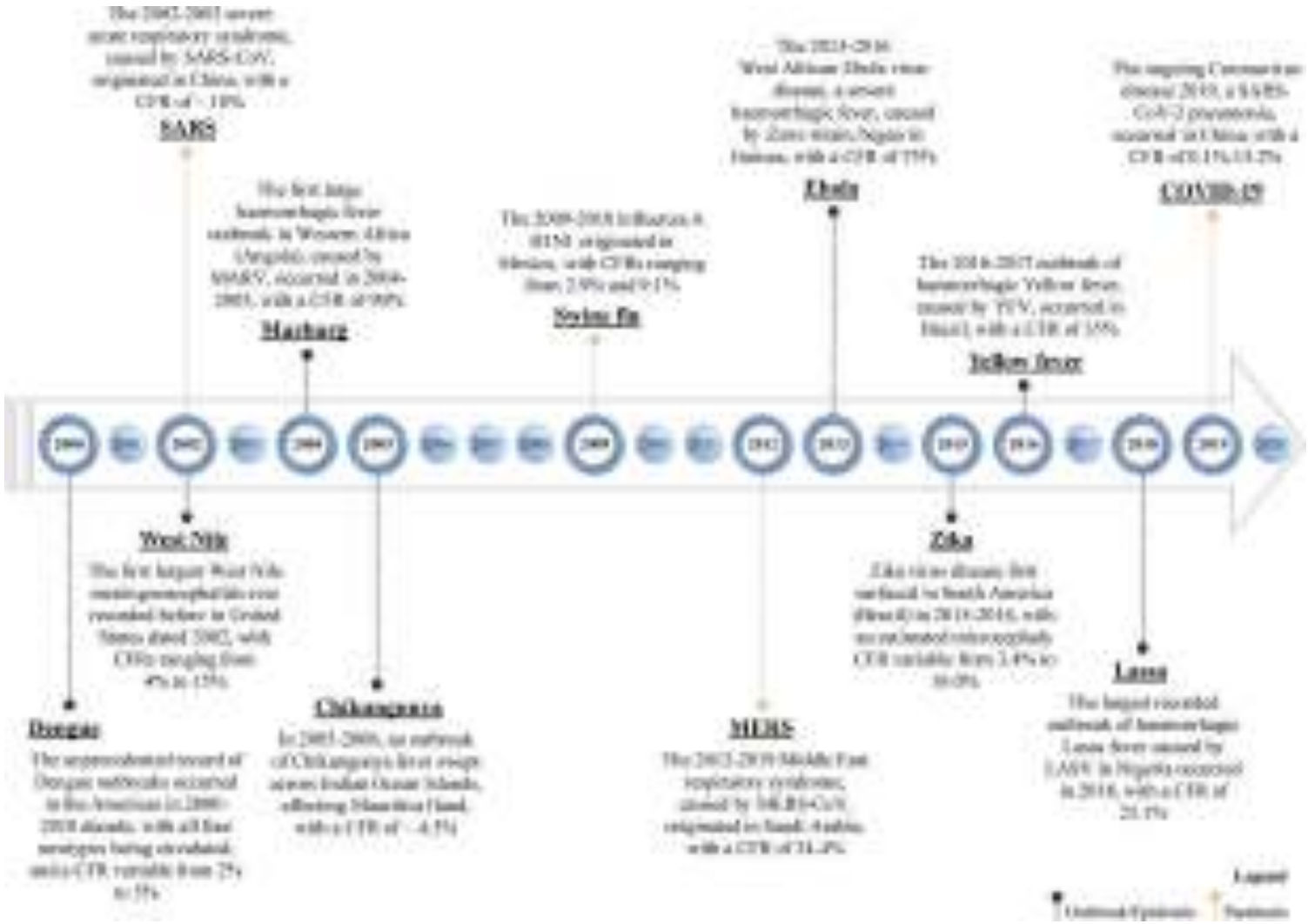
Fauci (2005); Morens & Fauci (2013)

David M. Morens and Anthony S. Fauci. Emerging Infectious Diseases: Threats to Human Health and Global Stability. PLOS Pathogens. July 4, 2013. DOI: 10.1371/journal.ppat.1003467. http://journals.plos.org/plospathogens/article?id=10.1371/journal.ppat.1003467#s3

Timeline of emerging and re-emerging viral diseases

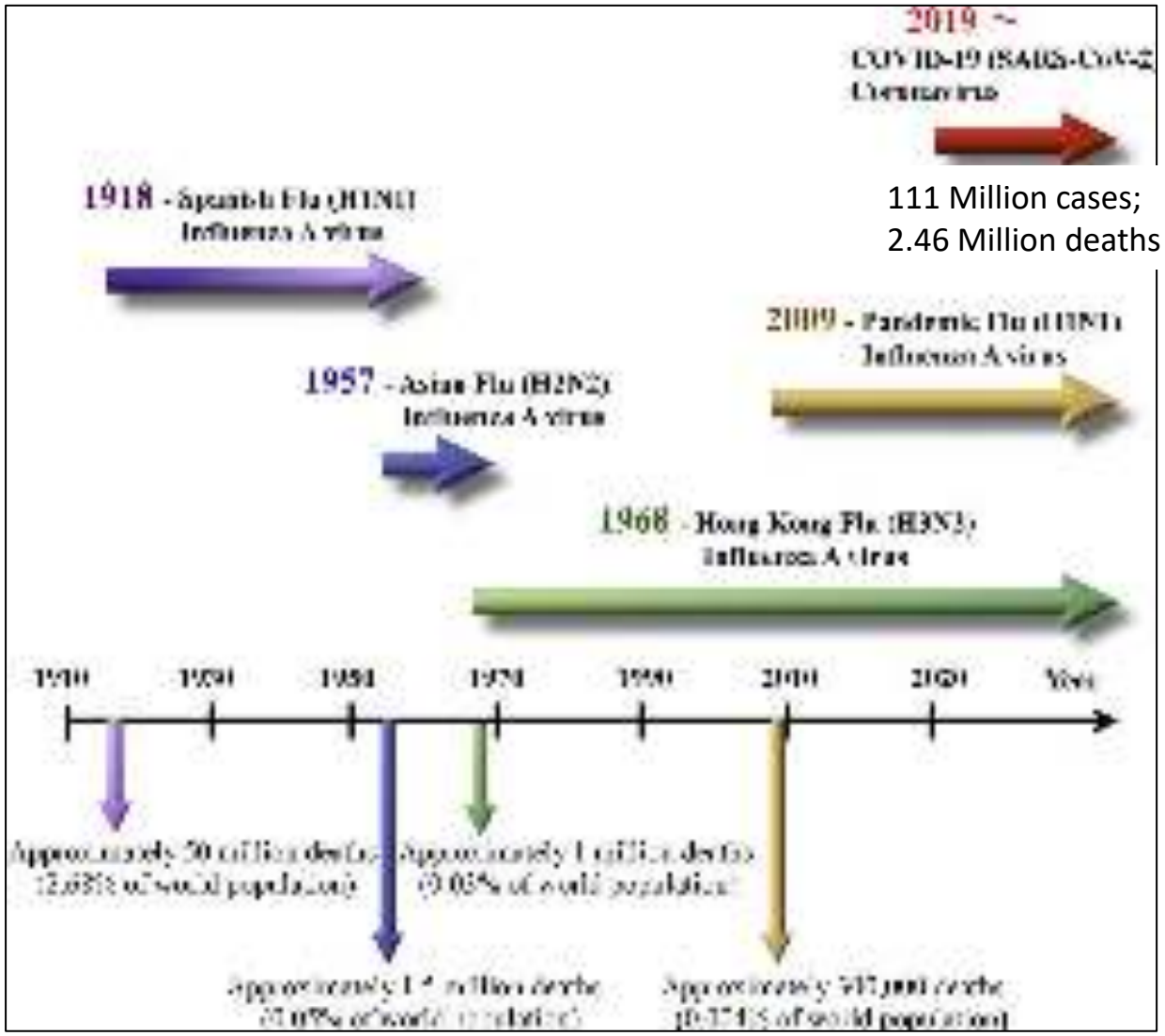
The year on the timeline is the year of the emergence or re-emergence of the schematically reported viral epidemic outbreaks within a certain geographic area; the overall given values of CFR (case fatality rate) refer to “the proportion of cases of a specified condition that are fatal within a specified time,” according to Dictionary of Epidemiology (228).

SARS-CoV, severe acute respiratory syndrome coronavirus; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; MERS-CoV, Middle East respiratory syndrome coronavirus; MARV, Marburg virus; YFV, Yellow Fever Virus; and LASV, Lassa virus.



Maria Trovato, et al (2020.09.03). Viral Emerging Diseases: Challenges in Developing Vaccination Strategies. Frontiers in Immunology; vol. 11: p2130. https://www.frontiersin.org/article/10.3389/fimmu.2020.02130

A timeline of five pandemics since 1918 and the globally circulating viruses afterward.



111 Million cases;
2.46 Million deaths as of 22 Feb 2021

Yen-Chin Liu, et al (2020.08). COVID-19: The first documented coronavirus pandemic in history, Biomedical Journal, Volume 43, Issue 4, 2020, Pages 328-333. https://doi.org/10.1016/j.bj.2020.04.007

Scope of Topics to be Covered

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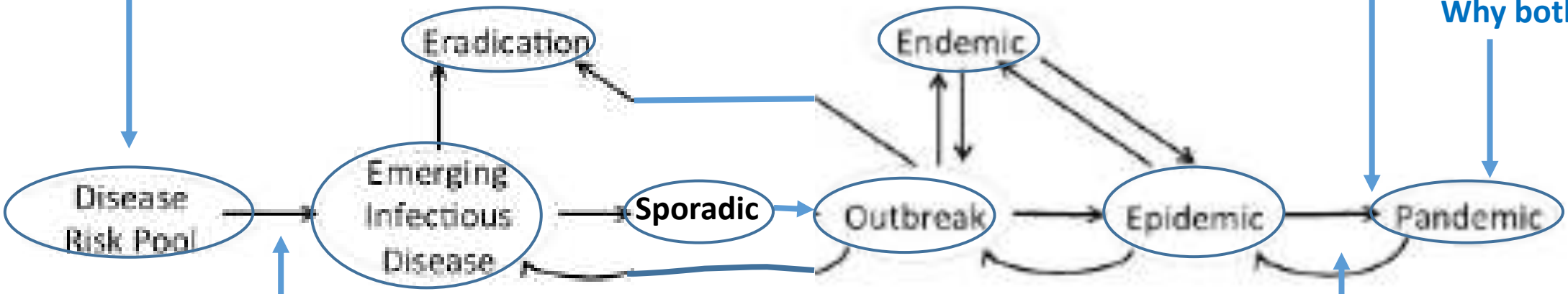

Why bother?

Can disease emergence be prevented?

Can pandemics be predicted?

National Research Council 2016. *The Neglected Dimension of Global Security: A Framework to Counter Infectious Disease Crises*. Washington, DC: The National Academies Press. p18 https://doi.org/10.17226/21891.

https://www.newscientist.com/term/pandemic/

Can Pandemics be Predicted?

Is the Pandemic a Black Swan Event?

- Taleb, in his book [2], coined the term “black swan” to describe random events that form part of our lives.
- These events have the following three key attributes/signs:
  1. outlier, being outside the realm of regular expectations;
  2. carries an extreme impact; and
  3. explanations for the occurrence are concocted after the fact, making it explainable and predictable.

Nassim Nicholas Taleb

The pandemic is being widely described as a Black Swan event,

- an event that has outsized impact,
- that is harder to predict, and
- even harder to compute it probabilities.

A contrary view is that, in many ways,

- it is an entirely expected event,
- given that all the drivers of risk were there in plain sight (1).

Pramod Kumar Mishra (2020). **COVID-19, Black Swan events and the future of disaster risk management in India. Progress in Disaster Science,** Volume 8, December 2020, 100137
Nassim Nicholas Taleb (2009). The Black Swan: The Impact of the Highly Improbable. 2. London: Penguin Book; 2009

Pandemics as Risk Versus Uncertainty

Most risks can be
- anticipated and
- measured with varying degrees of probability,

Uncertainty is
- very difficult to measure
- Because it is
  - subjective,
  - multi-dimensional concept that varies based on
  - its source and
  - the degree to which it is experienced

Piyush Sharma, et al. (2020.05.25). **Managing uncertainty during a global pandemic: An international business perspective.** J Bus Res. 2020 Aug; 116: 188–192. doi: 10.1016/j.jbusres.2020.05.026

Definition, Types and Dimensions of Uncertainty

- **Environmental uncertainty**
  - that includes political, economic, government, cultural and discontinuous uncertainty,
  - represents both formal and informal parts of a country's environment
- **Industry uncertainty**
  - includes input, demand, competition and technological uncertainty
- **Firm uncertainty**
  - relates to behavioral, R&D, operating and previous experience uncertainty

The disconnect that each of these dimension across different national boundaries amplify the rapid global spread of Covid-19

"perceived inability to predict something accurately" resulting from a lack of confidence in one's knowledge in a situation

Based on its:

- Source
  - (environmental, industry or company/firm characteristics)
- Nature
  - (exogenous vs. endogenous)

Piyush Sharma, et al. (2020.05.25). **Managing uncertainty during a global pandemic: An international business perspective.** J Bus Res. 2020 Aug; 116: 188–192. doi: 10.1016/j.jbusres.2020.05.026

Two Strategies to Manage Uncertainty

Reduce uncertainty (Risk management)	• Cope with uncertainty (Strategic management)

• natural motivator that guides organisations' behavior
• involves
  • information gathering,
  • proactive collaboration or cooperation, and
  • networking;
	• allows firms to adapt their strategy to deal with the type of uncertainty faced by them
	• consists of
	  • flexibility (diversification and operational adaptation),
	  • imitation (copy competitors and early movers),
	  • reactive collaboration and/or
	  • cooperation, control and avoidance.

Piyush Sharma, et al. (2020.05.25). **Managing uncertainty during a global pandemic: An international business perspective.** J Bus Res. 2020 Aug; 116: 188–192. doi: 10.1016/j.jbusres.2020.05.026

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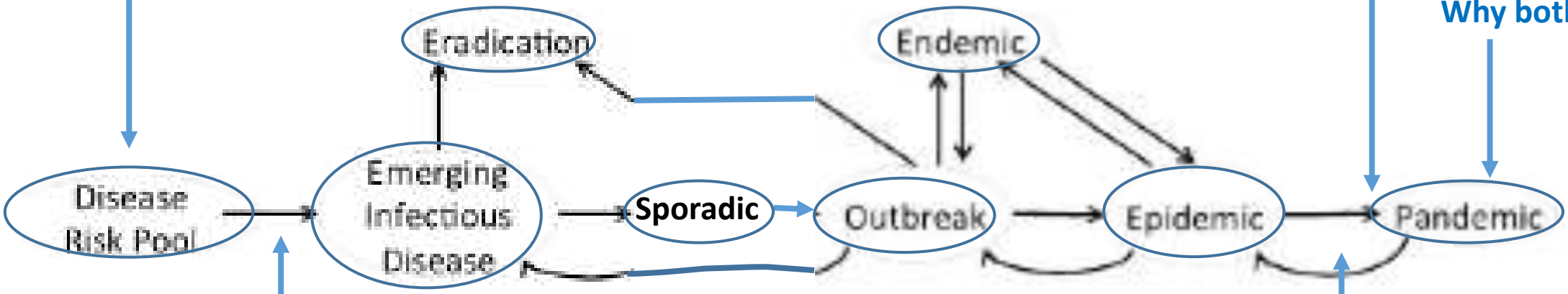

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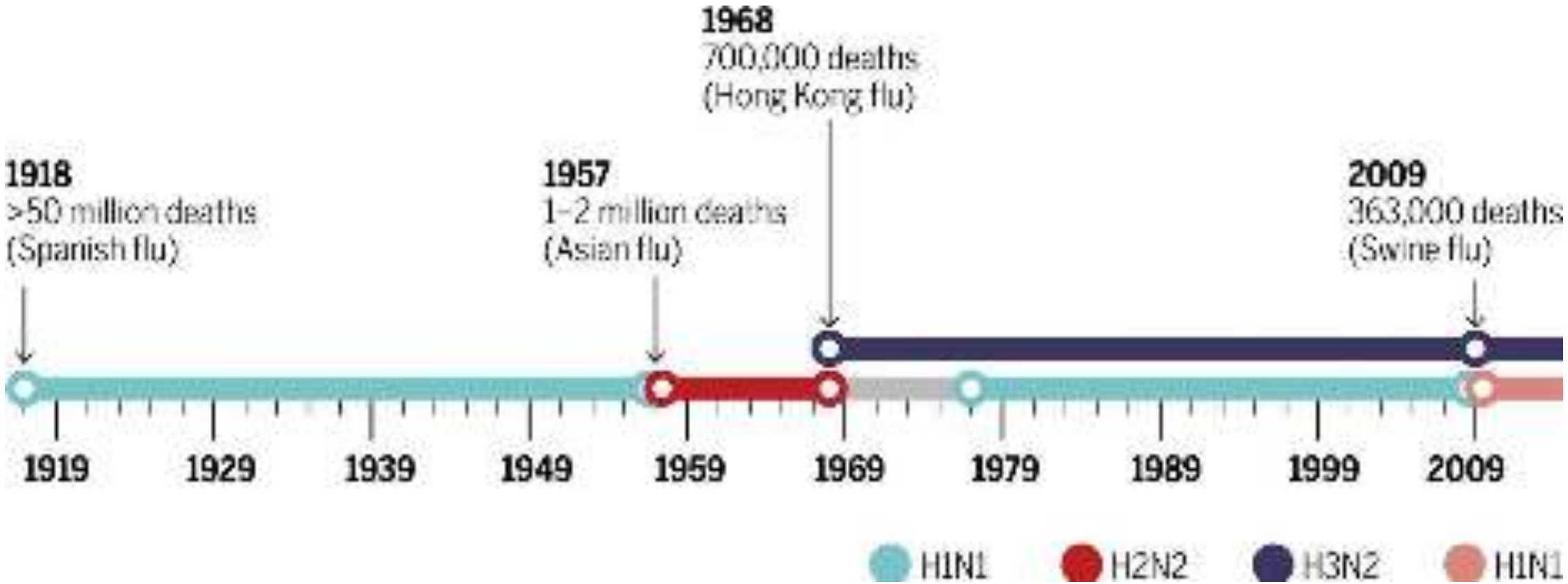
https://apru.org/event/perspectives-of-covid-19-pandemics-epidemiology-prevention-and-control/

How to Prevent a Pandemic

Fig. 2 Influenza pandemics of the past 100 years.



Jeffery K. Taubenberger et al., (2019). The 1918 influenza pandemic: 100 years of questions answered and unansweredSci Transl Med 2019;11:eaau5485
DOI: 10.1126/scitranslmed.aau5485

Preparing for the Next Influenza Pandemic

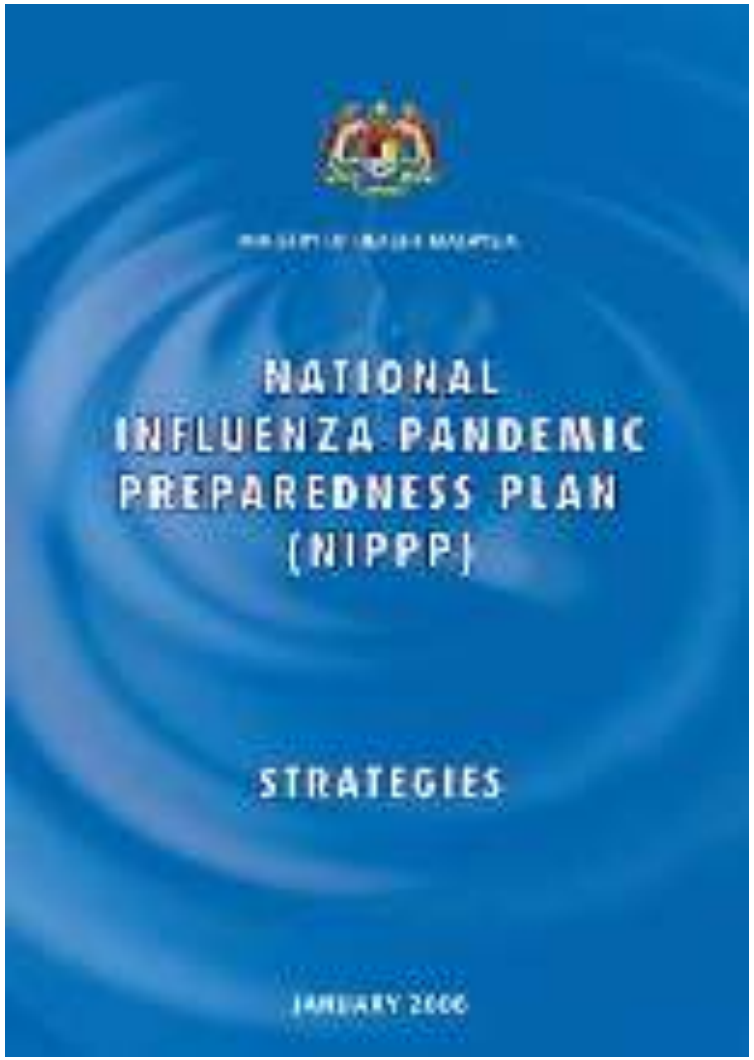
The World Health Organization (WHO),

- believed that the world was closer to another influenza pandemic than it has been any time since 1968, when the last of the 20th century's three pandemics swept the globe,
- has developed guidelines on pandemic influenza preparedness and response.

- The **March 2005** plan includes
  - guidance on roles and responsibilities in preparedness and response;
  - information on pandemic phases; and
  - recommended actions for before, during, and after a pandemic

https://en.wikipedia.org/wiki/Influenza_pandemic#cite_note-144

Malaysia's NIPPP (2006)



Pandemic Influenza Preparedness Plans

https://apps.who.int/iris/bitstream/handle/10665/259893/WHO-WHE-IHM-GIP-2017.1-eng.pdf;jsessionid=A6ED2D9B20D1C8CBB48FDD519C6E4A4F?sequence=1

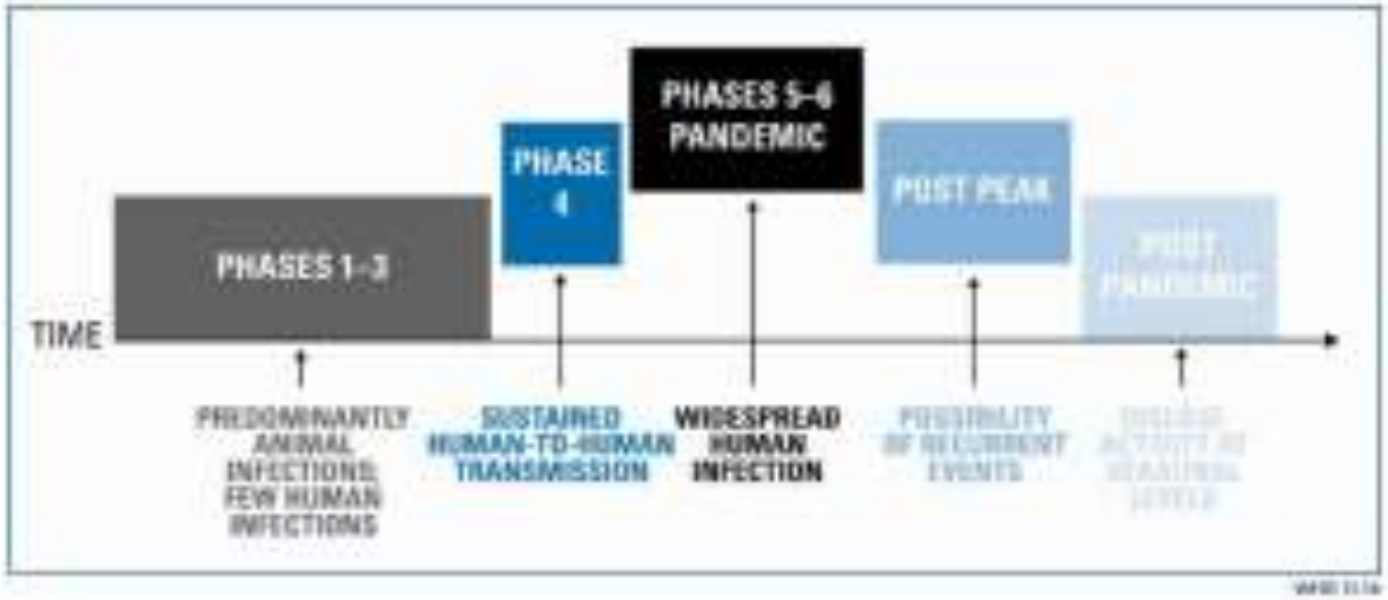
https://apps.who.int/iris/bitstream/handle/10665/259884/9789241513623-eng.pdf?sequence=1

WHO (2018). Essential steps for developing or updating a national pandemic influenza preparedness plan

WHO (2018). A practical guide for developing and conducting simulation exercise to test and validate pandemic influenza preparedness plans

WHO (2019). Pandemic influenza preparedness in WHO Member States. Report of a Member States survey

WHO's 6 Pandemic Phases (2009)

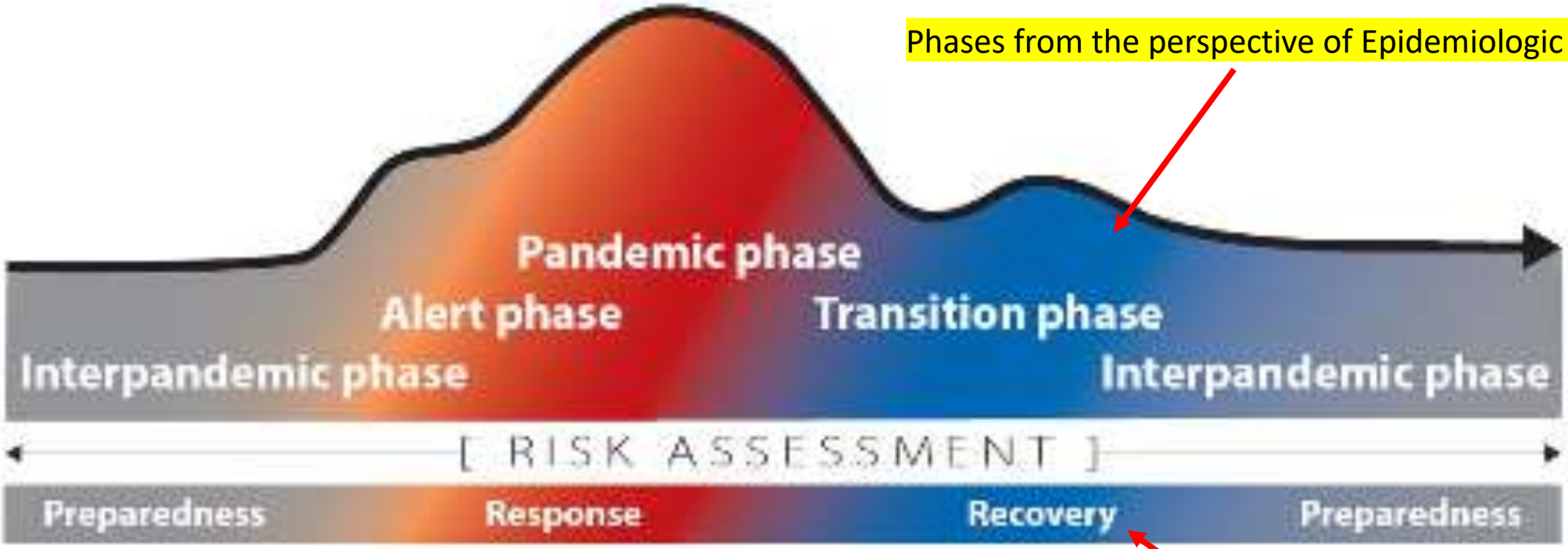


Interpandemic phase New virus in animals, no human cases	Low risk of human cases	1
	Higher risk of human cases	2
Pandemic alert New virus causes human cases	No or very limited human-to-human transmission	3
	Evidence of increased human-to-human transmission	4
	Evidence of significant human-to-human transmission	5
Pandemic	Efficient and sustained human-to-human transmission	6

- The World Health Organization (WHO) has been instrumental in securitising pandemic influenza (WHO, 2007).
- Its 2009 guidance document referred to a six-phase structure of pandemics based on the extent of transmission – not the severity of a disease

https://www.who.int/csr/disease/swineflu/phase/en/

WHO (2013) The Continuum of Pandemic Phases



Phases from the perspective of Epidemiologic theory

WHO (2017). Pandemic Influenza Risk Management Guidance. https://www.who.int/influenza/preparedness/pandemic/PIRM_update_052017.pdf?ua=1

Phases from the perspective of Crisis Management theory

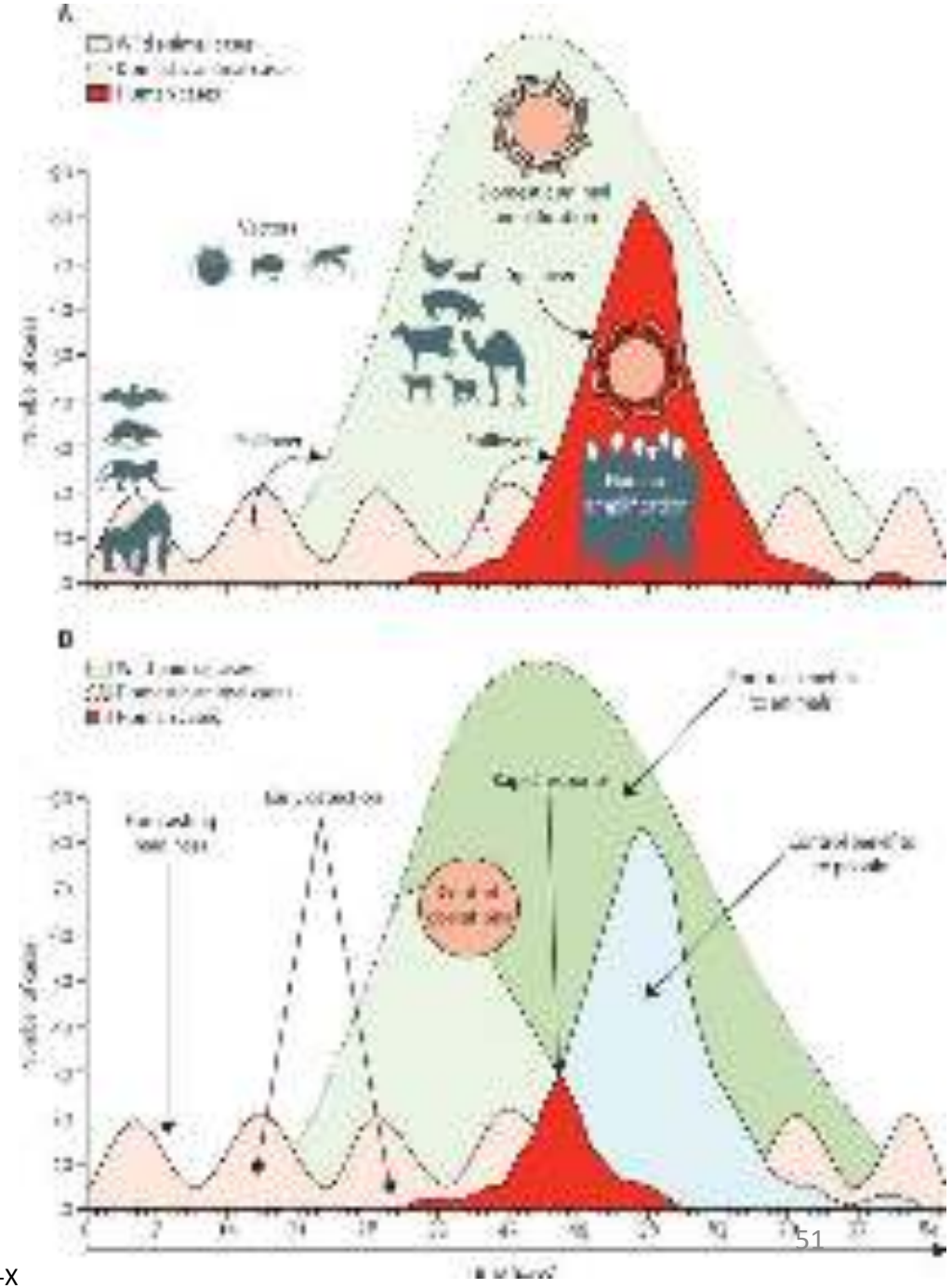
The updated guidelines of the WHO (2013) instead stress 'national risk assessments' where each WHO member state is encouraged to conduct its own risk assessments and to adopt a framework of 'Emergency risk management for health'

Importance of Early Detection and Control

(A)Transmission of infection and amplification in people (bright red) occurs after a pathogen from wild animals (pink) moves into livestock to cause an outbreak (light green) that amplifies the capacity for pathogen transmission to people.

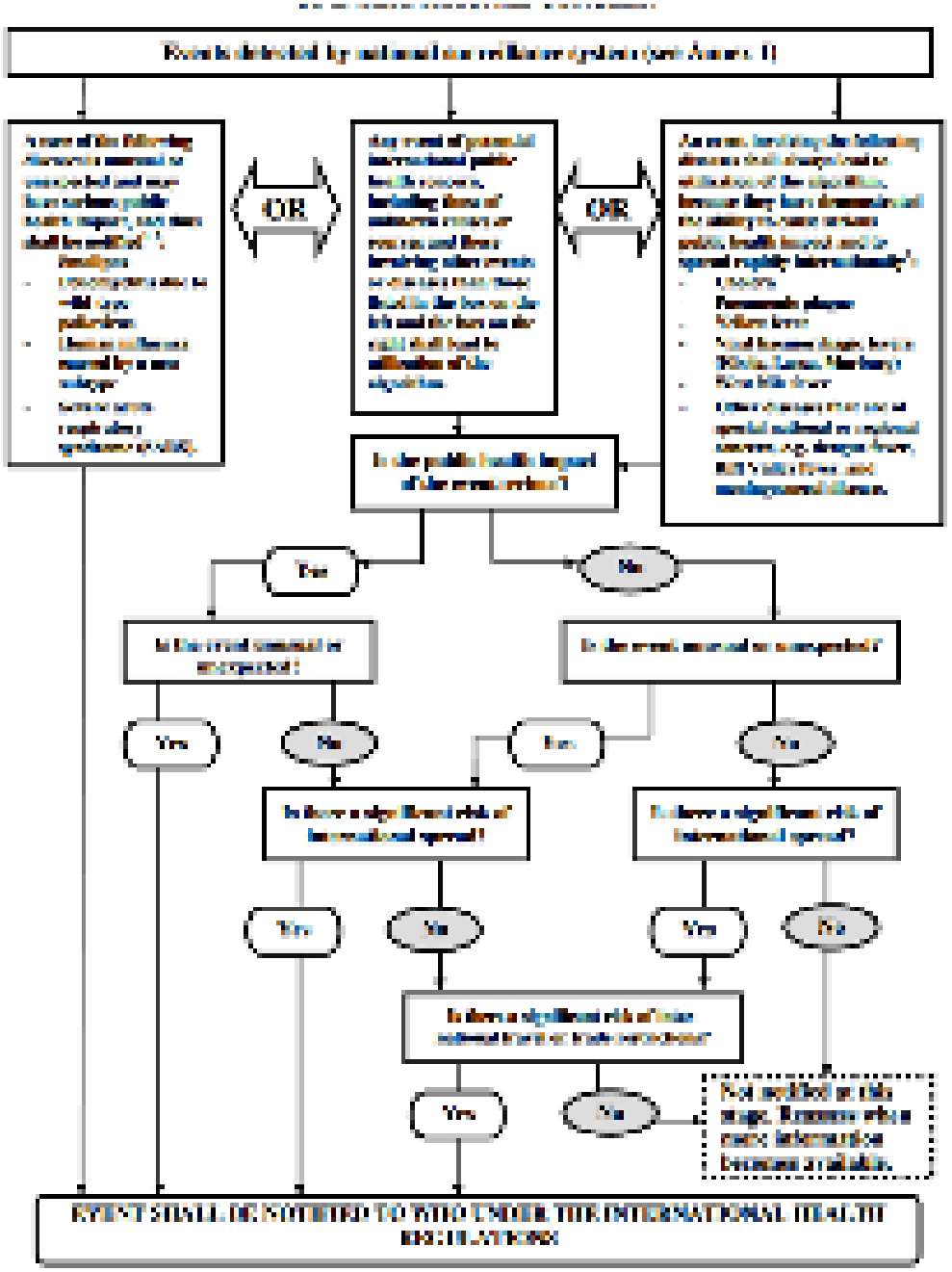
(B)Early detection and control efforts reduce disease incidence in people (light blue) and animals (dark green).

Spillover arrows shows cross-species transmission.

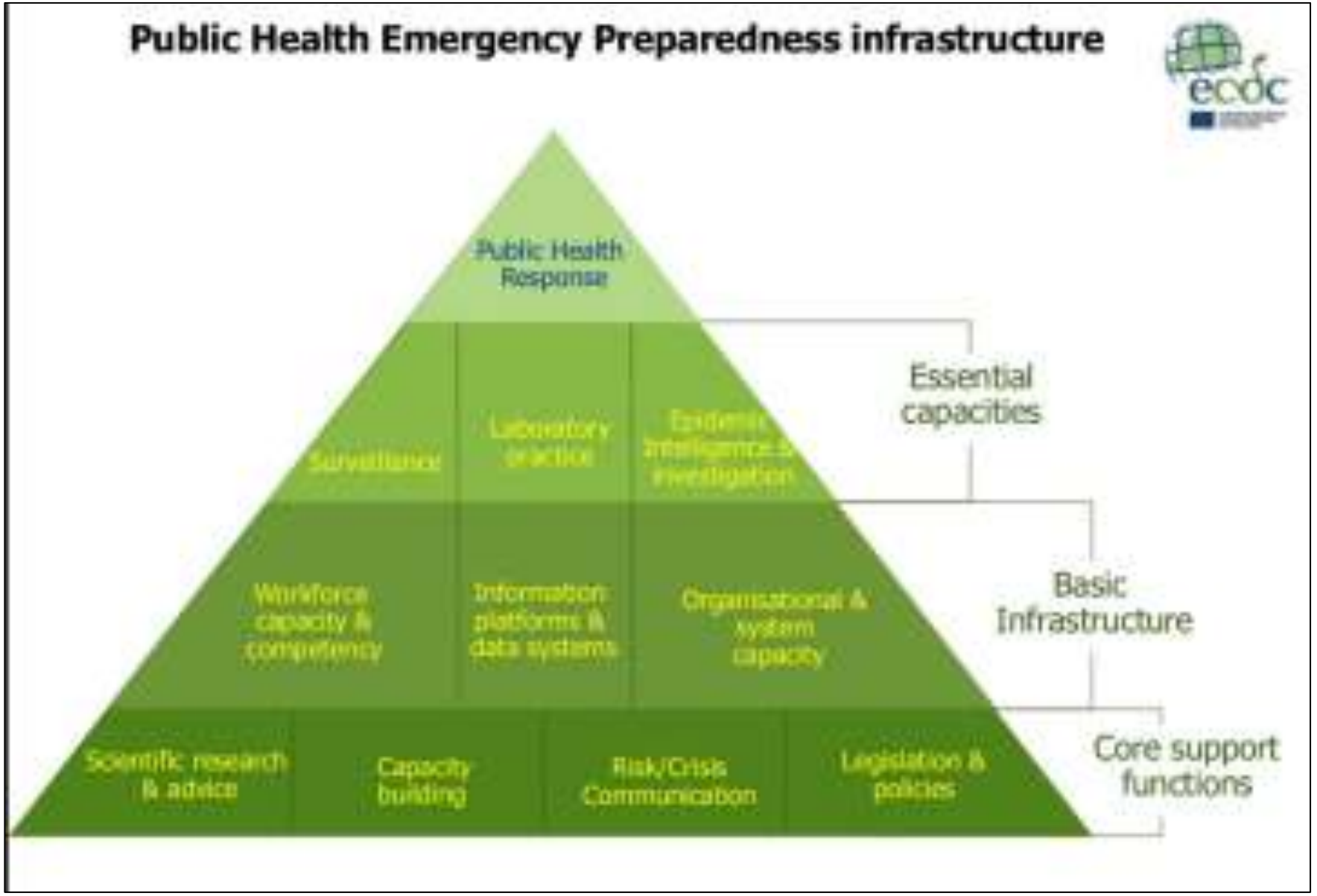


William B Karesh, et al/ (2012). **Ecology of zoonoses: natural and unnatural histories**
The Lancet. Volume 380, ISSUE 9857, P1936-1945, December 01, 2012. DOI:https://doi.org/10.1016/S0140-6736(12)61678-X

Public Health Emergency of International Concern



INTERNATIONAL HEALTH REGULATIONS (2005) SECOND EDITION. P43
https://apps.who.int/iris/bitstream/handle/10665/43883/9789241580410_eng.pdf?sequence=1



Karl Ekdahl (2014). ECDC preparedness work. **European Centre for Disease Prevention and Control**
https://www.slideshare.net/ECDC_EU/cdc-preparedness-work-how-ecdc-is-supporting-the-commission-and-the-member-states-prof-karl-ekdahl-head-of-public-health-capacity-and-communication-unit-ecdc

International Health Regulations Core Capacities

IHR Core Capacities	Component of core capacity
1: National legislation, policy and financing	National legislation and policy
	Financing
2: Coordination and NFP communications	IHR coordination, communication and advocacy
3: Surveillance	Indicator based surveillance
	Event based surveillance
4: Response	Rapid response capacity
	Case management
	Infection control
	Disinfection, decontamination and vector control
5: Preparedness	Public health emergency preparedness and response
	Risk and resource management for IHR preparedness
6: Risk communication	Policy and procedures for public communications
7: Human resources	Human resource capacity
8: Laboratory	Policy and coordination of laboratory services
	Laboratory diagnostic and confirmation capacity
	Specimen collection and transport

Karl Ekdahl (2014). ECDC preparedness work. **European Centre for Disease Prevention and Control**
https://www.slideshare.net/ECDC_EU/cdc-preparedness-work-how-ecdc-is-supporting-the-commission-and-the-member-states-prof-karl-ekdahl-head-of-public-health-capacity-and-communication-unit-ecdc

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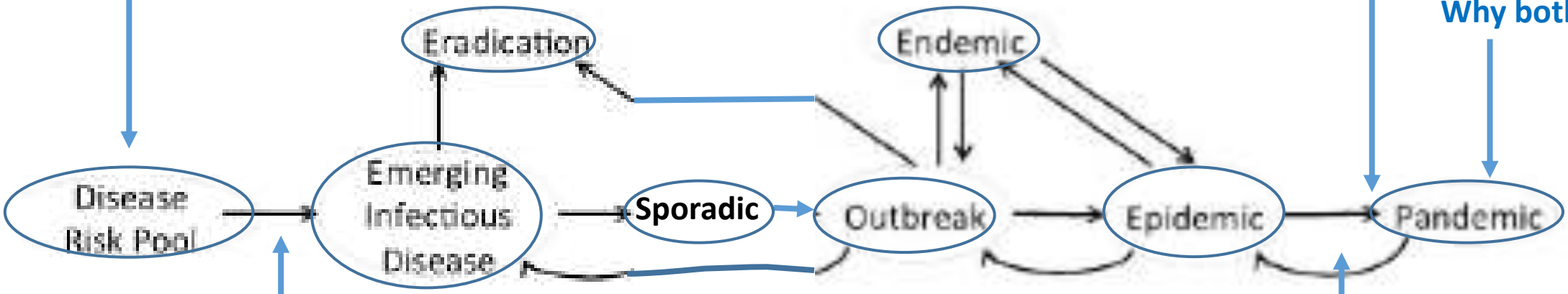

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Global Health Security Index

- The **Global Health Security Index** is an assessment of global health security capabilities in 195 countries prepared by the Johns Hopkins Center for Health Security, the Nuclear Threat Initiative (NTI) and the Economist Intelligence Unit (EIU).
- The GHS Index assesses countries' health security and capabilities across six categories, 34 indicators, and 85 sub-indicators.
- The findings are drawn from open source information that answered 140 questions across the categories.
- The full report offers 33 recommendations to address the gaps identified by the index.

https://www.ghsindex.org/

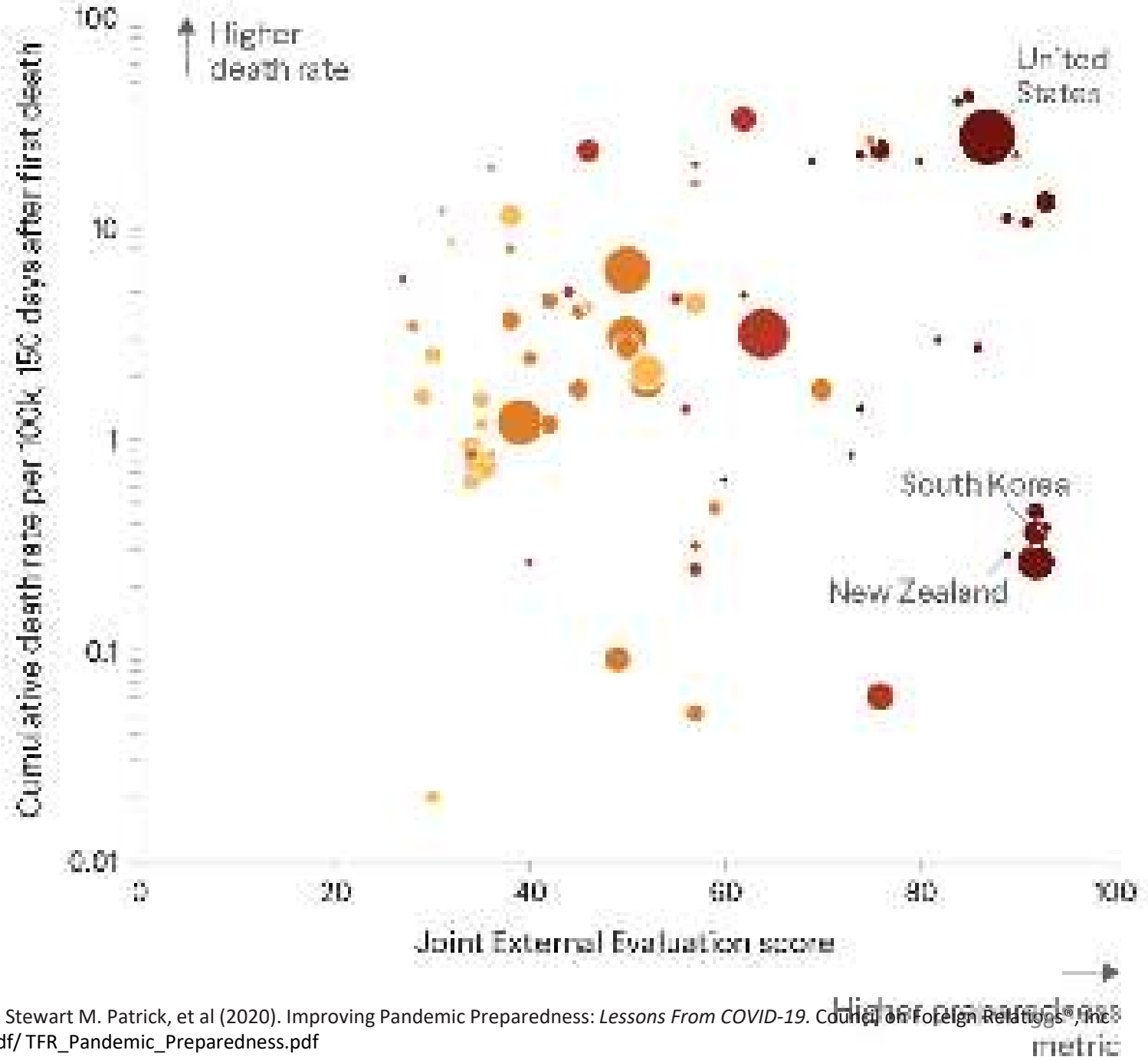
The top 5 countries and with respect to overall score of the 6 GHS Index categories, with Malaysia and Singapore also shown for comparison.

Overall Score		1. Prevention of the emergence or release of pathogens.		2. Early detection and reporting for epidemics of potential international concern		3. Rapid response to and mitigation of the spread of an epidemic	
Rank	Score	Rank	Score	Rank	Score	Rank	Score
1. United States	83.5	1. United States	81.1	1. United States	98.2	1. United Kingdom	91.9
2. United Kingdom	77.9	2. Sweden	81.1	2. Australia	97.3	2. United States	79.7
3. Netherlands	75.6	3. Thailand	75.5	3. Latvia	97.2	3. Switzerland	79.3
4. Australia	75.5	4. Netherlands	73.7	4. Canada	95.4	4. Netherlands	79.1
5. Canada	75.3	5 Denmark	72.9	5. South Korea	92.1	5. Thailand	78.6
18. Malaysia	52.2	29. Singapore	56.2	28. Malaysia	73.2	11. Singapore	64.6
24. Singapore	50.7	35. Malaysia	51.4	40. Singapore	64.5	16. Malaysia	61.3

4. Sufficient & robust health system to treat the sick & protect health workers		5. Commitments to improving national capacity, financing and adherence to norms		6. Overall risk environment and country vulnerability to biological threats	
Rank	Score	Rank	Score	Rank	Score
1. United States	73.8	1. United States	90.2	1. Liechtenstein	87.9
2. Thailand	70.5	2. United Kingdom	81.2	2. Norway	87.1
3. Netherlands	70.2	3. Australia	77.0	3. Switzerland	86.2
4. Canada	67.7	4. Finland	75.4	4. Luxembourg	84.7
5 Denmark	72.9	5. Canada	74.7	5. Austria	84.6
15. Malaysia	57.1	45. Malaysia	58.5	25. Singapore	80.9
38. Singapore	41.4	101. Singapore	47.3	32. Malaysia	72.0

Cameron, E. E., Nuzzo, J. B., & Bell, J. A. (2019). *Global Health Security Index: Building Collective Action and Accountability* (p. 324). Johns Hopkins Bloomberg School of Public Health, NTI, The Economist. https://www.ghsindex.org/wp-content/uploads/2019/10/2019-Global-Health-Security-Index.pdf

‘Joint External Evaluation’ of the IHR Preparedness Metrics Did Not Predict Successful Pandemic Response

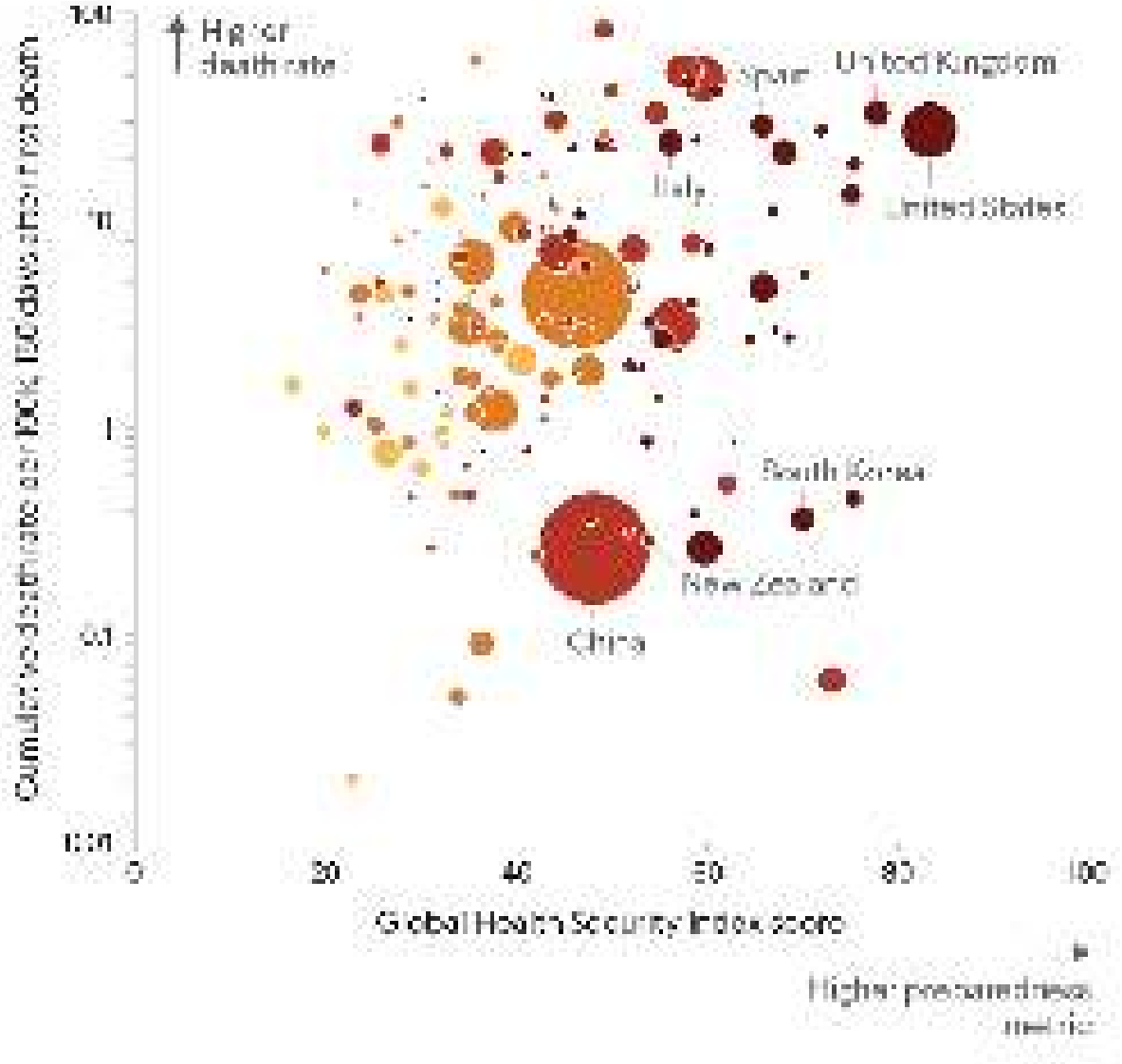


Sylvia Mathews Burwell, Frances Fragos Townsend, Thomas J. Bollyky and Stewart M. Patrick, et al (2020). Improving Pandemic Preparedness: *Lessons From COVID-19.* Council on Foreign Relations®, Inc https://www.cfr.org/report/pandemic-preparedness-lessons-COVID-19/pdf/ TFR_Pandemic_Preparedness.pdf

The ‘2019 Global Health Security Index’ Preparedness Metrics Did Not Predict Successful Pandemic Response

The 2019 Global Health Security (GHS) Index includes

- important and relevant measures for the current pandemic that go beyond the JEE, such as
  - rapid response to and mitigation of the spread of an epidemic,
  - a robust health system to treat the sick and protect health workers,
  - and adherence to norms.



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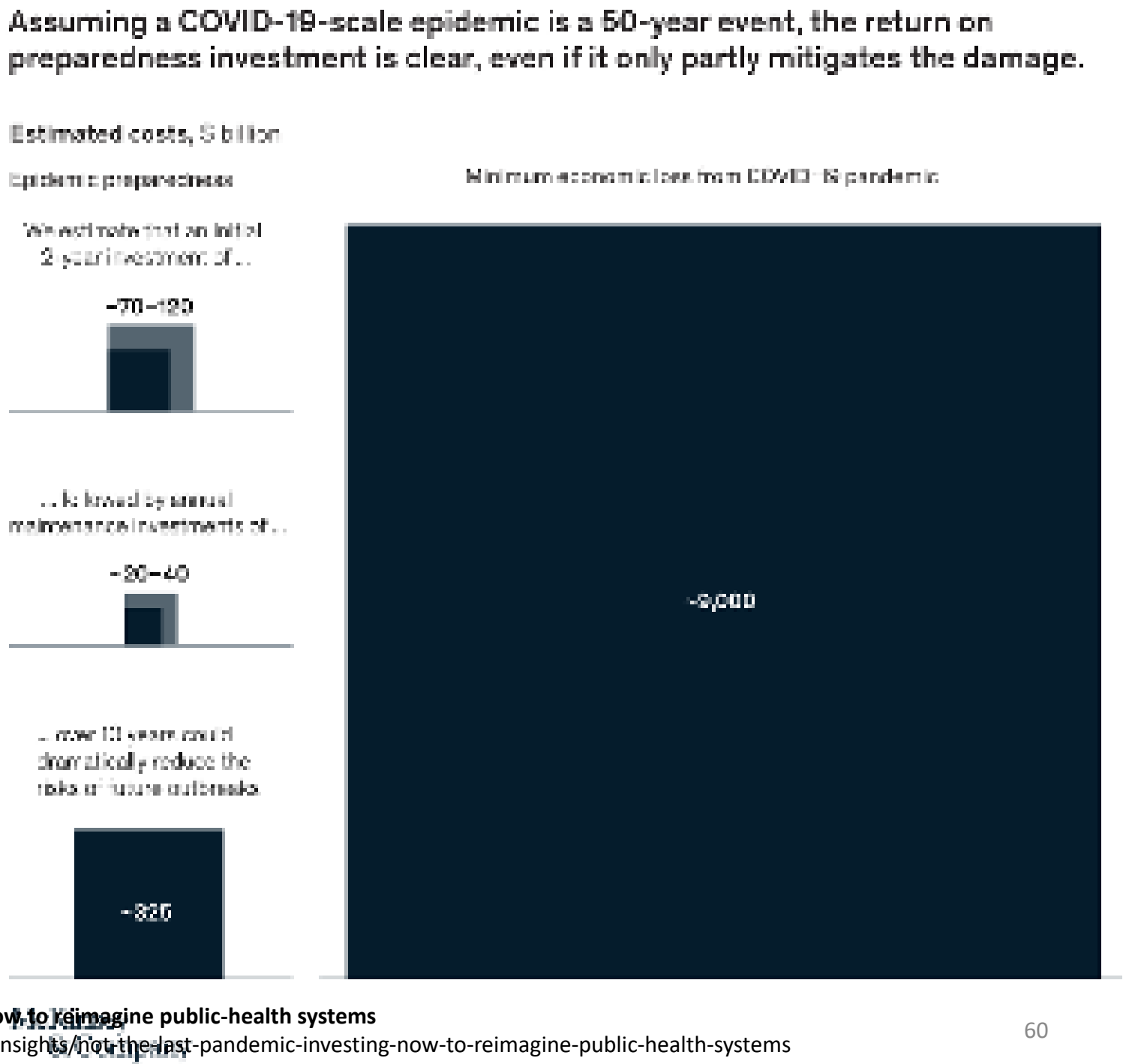
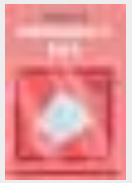
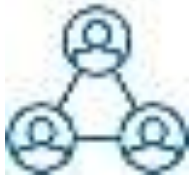
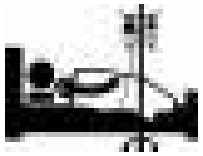
Return on Pandemic Preparedness Investment



Matt Craven, et al (2020.07.13). Not the last pandemic: Investing now to reimagine public-health systems
https://www.mckinsey.com/industries/public-and-social-sector/our-insights/not-the-last-pandemic-investing-now-to-reimagine-public-health-systems

Five Shifts in Healthcare Systems That Can Help Reduce the Chance of Future Pandemics

	From	To	Rationale
	''Break glass in case of emergency'' response systems	''Always on'' systems and partnerships that can scale rapidly during epidemics	Outbreak response is most effective when it uses mechanisms that we apply regularly
	Uneven disease surveillance	Strengthened global, national, and local mechanisms to detect infectious diseases	Effective detection capacity is needed at all levels
	Waiting for outbreaks	An integrated epidemic-prevention agenda	Targeted interventions can reduce pandemic risk
	A scramble for healthcare capacity	Systems ready to surge while maintaining essential services	Epidemics require the ability to divert healthcare capacity quicky, without lessening core services
	Underinvestment in R&D for emerging infectious diseases	A renaissance in infectious disease R&D	Covid-19 has shown how fast we can move against infectious diseases when we are motivated

Matt Craven, et al (2020.07.13). Not the last pandemic: Investing now to reimagine public-health systems
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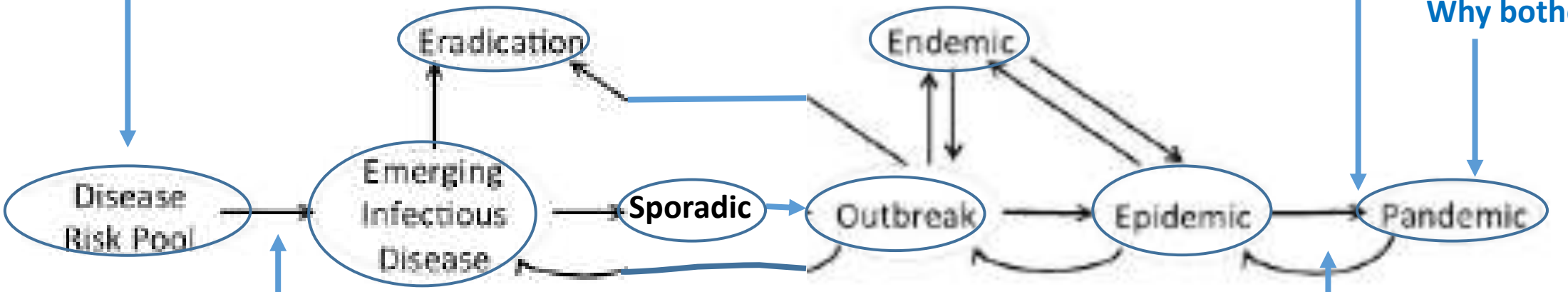

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https://www.researchgate.net/figure/the-five-principles-of-good-governance-adopted-in-the-Project-Source-authors_fig6_315553362

Pre-requisites for Good Responses

Trust in Science, Public Authorities, and the Media
In order to contain the virus

''But to achieve such a level of compliance (with advice regarding COVID-19 prevention and control measures) and co-operation, you need trust.

People need to trust science,
to trust public authorities, and
to trust the media.

Over the past few years, irresponsible politicians have deliberately undermined trust in science, in public authorities and in the media

Normally, trust that has been eroded for years cannot be rebuilt overnight.

But these are not normal times.
In a moment of crisis, minds too can change quickly."

Yuval Noah Harari

Yuval Noah Harari (2020-03-20). The world after coronavirus. Financial Times
shttps://www.ft.com/content/19d90308-6858-11ea-a3c9-1fe6fedcca75

Key Determinants of Success During Containing the Virus and Rolling out the Vaccines

The key determinant of success is morphing from the credibility of the government to the credibility of the health-care system

Data system

Surveillance system

state-level funding
for the infrastructure

- To be ready for a pandemic, data systems, surveillance systems, and state-level funding for the infrastructure must be in place.
- Vaccines are part "technologies of trust" that rely on people "maintaining confidence in national and international structures through which vaccines are delivered."

Uri Friedman (2021.01.23) **One Country Has Jumped Ahead on Vaccinations. https://www.theatlantic.com/ideas/archive/2021/01/why-israels-vaccine-success-might-be-hard-replicate/617780/**

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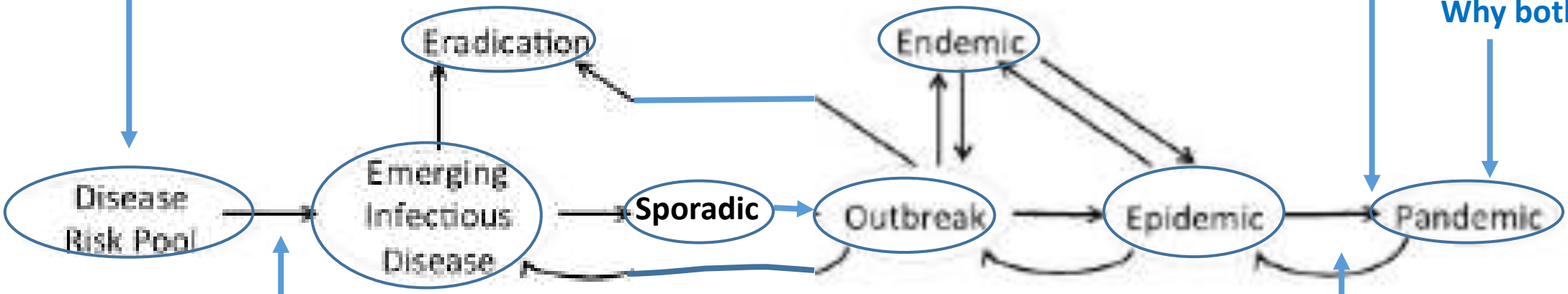

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https://theconversation.com/how-to-model-a-pandemic-134187

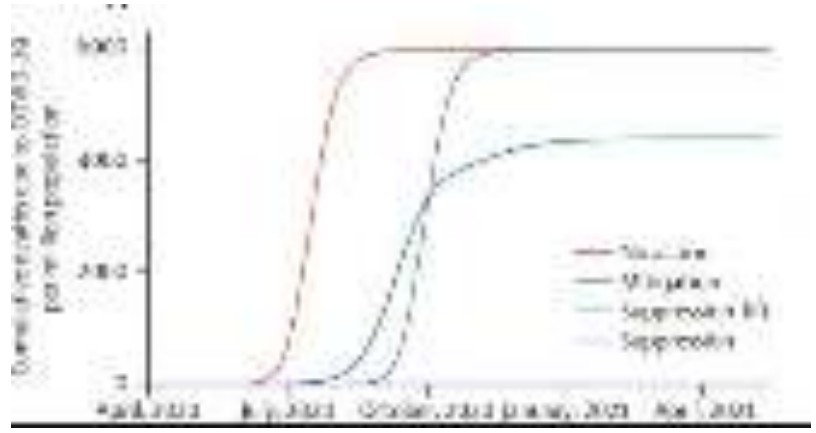
Why We Need Models

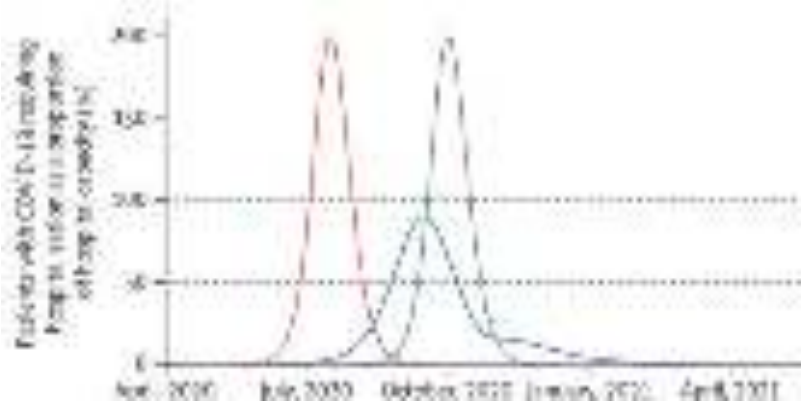
Models

- It is unlikely that we will ever be able to predict precisely
  - where or
  - when the next pandemic will occur

- But once an outbreak of pandemic potential has been identified, mathematical and statistical models are important tools for pandemic planning and response.

- They can be used to
  - synthesize the available data to provide enhanced situational awareness,
  - predict the future course of the pandemic and likely associated social and economic costs,
  - plan mitigation strategies.



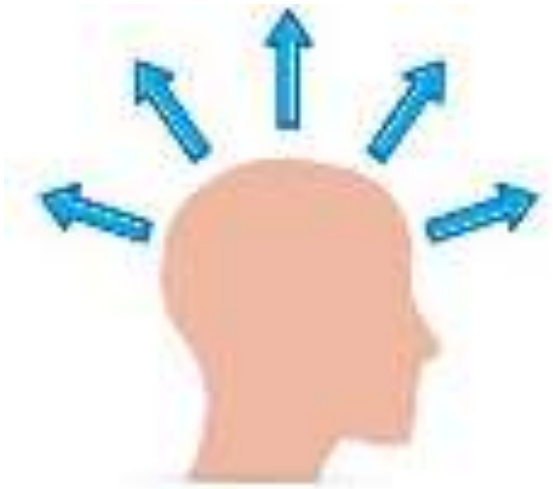


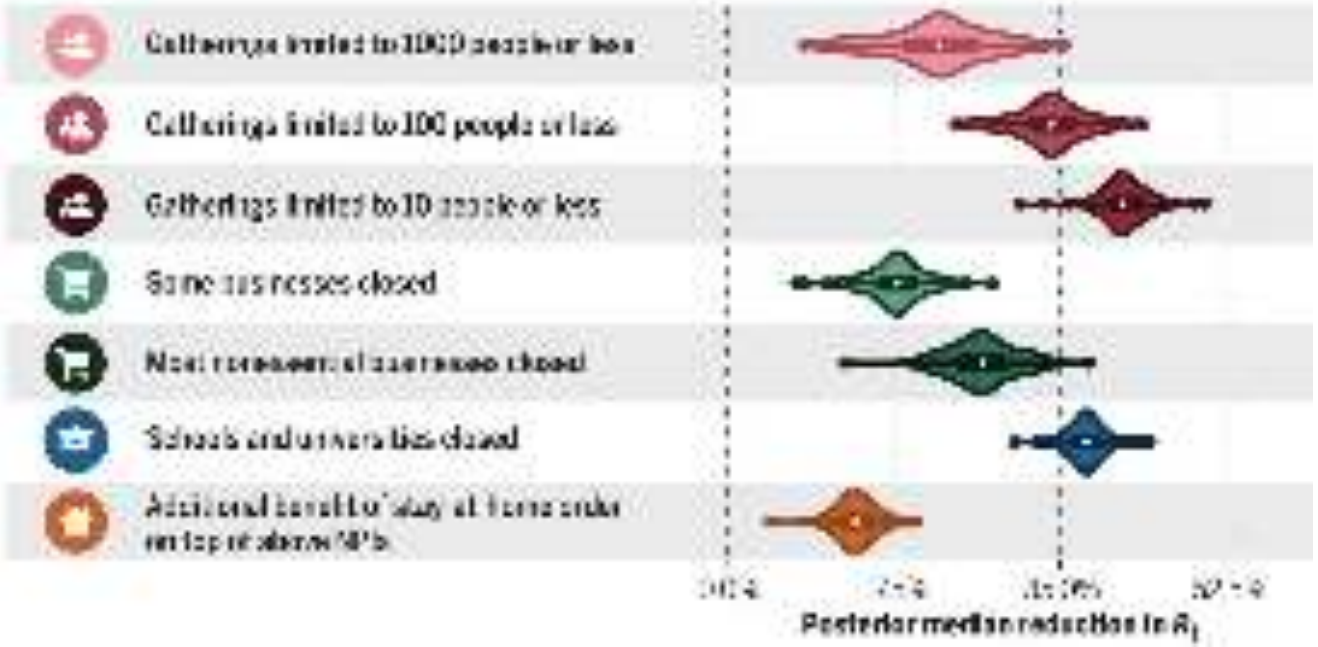
https://www.thelancet.com/journals/langlo/article/PIIS2214-109X(20)30288-6/fulltext

Shearer FM, Moss R, McVernon J, Ross JV, McCaw JM (2020) Infectious disease pandemic planning and response: Incorporating decision analysis. PLOS Medicine 17(1): e1003018. https://doi.org/10.1371/journal.pmed.1003018. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003018

Two Groups of Pandemic Preparedness and Response Models

The pandemic preparedness and response models can be broadly classified into two groups





Those aiming to inform situational awareness

Those aiming to understand the merits of possible interventions

https://science.sciencemag.org/content/371/6531/eabd9338.full

Shearer FM, Moss R, McVernon J, Ross JV, McCaw JM (2020) Infectious disease pandemic planning and response: Incorporating decision analysis. PLOS Medicine 17(1): e1003018. https://doi.org/10.1371/journal.pmed.1003018. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003018

Situational Awareness

- In the current generation of pandemic plans, **pandemic impact** is typically considered in terms of **disease transmissibility** and **severity**.
- **At the onset of a pandemic**,
  - these pathogen characteristics will be unknown and
  - must therefore be characterized as they emerge,
  - because even pandemics of well-characterized pathogens will differ in these measures sufficiently to create uncertainty as to the best response.
- **As our understanding of the probable impact of a pandemic improves**,
  - policy makers can then use this information to help decide
    - on the overall scale of response,
    - which control measures to implement, and
    - when to deploy them.

Shearer FM, Moss R, McVernon J, Ross JV, McCaw JM (2020) Infectious disease pandemic planning and response: Incorporating decision analysis. PLOS Medicine 17(1): e1003018. https://doi.org/10.1371/journal.pmed.1003018. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003018

Data Needed for Situational Awareness

- Given the dependency of response plans and decision-making on assessments of situational awareness,
  - gathering the appropriate information as early as possible in an outbreak has been identified as a priority for surveillance and real-time data analysis activities.
- To this end, advances have recently been made in the design of early outbreak surveillance methods such as
  - **First Few Hundred (FF100)** household transmission studies, and the
  - development of novel algorithms for analyzing the resulting data.
- **FF100 studies involve**
  - the collection of data from confirmed infections and their household contacts,
  - including the date of symptom onset and
  - final outcome,
    - until a satisfactory characterization of the pathogen is achieved

Shearer FM, Moss R, McVernon J, Ross JV, McCaw JM (2020) Infectious disease pandemic planning and response: Incorporating decision analysis. PLOS Medicine 17(1): e1003018. https://doi.org/10.1371/journal.pmed.1003018. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003018

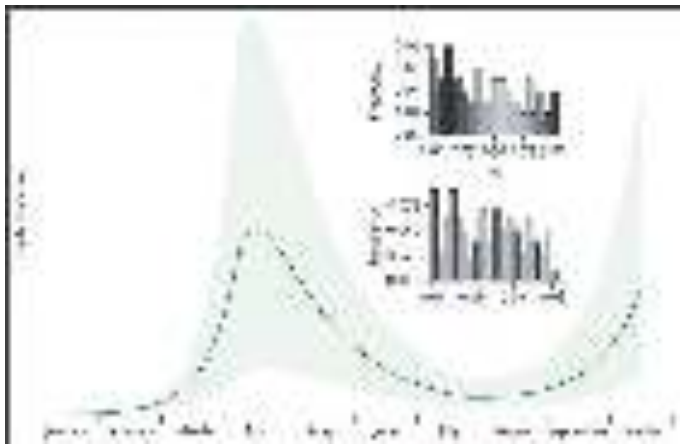
Results from models

Data analysis using the FF100-specific algorithms will produce, estimates of

- pathogen transmissibility and
- severity,
  - enabling timely identification of the pandemic scenario that best characterizes an actual outbreak.

Similarly, epidemic forecasting algorithms that leverage routine surveillance data

- can be used to rapidly predict pandemic characteristics relevant to policy makers



https://www.thelancet.com/article/S0140-6736(20)31689-5/fulltext

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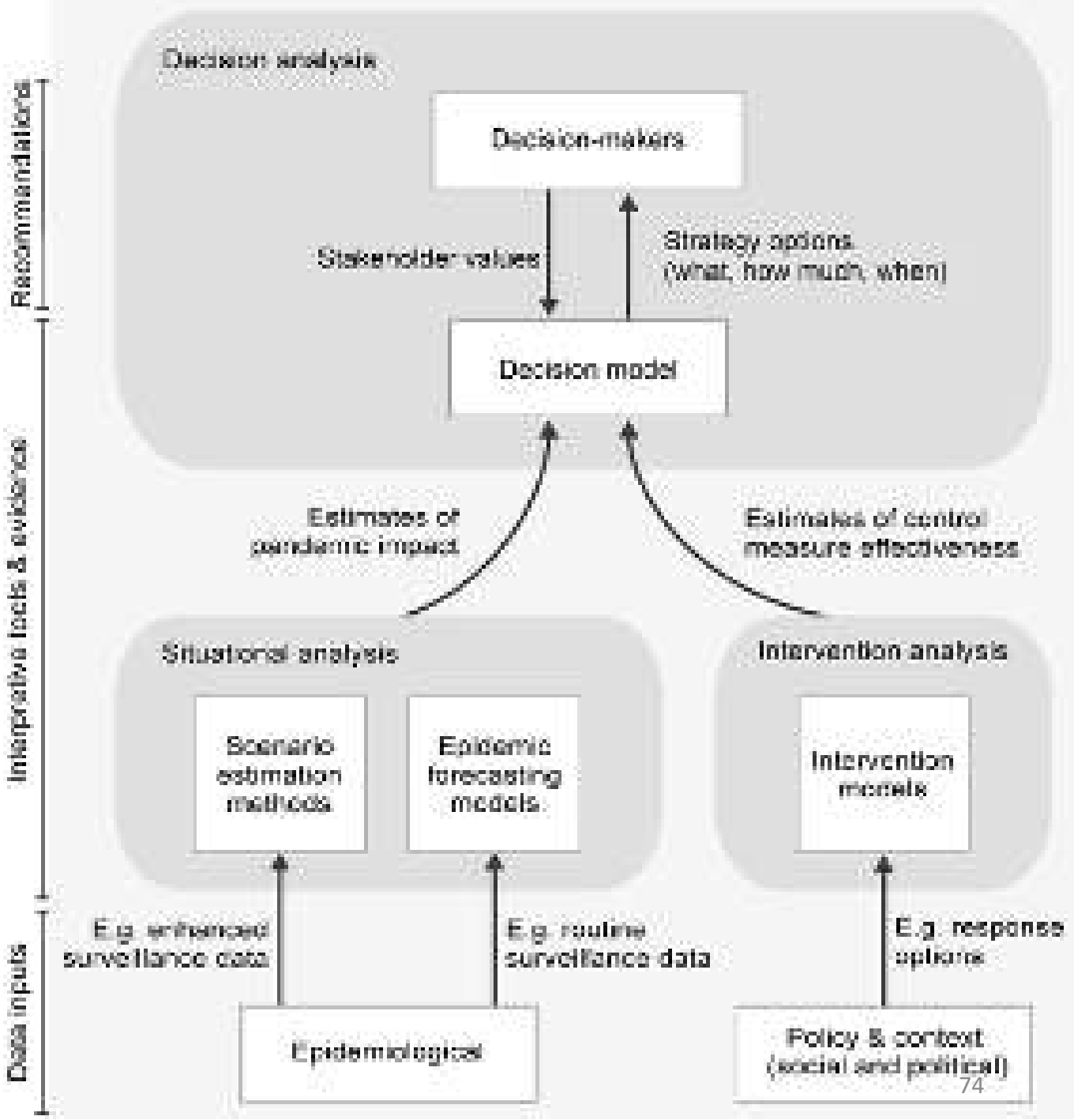
A decision support system for pandemic response

- Despite advances in methods for gaining situational awareness and assessing intervention impact,
  - a major gap exists in terms of integrating the outputs from these methods with the advice contained in pandemic response policy.
- Policy documents
  - will typically recognize the importance of methods for estimating pandemic impact (such as FF100), and
  - their response advice is often informed by intervention models, but
    - they do not articulate
      - how these data and analytics will contribute to decision-making in real time during a pandemic.

Shearer FM, Moss R, McVernon J, Ross JV, McCaw JM (2020) Infectious disease pandemic planning and response: Incorporating decision analysis. PLOS Medicine 17(1): e1003018. https://doi.org/10.1371/journal.pmed.1003018. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003018

Proposed Decision Support System



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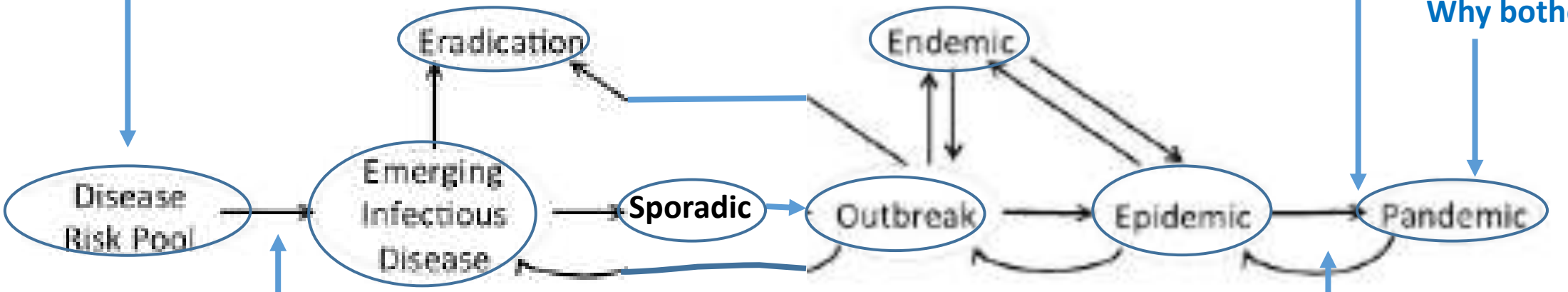
Scope of Topics to be Covered

The Environment
- Viruses
- Global virome project
- Characteristics likely to emerge
- Factors relating to disease emergence

- Pandemic Preparedness Plan
- Global health security
- Prerequisites for successful response
- Why we need Models

- **Improving global response**
- Improving national response

Why bother?



Can disease emergence be prevented?

Can pandemics be predicted?

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https://www.euractiv.com/section/cities-regions/opinion/eu-global-response-to-covid-19-a-global-pandemic-with-local-solutions/

Improving Global Response

Daily confirmed COVID-19 deaths, rolling 7-day average, Feb 19, 2021

Limited testing and challenges in the attribution of the cause of death means that the number of confirmed deaths may not be an accurate count of the true number of deaths from COVID-19.

The huge numbers of Covid-19 cases and deaths reveal the inadequacy of the global systems in place to protect against pandemics.

Note: The rolling average is the average across seven days – the confirmed deaths on the particular date, and the previous six days. For example, the value for 27th March is the average over the 21st to 27th March.

https://ourworldindata.org/coronavirus-data

Inadequacy of current public health architecture to deal with pandemics.

The current public health architecture was built for outbreaks and epidemics.

- the spread of the disease is geographically limited,
- so that non-affected countries can, at least in theory, help those affected.

But pandemics require a different approach.

In a pandemic,

- almost everyone is involved simultaneously,
- thus, a more significant and simultaneous demand for resources from international organizations.
- In this case, it is not enough that countries trust themselves and each other to prevent the spreading.
- Strengthened interagency relationships would be invaluable in this context.

Verônica Moreira (2021.01.02). The pandemic that poses challenges beyond health. **Interagency.institute.**

Effects of Globalisation on Disasters

Globalization has changed businesses and our way of life in the last few decades

In the past we have managed to bounce back every time after a period of setback arising from:

natural disasters

(e.g., bushfires, droughts, earthquakes, floods, and hurricanes)

human disasters

(e.g., global financial crisis, pandemics such as SARS and Ebola, terrorism and wars)

Covid-19 is a unique case due to the

- speed with which it has spread all over the world
- havoc it has caused to the global economy.

The Responses to Covid-19 Pandemic has Mostly been National

- The COVID-19 pandemic tells us about the world in which we live.
- It is a textbook manifestation of globalization.
  - What happened in Wuhan did not stay in Wuhan.
  - This virus does not respect any borders.
- Additional global health challenges will continue to present themselves, as will other risks associated with globalization, from climate change to cyberthreats and terrorism.
- What is so remarkable, then, is that the response to this global crisis has been almost entirely national.
  - There is little international cooperation and coordination occurring.
  - Even the developed countries failed to catalyze a collective response through the
    - WHO,
    - Group of Twenty,
    - Group of Seven, or
    - UN Security Council.
  - Countries are closing borders, hoarding medical equipment, competing to develop a vaccine, (and buying up vaccines).

Sylvia Mathews Burwell, Frances Fragos Townsend, Thomas J. Bollyky and Stewart M. Patrick, et al (2020). Improving Pandemic Preparedness: *Lessons From COVID-19.* Council on Foreign Relations®, Inc https://www.cfr.org/report/pandemic-preparedness-lessons-COVID-19/pdf/ TFR_Pandemic_Preparedness.pdf

We live in an Epidemiologically Interdependent World

- We live in an epidemiologically interdependent world,
  - outbreaks anywhere can hopscotch around the world at jet aircraft speeds.

- Preserving global public health depends in large part on three things:
  - timely and credible action by governments where outbreaks occur;
  - firm direction and leadership from the WHO in coordinating international responses; and
  - responsible behavior by other nations that naturally want to protect their own citizens from disease

https://www.nytimes.com/2020/07/07/opinion/coronavirus-world-health-organization.html

Stewart M. Patrick (2020.02.03). **The Wuhan Coronavirus Poses Three Tests for Global Public Health. World Politics Review. https://www.worldpoliticsreview.com/articles/28510/the-wuhan-coronavirus-poses-three-tests-for-global-public-health**

What Went Wrong Globally

- Pandemics, of course, are by definition global and
  - can be defeated only through international cooperation.
- Unfortunately, the multilateral response to COVID-19 has been chaotic and haphazard, partly due to:
  - the WHO's inadequate authorities and resources,
    - which hamstring its leadership in global health emergencies.
  - national governments failing to comply with the International Health Regulations (IHR),
    - a binding international treaty that obliges nations to
      - build baseline capacities to detect and respond to global public health emergencies, and
      - report to WHO any serious outbreaks as well as trade and travel restrictions they impose.
  - Unable to enforce compliance with the obligations under the IHR,
    - the WHO is effectively toothless,
      - explaining its deferential attitude toward some member states.

Sylvia Mathews Burwell, Frances Fragos Townsend, Thomas J. Bollyky and Stewart M. Patrick, et al (2020). Improving Pandemic Preparedness: *Lessons From COVID-19.* Council on Foreign Relations®, Inc https://www.cfr.org/report/pandemic-preparedness-lessons-COVID-19/pdf/ TFR_Pandemic_Preparedness.pdf

Weaknesses of the WHO with respect to Covid-19 Response

- The COVID-19 experience confirms that WHO
  - has an important leadership role in the health aspects of public health emergencies but
  - lacks the geopolitical heft to address the
    - broader diplomatic, economic, and security implications of pandemics.

- WHO has the mandate and expertise to lead global epidemic and pandemic response
  - but it is beleaguered, overstretched, and underfunded.
- WHO succeeded in:
  - prompting China (eventually) to notify the world of the outbreak of the SARS-CoV-2 virus and
  - supporting international coordination of many technical aspects of the COVID-19 challenge, particularly in low-income nations.
- WHO failed to
  - ensure that many member states comply with IHR obligations
  - constructively coordinate with the private sector.

- The WHO Emergencies Program is under-resourced and lacks surge capacity.

Sylvia Mathews Burwell, Frances Fragos Townsend, Thomas J. Bollyky and Stewart M. Patrick, et al (2020). Improving Pandemic Preparedness: *Lessons From COVID-19.* Council on Foreign Relations®, Inc https://www.cfr.org/report/pandemic-preparedness-lessons-COVID-19/pdf/ TFR_Pandemic_Preparedness.pdf

It is not enough that each country acts alone

- Pandemics are a global threat, so it's simply not enough for each country to act alone.
- The international community must
- provide support and incentives to low-income countries with the weakest health systems to
    - prioritize investments in preparedness and to help close their funding gaps.
- The World Health Organization(WHO), together with other global and regional organizations,
    - has a critical role to play in providing advice and technical assistance to countries,
    - to oversee the International Health Regulations and
    - lead a multinational response to emerging pandemic threats.
- Neighboring countries
    - need to have coordinated response plans at the ready to help contain outbreaks at their source.

Pandemic Action network (2020.05) . Break the cycle of panic and neglect: preventing the next pandemic. https://pandemicactionnetwork.org/wp-content/uploads/2020/05/Break-the-Cycle-of-Panic-and-Neglect-Preventing-the-Next-Pandemic-1.pdf

We Have to Continue Services for Other Health Needs

- Global initiatives designed to address specific health needs
  - such as HIV, vaccines or maternal and child health
  - should also be equipped to help enhance overall health system preparedness,
    - since an infectious disease pandemic threatens progress in other health areas,

Pandemic Action network (2020.05) . Break the cycle of panic and neglect: preventing the next pandemic. https://pandemicactionnetwork.org/wp-content/uploads/2020/05/Break-the-Cycle-of-Panic-and-Neglect-Preventing-the-Next-Pandemic-1.pdf

Obstacles and Weaknesses to Effective Multilateral Response

Multiple obstacles thwarted an effective multilateral response.

- a lack of coordination across nations and
- a breakdown of compliance with established norms and international agreements,
  - notably the International Health Regulations (IHR), the main international agreement governing dangerous disease events.

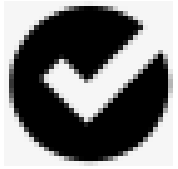
  - These weaknesses are due to national governments, which remain torn between their
    - desire for effective global health governance and their
    - resistance to expanding the authorities, funding, and capacities of WHO and other international agencies.

- Rising geopolitical competition—particularly between the United States and China—further frustrated multilateral cooperation at the
  - Group of Twenty (G20),
  - Group of Seven (G7), and
  - UN Security Council

Sylvia Mathews Burwell, Frances Fragos Townsend, Thomas J. Bollyky and Stewart M. Patrick, et al (2020). Improving Pandemic Preparedness: *Lessons From COVID-19.* Council on Foreign Relations®, Inc https://www.cfr.org/report/pandemic-preparedness-lessons-COVID-19/pdf/ TFR_Pandemic_Preparedness.pdf

Some Policy Options to Reduce and Address Pandemic Risk

- Launching a high-level intergovernmental council on pandemic prevention to
  - provide decision-makers with the best science and evidence on emerging diseases;
  - predict high-risk areas;
  - evaluate the economic impact of potential pandemics and to highlight research gaps, and
  - coordinate the design of a global monitoring framework.



- Countries setting mutually-agreed goals or targets within the framework of an international accord or agreement – with clear benefits for people, animals and the environment.

- Institutionalizing the 'One Health' approach in national governments to
  - build pandemic preparedness, enhance pandemic prevention programs, and
  - investigate and control outbreaks across sectors.

- Developing and incorporating pandemic and emerging disease risk health impact assessments in major development and land-use projects,
  - while reforming financial aid for land-use so that
  - benefits and risks to biodiversity and
  - health are recognized and explicitly targeted.

IPBES (2020) Workshop Report on Biodiversity and Pandemics of the Intergovernmental Platform on Biodiversity and Ecosystem Services. Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. https://ipbes.net/sites/default/files/2020-12/IPBES%20Workshop%20on%20Biodiversity%20and%20Pandemics%20Report_0.pdf

What Regional Bodies Should Do

- Regional bodies like the European, the African Union and ASEAN should:
  - Coordinate strong regional and sub-regional preparedness capabilities e.g.
    - disease surveillance systems,
    - referral laboratories,
    - local supply chains and
    - stockpiles of personal protective equipment, medicines, and other vital equipment and supplies.
  - Strengthen their capacity to
    - provide technical assistance to member countries to
    - promote timely and accurate surveillance,
    - data sharing,
    - adequate supply chains and support the development and implementation of robust national health security action plans

Pandemic Action network (2020.05) . Break the cycle of panic and neglect: preventing the next pandemic. https://pandemicactionnetwork.org/wp-content/uploads/2020/05/Break-the-Cycle-of-Panic-and-Neglect-Preventing-the-Next-Pandemic-1.pdf

What the Global Institutions Like the United Nations Should Do -1

Global Institutions like the United Nations, the World Bank and international funding agencies should:

- Establish time-bound targets for full compliance with the International Health Regulations
  - and measure progress against international health security assessments, e.g. the JEEs or the Global Health Security Index.

- Create an integrated real-time data system that can interact across countries
  - to inform the actions, studies, and preparedness of every country allowing the global community to deploy testing efforts, data from field hospitals, and measures of caseload and fatalities.

- Establish a Global Health Security Challenge Fund
  - to channel additional funding for urgent COVID-19 preparation and detection needs and to close critical preparedness gaps for the next pandemic.
  - The fund should prioritize funding for the implementation of National Action Plans for low-income countries that have completed JEEs and demonstrated commitments to domestic financing.

Pandemic Action network (2020.05) . Break the cycle of panic and neglect: preventing the next pandemic. https://pandemicactionnetwork.org/wp-content/uploads/2020/05/Break-the-Cycle-of-Panic-and-Neglect-Preventing-the-Next-Pandemic-1.pdf

What the Global Institutions Like the United Nations Should Do -2

Global Institutions like the United Nations, the World Bank and international funding agencies should:

- Bolster the WHO and ensure it has the mandate and resources necessary
  - to effectively lead a global pandemic response, monitor country preparedness and guide and support countries on their national action plans.

- Ensure other major global health initiatives and financing mechanisms (e.g. Global Fund, Gavi, Global Financing Facility, UHC 2030, SDG3 Global Action Plan) are designed and/or evaluated with a view toward advancing pandemic preparedness.

Pandemic Action network (2020.05) . Break the cycle of panic and neglect: preventing the next pandemic. https://pandemicactionnetwork.org/wp-content/uploads/2020/05/Break-the-Cycle-of-Panic-and-Neglect-Preventing-the-Next-Pandemic-1.pdf

Recommendations For the UN to Establish a Permanent Global Health Security Coordinator

- The WHO is not a perfect institution,
  - but no multilateral substitute exists for it in the current pandemic or the next one.
  - thus countries collaborate to ensure adequate, dedicated funding for WHO's Health Emergencies Program.

- In addition, it is recommended that the United Nations establish a permanent global health security coordinator who should
  - report directly to the UN secretary-general
  - coordinate diplomatic, economic, and security responses to future pandemics and additional waves of the current one,
  - be charged with leading a coherent response to global health threats across the UN system,
  - support any activity by the Security Council in pandemic response, and
  - maintain direct links to the leadership of the International Monetary Fund (IMF), World Bank, World Trade Organization (WTO), and other relevant multilateral forums, such as the G20 and G7.

- WHO should maintain its lead role in mobilizing UN and international collaboration on issues that fall within the scope of the health field.

Sylvia Mathews Burwell, Frances Fragos Townsend, Thomas J. Bollyky and Stewart M. Patrick, et al (2020). Improving Pandemic Preparedness: *Lessons From COVID-19.* Council on Foreign Relations®, Inc https://www.cfr.org/report/pandemic-preparedness-lessons-COVID-19/pdf/ TFR_Pandemic_Preparedness.pdf

Review the IHR

- COVID-19 has revealed the danger of relying on a weak IHR system that
  - does not motivate governments to promptly report and share timely, relevant information about public health risks.
- The WHO member states should establish an IHR review conference to discuss how to
  - improve member states' compliance with IHR,
  - increase information sharing and transparency, and
  - enhance the competence and consistency of WHO's Emergency Committee when advising on the declaration of PHEICs.

- The current pandemic also demonstrates the inherent vulnerability of an international system of pandemic detection that relies so heavily on the
  - transparency,
  - judgment, and
  - discretion of individual national governments

Sylvia Mathews Burwell, Frances Fragos Townsend, Thomas J. Bollyky and Stewart M. Patrick, et al (2020). Improving Pandemic Preparedness: *Lessons From COVID-19.* Council on Foreign Relations®, Inc https://www.cfr.org/report/pandemic-preparedness-lessons-COVID-19/pdf/ TFR_Pandemic_Preparedness.pdf

Multilateral Mechanisms Needed

- Countries should support multilateral mechanisms to
  - develop,
  - manufacture,
  - allocate, and
  - deliver COVID- 19 vaccines,
  - therapeutics, and
  - diagnostics in a globally fair manner consistent with public health needs.

- Without such global coordination, countries have been bidding against one another, driving up the price of vaccines and related materials.

- The resulting arms race threatens to
  - prolong the pandemic,
  - generate resentment against vaccine-hoarding nations, and
  - undermine the countries' economic, diplomatic, and strategic interests.

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Increase International Assistance for Pandemic Preparedness

international assistance for pandemic preparedness has never amounted to more than 1 percent of overall global health assistance

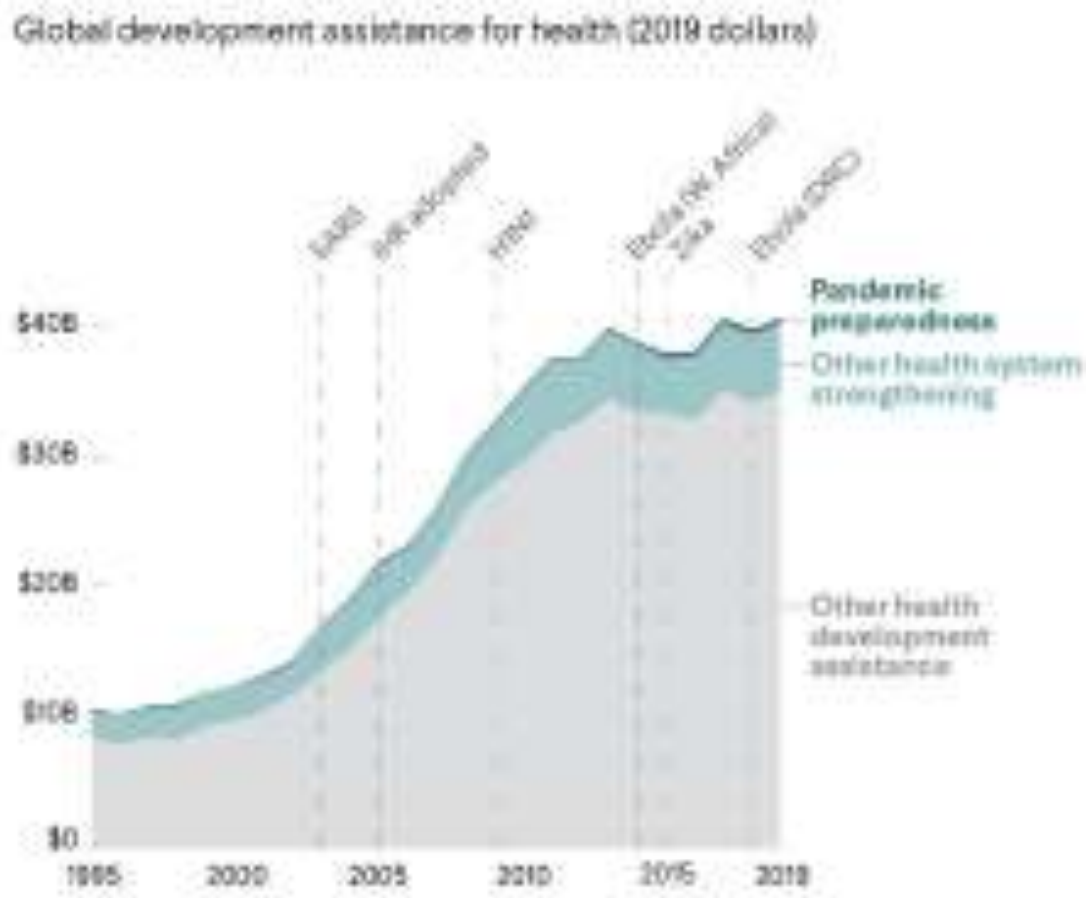

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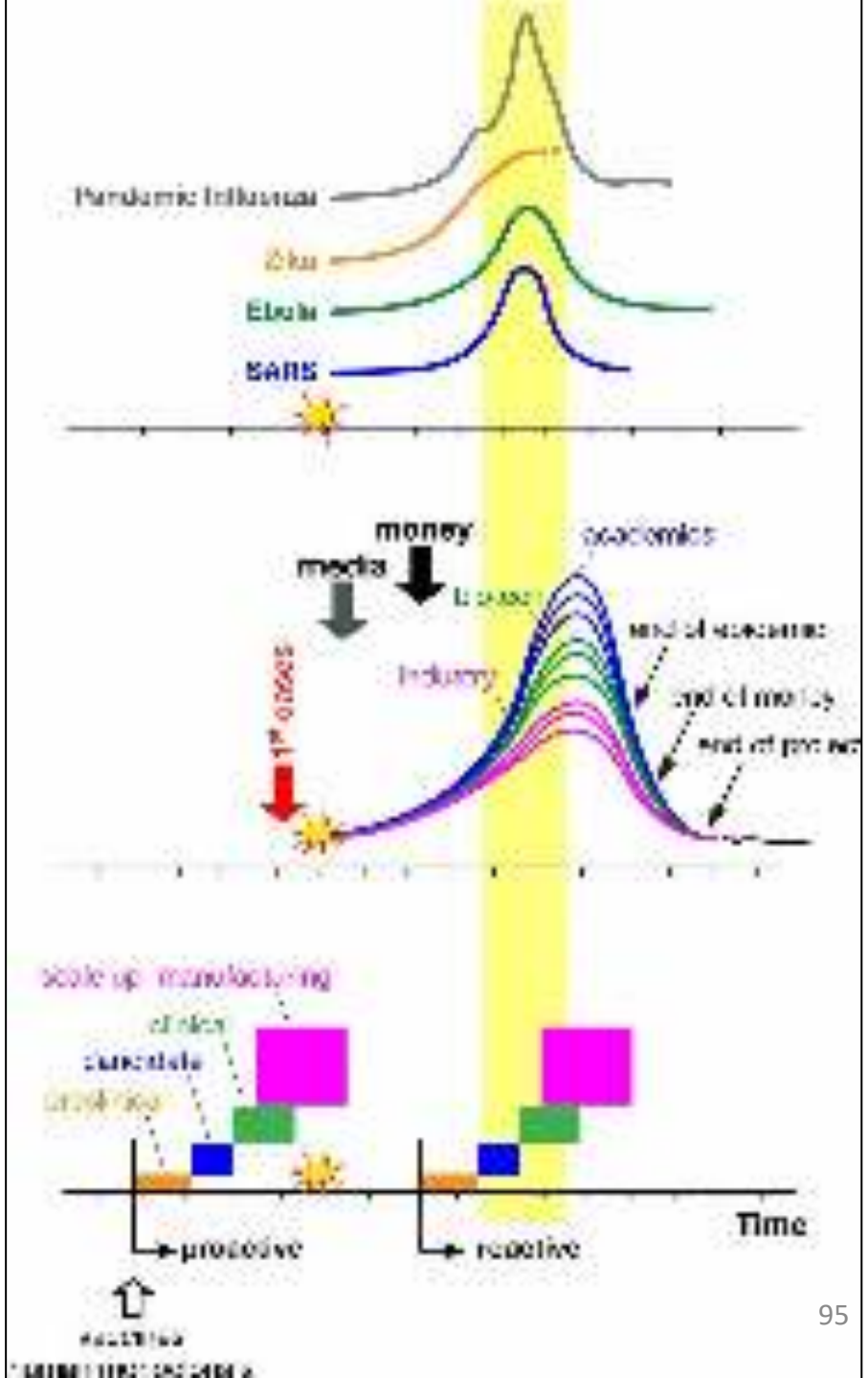
Fig. 1. Schematic representations of the progression of some emerging diseases:

- (*Top*), the progression of vaccine development activities following an emerging infection

- (*Middle*), and the steps required for vaccine delivery using the present, reactive, approach compared with the proposed, proactive, approach for vaccines and human monoclonals

- (*Bottom*). Temporal scales and frequency of cases are for illustrative purposes only and differ for each disease. Industry indicates large vaccine manufacturers.



Bloom, DE, et al (2017). Emerging infectious diseases: A proactive approach. https://www.pnas.org/content/114/16/4055

Scope of Topics to be Covered

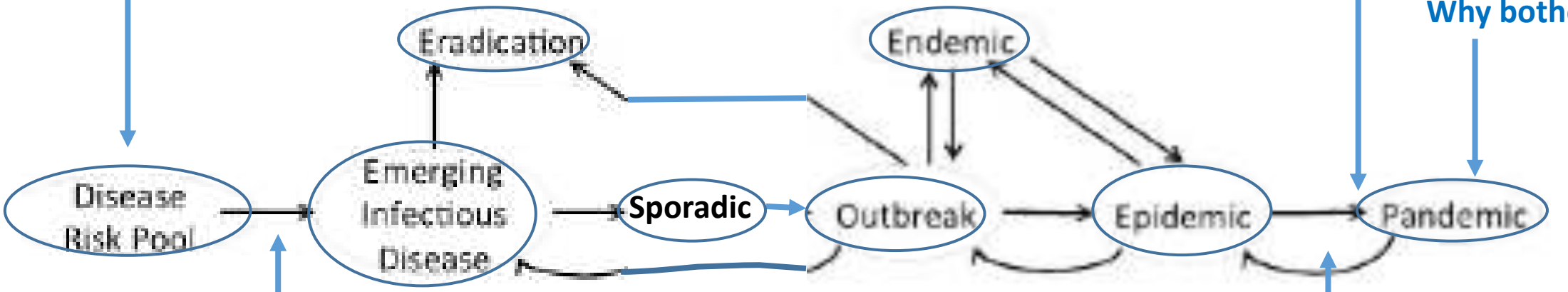
The Environment

- Viruses
- Global virome project
- Characteristics likely to emerge
- Factors relating to disease emergence

- Pandemic Preparedness Plan
- Global health security
- Prerequisites for successful response
- Why we need Models

- Improving global response
- Improving national response

Why bother?



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https://www.vectorstock.com/royalty-free-vector/spectrum-hexagon-malaysia-map-vector-20667629

Improving National Responses

What Countries Should Do

Countries should:

- Measure their capacity to prevent, detect and respond to public health risks by undertaking a Joint External Evaluation every two years and making it public.
- Develop National Health Security Action Plans with time-bound targets and benchmarks for IHR compliance.
- Fund National Health Security Action Plans through national budgets with international financing to close financing gaps where needed.
- Implement: Improvements should result in improved scores on international health security assessments e.g. JEEs and/or Global Health Security Index, with the aim to reach IHR compliance by 2024.
- Support: Ensure the WHO and other international organizations have the necessary resources and capabilities to guide countries on their preparedness efforts, monitor compliance and lead an effective global response

Pandemic Action network (2020.05) . Break the cycle of panic and neglect: preventing the next pandemic. https://pandemicactionnetwork.org/wp-content/uploads/2020/05/Break-the-Cycle-of-Panic-and-Neglect-Preventing-the-Next-Pandemic-1.pdf

The Importance of Preparation and Early Execution

- The world were caught unprepared by the COVID-19 pandemic despite decades of warnings of the threat of global pandemics and years of international planning
- One of the most important lessons of this pandemic is that preparation and early execution are essential for
  - detecting,
  - containing, and
  - rapidly responding to and
  - mitigating the spread of potentially dangerous emerging infectious diseases.

- In the early stages, a diverse group of nations was prepared to respond rapidly and aggressively to COVID- 19 with public health fundamentals, including
  - testing,
  - contact tracing,
  - isolating, and
  - clear, science-based risk communication to the public.

https://www.nst.com.my/news/nation/2020/12/648184/low-risk-quarantine-centre-maeps-be-reopened

https://www.wsj.com/articles/taiwans-coronavirus-example-11588026299

Sylvia Mathews Burwell, Frances Fragos Townsend, Thomas J. Bollyky and Stewart M. Patrick, et al (2020). Improving Pandemic Preparedness: *Lessons From COVID-19.* Council on Foreign Relations®, Inc https://www.cfr.org/report/pandemic-preparedness-lessons-COVID-19/pdf/ TFR_Pandemic_Preparedness.pdf

The Need for Flexible Action Plans

- A key lesson from the emergence of influenza A(H1N1)pdm09 was the need for pandemic policies to be adaptable to evolving pandemic scenarios.
  - Many countries found that their planning assumptions did not match the expected level of pandemic impact because they were based on the more lethal HPAI H5N1 virus.
  - In light of the relative mildness of A(H1N1)pdm09, which still had serious consequences, countries had to rapidly adjust their plans in order to deliver a proportionate response
- The World Health Organization (WHO) guiding document for pandemic influenza preparedness and response has since adopted a more flexible approach, emphasizing the importance of actions that can be scaled and targeted as needed.

Shearer FM, Moss R, McVernon J, Ross JV, McCaw JM (2020) Infectious disease pandemic planning and response: Incorporating decision analysis. PLOS Medicine 17(1): e1003018. https://doi.org/10.1371/journal.pmed.1003018. https://journals.plos.org/plosmedicine/article?id=10.1371/journal.pmed.1003018

Two Considerations Regarding Pandemic Preparedness Plans

- First:
  - who is responsible for them,
  - at what level in the government they have been developed, and
  - what mandate they are published.
    - The majority have been produced at a ministerial level and signed by the ministers of health in the respective countries.
- Two:
  - how the respective documents are characterised by their titles.
  - Some countries call them ‘plans’,
  - Others call them ‘strategies’.

Martin Holmberg & Britta Lundgren (2018) Framing post-pandemic preparedness: Comparing eight European plans, Global Public Health, 13:1, 99-114, DOI: 10.1080/17441692.2016.1149202

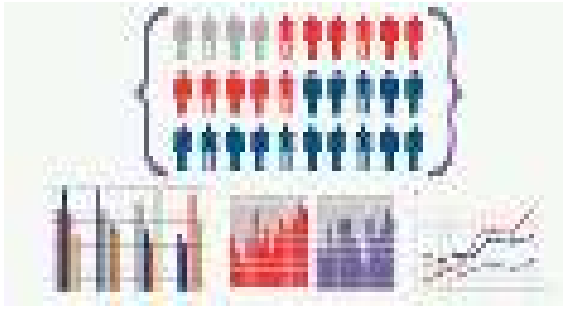
How to deal with Uncertainty in the Pandemic Preparedness Plans

Biological (viral) as well as Epidemiological Uncertainties in Pandemics

The ***viral* uncertainty** involves

- the identity of the virus and
- what constitutes a viral species.

- Knowledge about
  - viral reproduction,
  - recombination and reassortment
  - also leads to an understanding of the
    - inherent uncertainty that derives from the biology of the pandemic.



The ***epidemiological* uncertainty**

- depends on how the epidemic is framed.

- Epidemics can be framed
  - as isolated from social space and time, or
  - in a more context-inclusive and trans-disciplinary manner.
- The uncertainty is constructed in different way, depending on
  - whether social and cultural factors are weighed into the epidemiological process or not,
  - which might lead to alternative pathways of preparedness and response actions.

Martin Holmberg & Britta Lundgren (2018) Framing post-pandemic preparedness: Comparing eight European plans, Global Public Health, 13:1, 99-114, DOI: 10.1080/17441692.2016.1149202

Categories of Uncertainty

Status of world knowledge among the planning team	Status of Knowledge in the world	
	Knowns	Unknowns
Known	*Current facts (Tapped knowledge)* • E.g., there are some things that can be assumed about all influenza pandemics	*Identified unknown facts. (Unknown knowledge)* • e.g., there are some important things that vary between pandemics where we cannot make assumptions beforehand
Unknown	*Hidden facts (Untapped knowledge)* • E.g. Some knowledge that is known to the world is not known by the planners • Include members from many sectors and disciplines in the planning team to reduce the occurrence of 'unknown knowns'	*Complete Ignorance. (No knowledge at all)* • Inherent uncertainty and unpredictability • By declaring the unknown as certain or expected, the uncertainty can be put to strategic use

Martin Holmberg & Britta Lundgren (2018) Framing post-pandemic preparedness: Comparing eight European plans, Global Public Health, 13:1, 99-114, DOI: 10.1080/17441692.2016.1149202

The Perspectives Used to Frame Pandemic Phases

- At the core of pandemic framing is the construction of pandemic phases and what perspective to take on spatial and temporal developments of the pandemic.
- These phases can be defined and modelled in different ways depending on underlying theories.
  - If they are constructed from epidemiological theory,
    - they will include concepts such as pre- and post-outbreak, epidemic curve, peak and remission.
  - If they are motivated by crisis-management theory,
    - they will include concepts such as alarm, awareness, response and recovery.
  - the framing of the pandemic phases is central to each plan and that the plans contain competing frames.
- However, these theoretical stances do not provide the full story of how societies
  - identify new diseases and
  - they respond to these threats.

Martin Holmberg & Britta Lundgren (2018) Framing post-pandemic preparedness: Comparing eight European plans, Global Public Health, 13:1, 99-114, DOI: 10.1080/17441692.2016.1149202

Emphasis of the Response – Containment or Adaptation

- Is the emphasis of the response to a pandemic on
  - containment of the threat, delaying or reducing its spread or
  - adapting to it by mitigating actions?
- The emphasis might be placed on one or the other of these basic strategies, depending on the
  - state of beliefs, and
  - knowledge about the threatening infectious agent.
  - prevailing views are on governmental ability and societal resilience.

- The possibility to contain a pandemic early in its spread has been devalued by the WHO in the new guidelines (WHO, 2013)

Martin Holmberg & Britta Lundgren (2018) Framing post-pandemic preparedness: Comparing eight European plans, Global Public Health, 13:1, 99-114, DOI: 10.1080/17441692.2016.1149202

How to Address Vulnerabilities

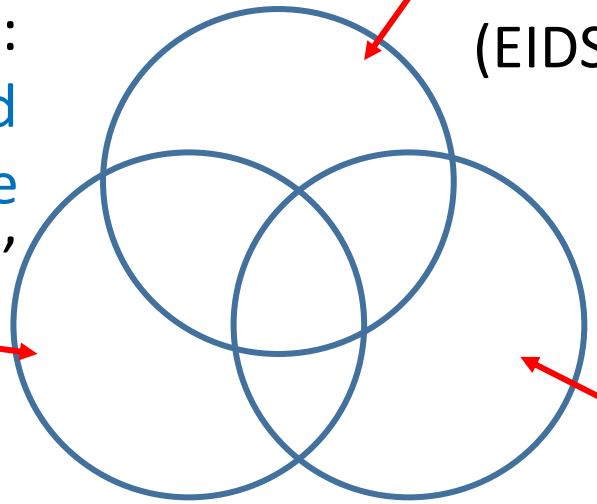
- An important question to ask is whether the national preparedness plans articulate a general vulnerability as a
  - form of insecurity (a security framing),
  - 'social determinants of health' framework (a development framing), or
  - framing of groups at risk for medical complications (an evidence-based medicine framing).
- In influenza pandemic preparedness,
  - attention has been directed toward identifying and protecting groups with chronic diseases or other conditions that put them at increased risk for medical complications from influenza (WHO, 2009).
- Vulnerability has also been described more universally as a lack of
  - immunity,
  - information and
  - resilience.
- vulnerability can also be described in terms of social structures
  - through the lens of the social determinants of health,
  - which could influence daily resilience and lead to disproportionate impact from a pandemic

Martin Holmberg & Britta Lundgren (2018) Framing post-pandemic preparedness: Comparing eight European plans, Global Public Health, 13:1, 99-114, DOI: 10.1080/17441692.2016.1149202

Three Outbreak Narratives that Influence the Types of Plans

Narrative 1: links veterinary concerns with agriculture and livelihood issues (EIDS as Zoonoses)

Narrative 3: focused on pandemic preparedness: 'a major economic and humanitarian disaster is around the corner and we must be prepared'



Narrative 2: focused on human public health where 'human-human spread is the real risk and could be catastrophic'.

This narrative invokes the use of epidemiological success stories such as vaccination interventions, antivirals, hygiene measures etc

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Weaknesses in Infectious Diseases Surveillance and Response Capabilities

- **The COVID-19 pandemic** has exposed overlooked weaknesses in the world's infectious-disease-surveillance and -response capabilities—
  - weaknesses that have persisted in spite of the obvious harm they caused during prior outbreaks.
- Many countries, including some thought to have strong response capabilities, failed to detect or respond decisively to the early signs of SARS-CoV-2 outbreaks.
  - That meant they started to fight the virus's spread after transmission was well established.
  - Once they did mobilize, some nations struggled to ramp up public communications, testing, contact tracing, critical-care capacity, and other systems for containing infectious diseases.
- Ill-defined or overlapping roles at various levels of government or between the public and private sectors resulted in further setbacks.
- Overall, delayed countermoves worsened the death toll and economic damage.

Matt Craven, et al (2020.07.13). Not the last pandemic: Investing now to reimagine public-health systems
https://www.mckinsey.com/industries/public-and-social-sector/our-insights/not-the-last-pandemic-investing-now-to-reimagine-public-health-systems

Weaknesses in Infectious Diseases Surveillance and Response Capabilities

- Correcting those weaknesses won't be easy.
- Government leaders:
  - In addition to focusing on navigating the current crisis, should also
    - making smart investments now can both
      - accelerate COVID-19 response and
      - strengthen public-health systems to reduce the chance of future pandemics.

- Investments in public health and other public goods are sorely undervalued;
- investments in preventive measures, whose success is invisible, are even more undervalued.

- Many such investments would have to be made in countries that cannot afford them.

Matt Craven, et al (2020.07.13). Not the last pandemic: Investing now to reimagine public-health systems
https://www.mckinsey.com/industries/public-and-social-sector/our-insights/not-the-last-pandemic-investing-now-to-reimagine-public-health-systems

Weakness of Some Countries in Responding to Covid-19 Pandemic

- The failure to maintain an adequate Strategic National Stockpile (SNS)—and to clarify the rules governing its use—led to shortages of essential medical supplies and competition among states over scarce medical equipment
- overdependence on a single nation, such as China, for essential medicines and medical equipment in a global pandemic.
- lack of a multilateral mechanism to encourage the joint development and globally equitable distribution of lifesaving vaccines, therapeutics, and diagnostics.
- limitations of existing national and global systems of epidemic threat surveillance and assessment, which left public health officials and researchers without access to timely data.

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Assure supplies of essential drugs, PPEs, Stockpiles

- creating an essential medicines list to set priorities for policy, investments, and regulatory reviews;
- improving the transparency of global supply chains, including enhanced data on the sourcing, pricing, and quality of drugs;
- diversifying overseas sources of production;
- expanding domestic production of critical medicines through government incentives for building new U.S. manufacturing capacities;
- Increasing national stockpiles of critical medicines;
- enhancing crisis cooperation on global supply chains among close partners and allies, including through emergency sharing arrangements; and
- strengthening multilateral regulatory cooperation among major producer nations to ensure common standards and quality control, including during emergencies.
- Providing regular updates on supply chain vulnerabilities relevant to both branded and generic drugs, from raw materials to finished products and the ancillary supplies (vials, syringes, etc.) involved in their use.
- Support multilateral mechanisms for the equitable allocation of vaccines.

Sylvia Mathews Burwell, Frances Fragos Townsend, Thomas J. Bollyky and Stewart M. Patrick, et al (2020). Improving Pandemic Preparedness: *Lessons From COVID-19.* Council on Foreign Relations®, Inc https://www.cfr.org/report/pandemic-preparedness-lessons-COVID-19/pdf/ TFR_Pandemic_Preparedness.pdf

Scope of Topics to be Covered

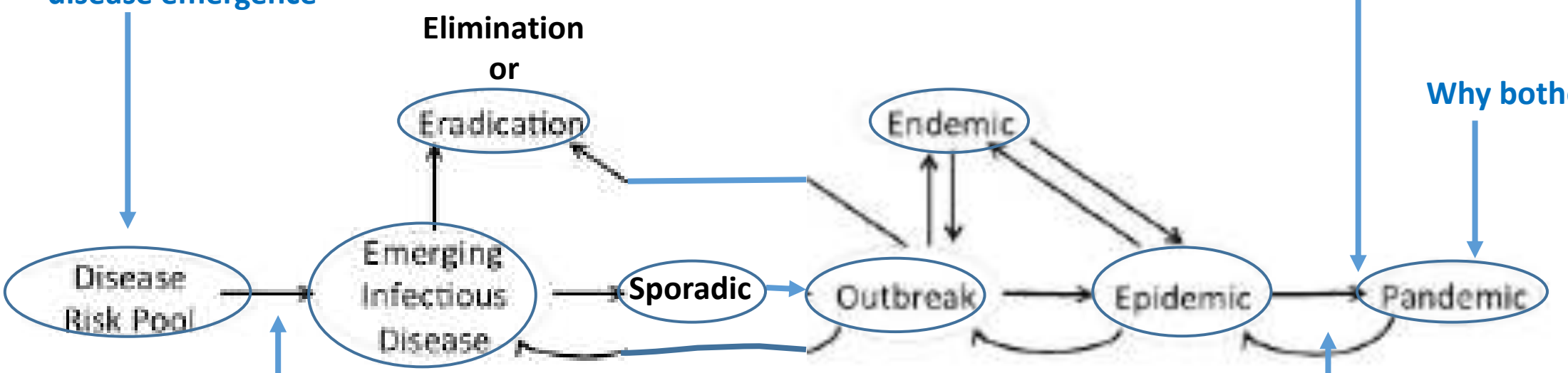
The Environment

- Viruses
- Global virome project
- Characteristics likely to emerge
- Factors relating to disease emergence

- Pandemic Preparedness Plan
- Global health security
- Prerequisites for successful response
- Why we need Models

- Improving global response
- Improving national response
- Technologies

Why bother?



Can disease emergence be prevented?

Can pandemics be predicted?

National Research Council 2016. *The Neglected Dimension of Global Security: A Framework to Counter Infectious Disease Crises*. Washington, DC: The National Academies Press. p18 https://doi.org/10.17226/21891.

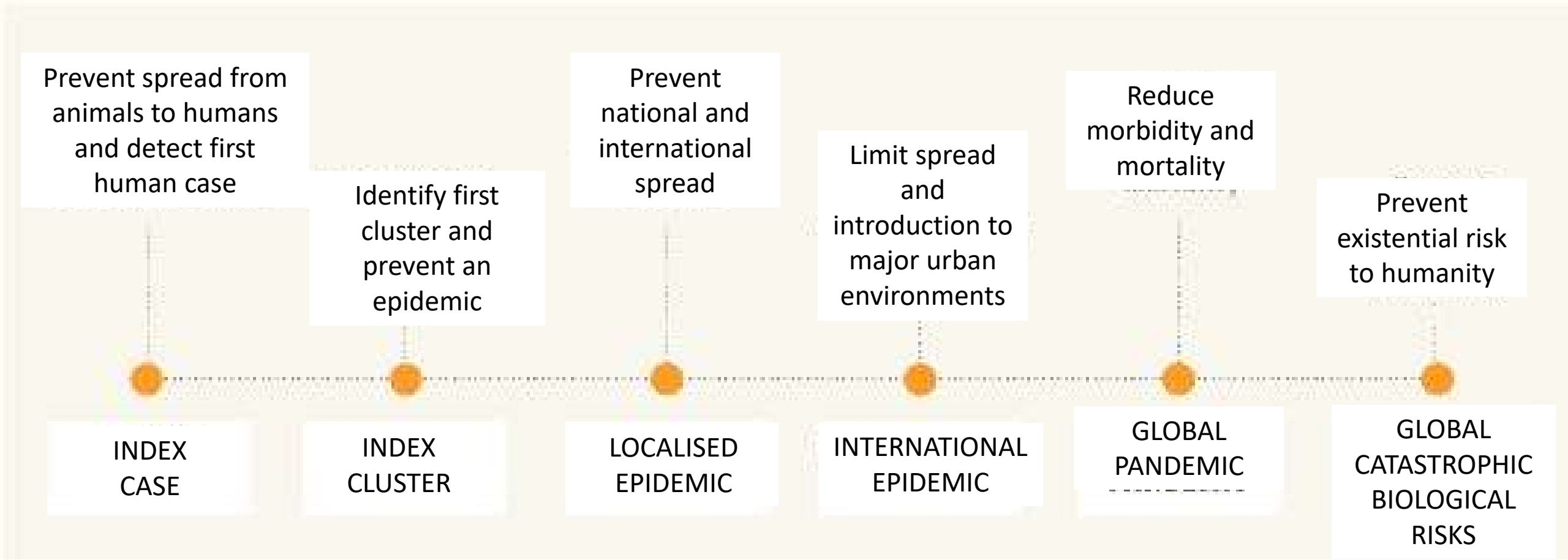
Technologies to Address Catastrophic Biological Events

Technologies to Address Global Catastrophic Biological Events

- In broad terms, in order to alter the course of a potential global catastrophic biological event, technologies must either
  - help prevent the emergence and geographic spread of a biological pathogen or
  - reduce disease severity and societal consequences, or
  - both.
- Several inflection points exist during an unfolding biological event
  - at which effective interventions can be implemented with maximal impact to interrupt event progression.

Johns Hopkins Center for Health Security (2017). **Technologies to address global catastrophic biological risks**

Examples of those potential inflection points of intervention



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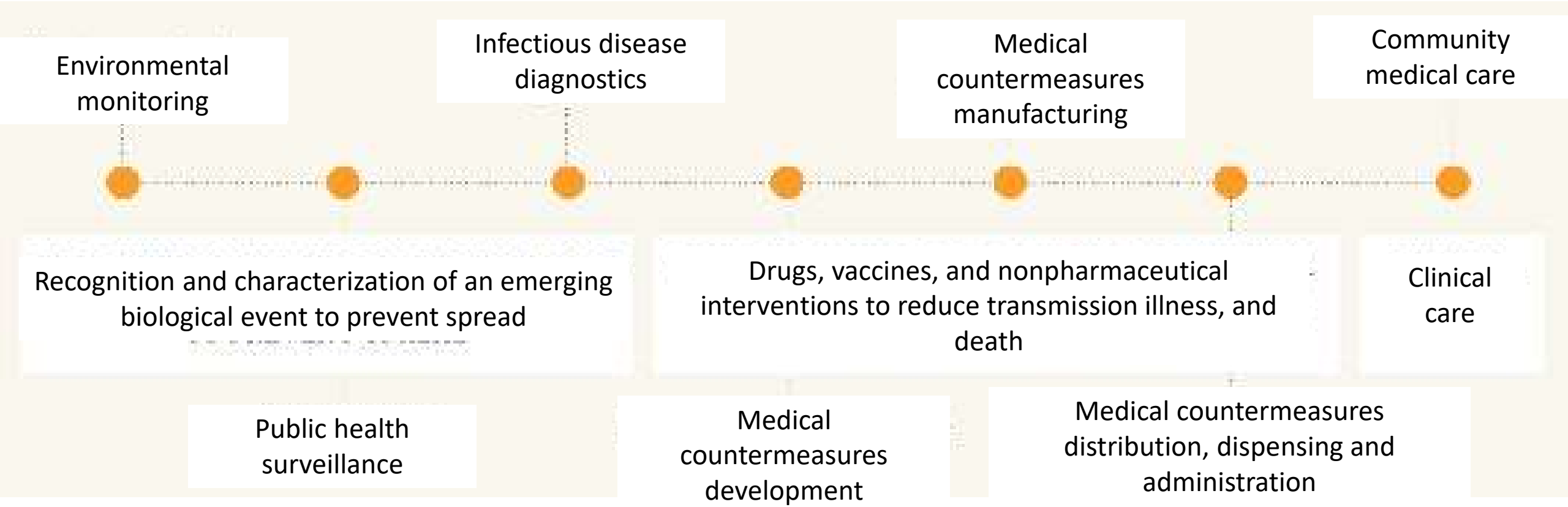
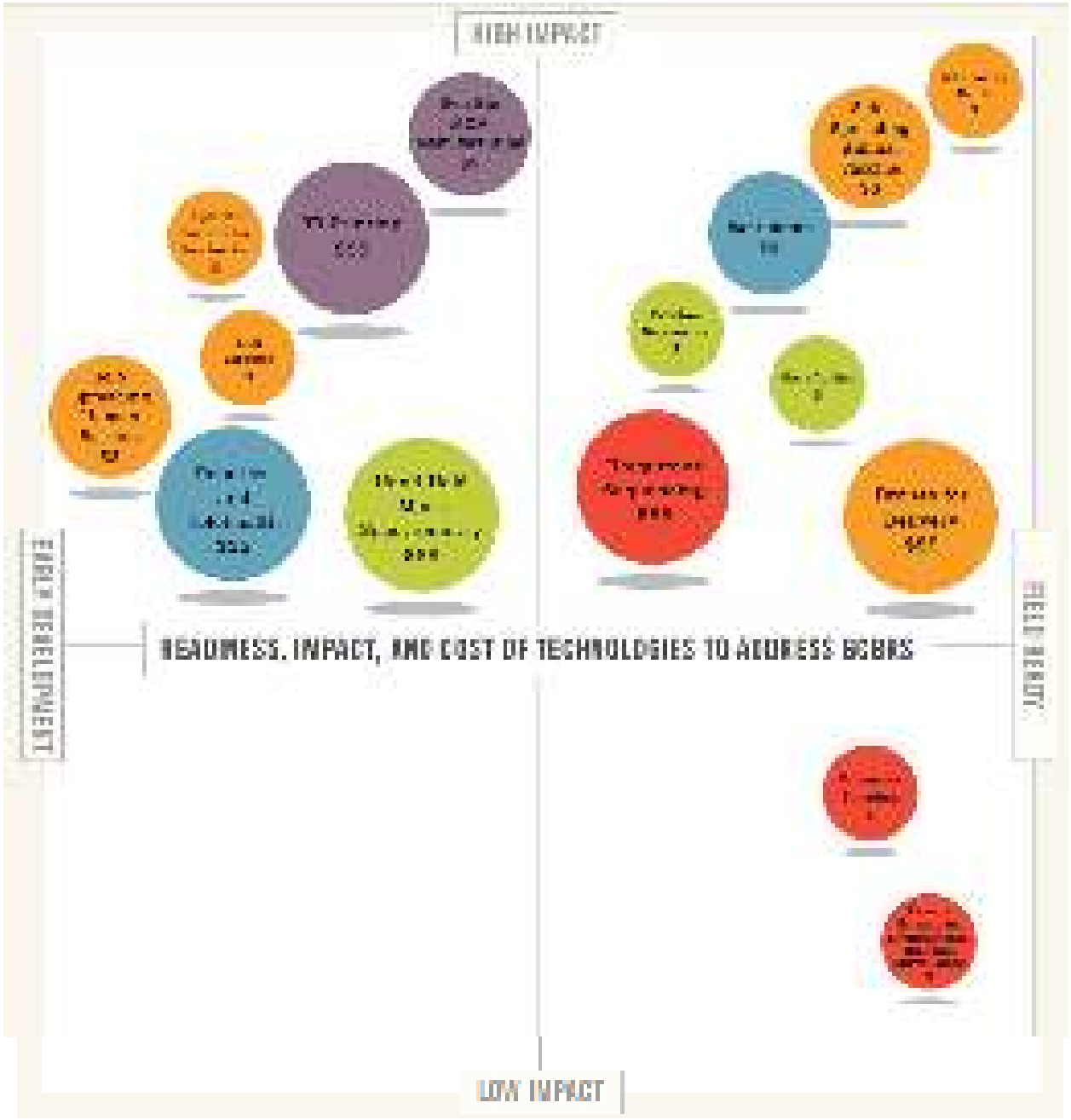


Technologies can be applied at each of these inflection points in a number of ways to reduce biological risk, including through:

- Better detection, surveillance, and characterization of a GCB event such that action can be taken to quickly prevent or quell a biological event; or
- Increased speed and global extent of the response, in both high- and low-resource settings, to mitigate the impacts of an unfolding event.

Johns Hopkins Center for Health Security (2017). **Technologies to address global catastrophic biological risks**



Johns Hopkins Center for Health Security (2017). **Technologies to address global catastrophic biological risks**

Five Broad Categories of Technologies for Prevention and Response to Severe Infectious Disease Emergencies.

Disease Detection, Surveillance, and Situational Awareness	Infectious Disease Diagnostics	Distributed Medical Countermeasure Manufacturing	Medical Countermeasure Distribution, Dispensing, and Administration	Medical Care and Surge Capacity
• Ubiquitous Genomic Sequencing and Sensing • Drone Networks for Environmental Detection • Remote Sensing for Agricultural Pathogens	• Microfluidic Devices • Handheld Mass Spectrometry • Cell-Free Diagnostics	• 3D Printing of Chemicals and Biologics • Synthetic Biology for Manufacturing Medical countermeasures	• Microarray Patches for Vaccine Administration • Self-Spreading Vaccines • Ingestible Bacteria for Vaccination • Self-Amplifying mRNA Vaccines • Drone Delivery to Remote Locations	• Robotics and Telehealth • Portable, Easy-to-Use Ventilator

Johns Hopkins Center for Health Security (2017). **Technologies to address global catastrophic biological risks**

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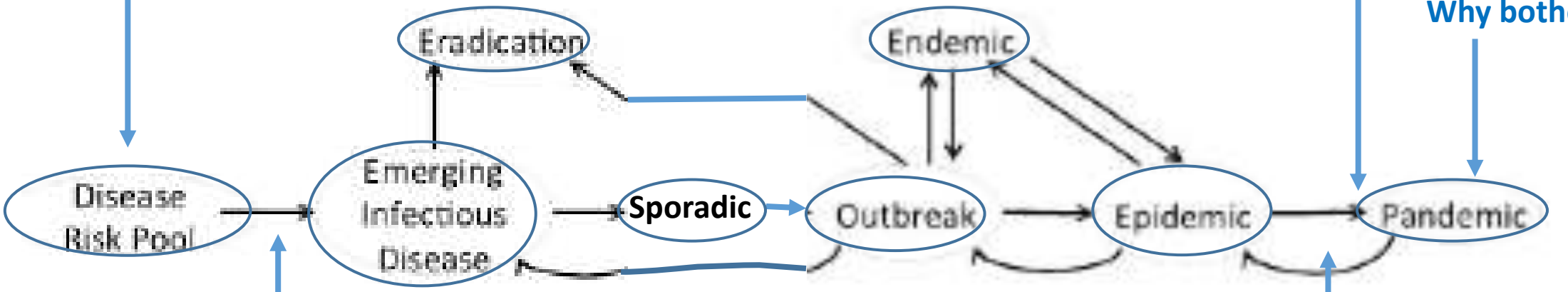

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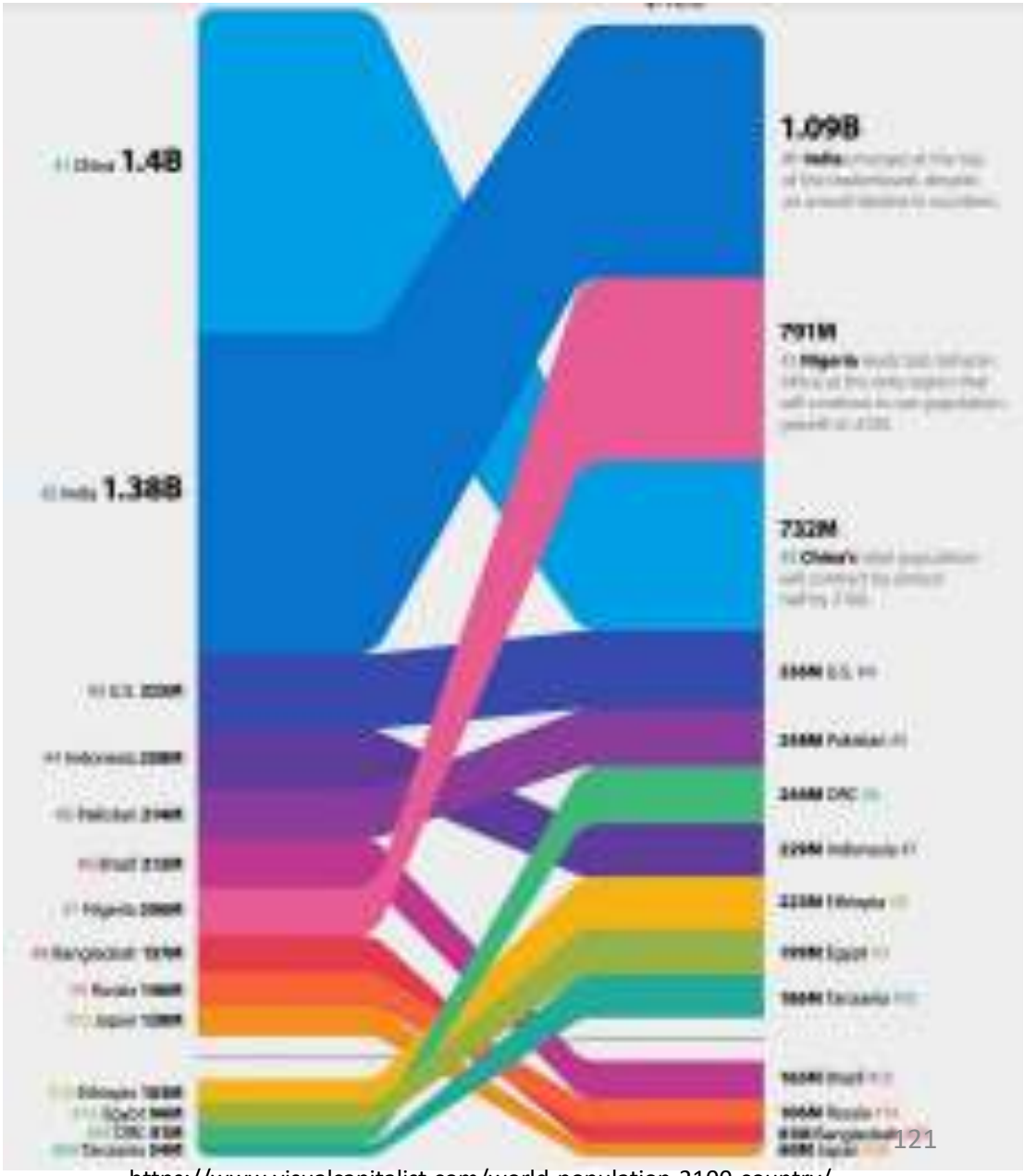
A New Consciousness

- In a densely interconnected world of nearly 8 billion humans, we have no choice but to hang together for the good of all.
- Pandemics are nature's loud wake-up call that we humans are mismanaging our own existence in the complex ecosystem
  - that we have thoughtlessly shaped,
  - within which we live, and
  - upon which our survival depends: planet Earth.
- We must not only wake up,
  - we must now get up,
  - with energy, and
  - start building a safer future on a healthier planet.

Top 10 countries by population
2017 (8 billion) 2100 (11 billion)



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Source: ImageFlow / Shutterstock