ASU Complex Adaptive Systems Initiative
Arizona State University

Biosecurity: A Multi-Dimensional Challenge of Escalating Complexity and Urgency

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Oncology Impact Partners
Virtual Infectious Disease and Immunology Conference
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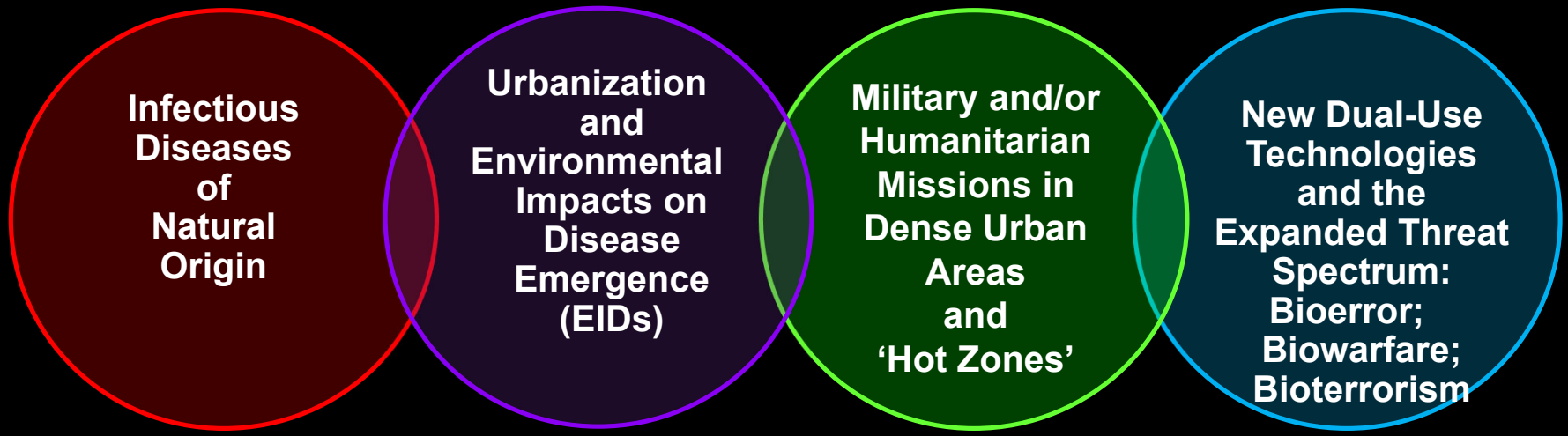
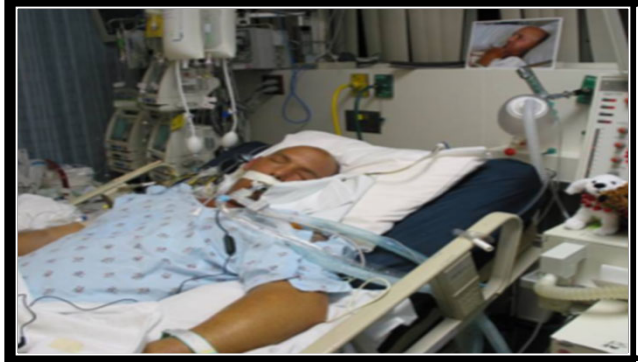
The Biosecurity Quartet



- shared dimensions in threat awareness deterrence, prevention, detection, treatment and recovery
- additional requirements in forensics, attribution and retribution for bioattacks

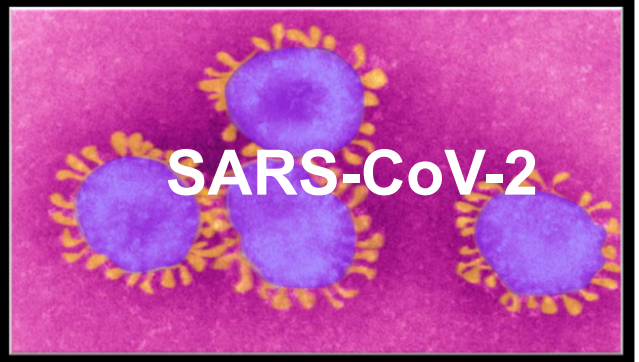
The Relentless Changing Dynamics of Infectious Diseases

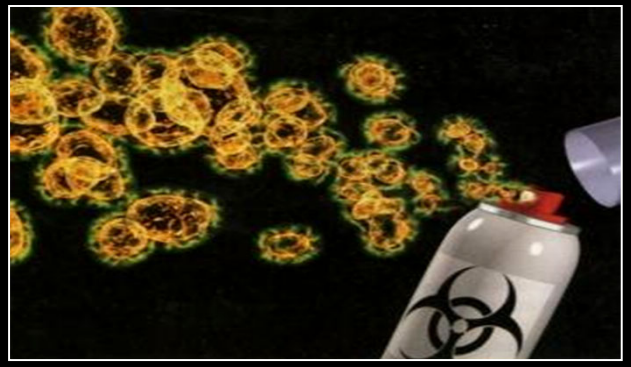
old foes resurgent: Rx – resistance

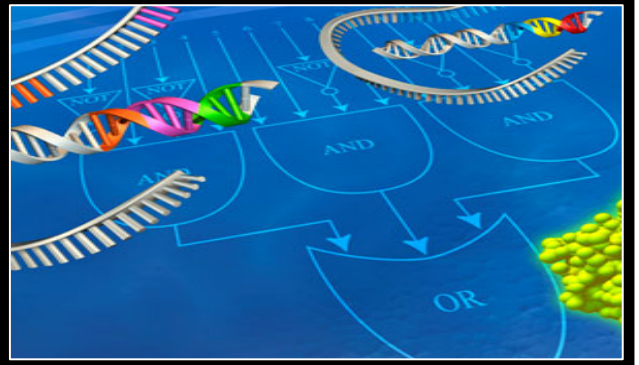


omnipresent pandemic threats

new foes: emerging infectious diseases







climate change and new vector ranges

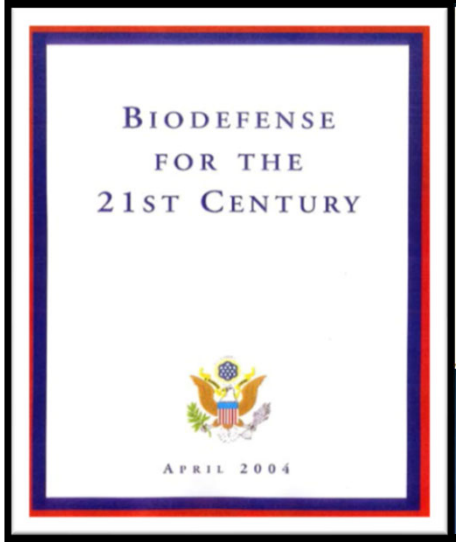
bioterrorism and bioweapons

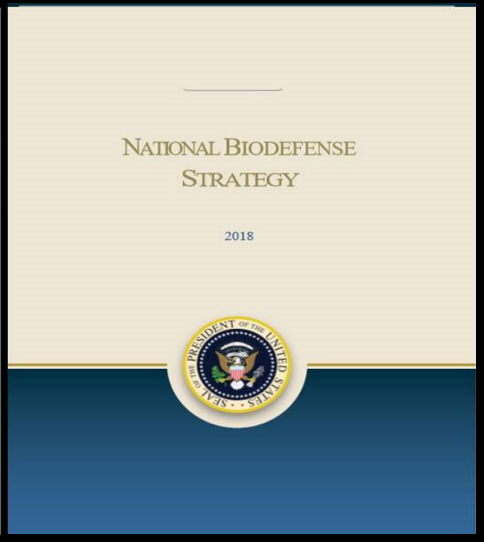
dual-use research of concern

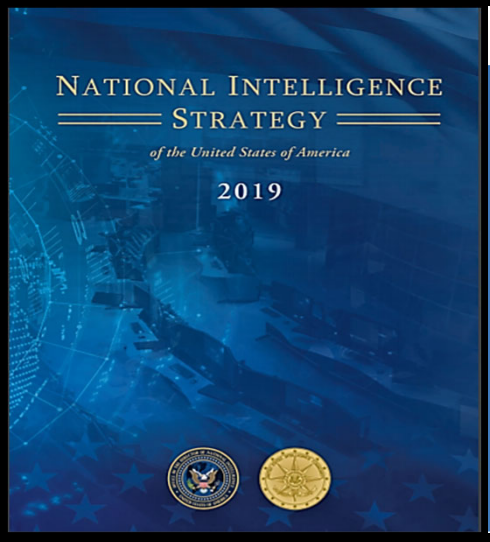
Biosecurity
Shared Features of Natural and Nefarious Threats

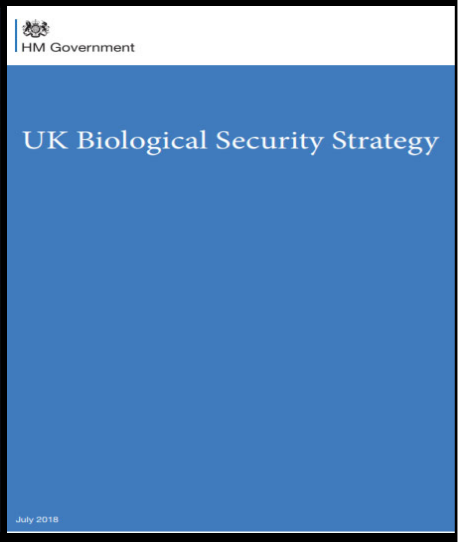
- surprise, stealth, spread and speed
- local events can quickly become global
- 'all hazards' and 'resilience': the foundations of response preparedness and planning
- cross-agency coordination (within government)
- cross-sector inter-dependencies (public, private, NGOs)
- global coordination (public health, diplomacy, media, law enforcement, intelligence communities, military, industry supply chains)

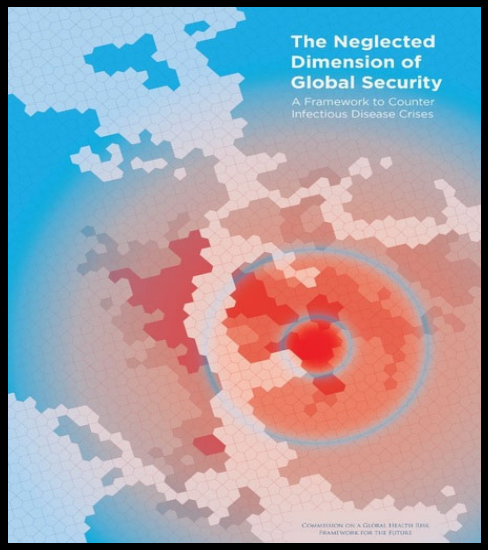
U.S. National Security Policy and Biodefense

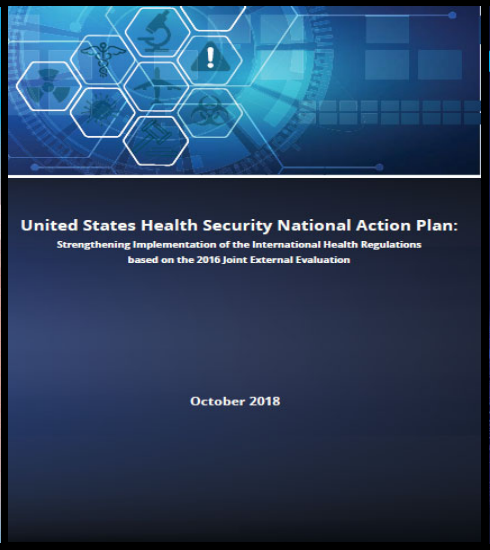


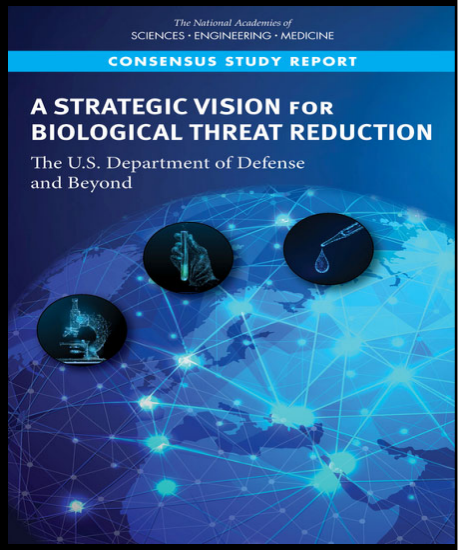












The Biosecurity Threat Spectrum

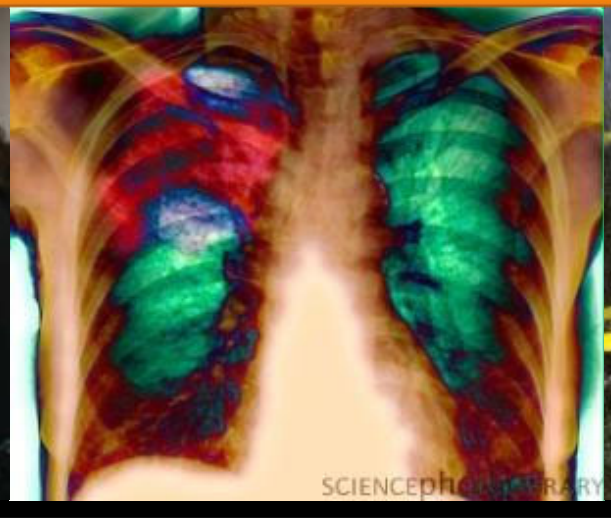
Time	Low Probability: High Consequence	High Probability: High Consequence
today		
• bioterrorism	X	
• natural infectious diseases(pandemic)		X
2030		
• bioterrorism		?
• natural infectious diseases (pandemic)		?
• convergent technologies - synthetic biology - artificial intelligence - robotics/autonomous systems - error/accident		?

Fundamentally Different Threat Categories:

Bombings and Hazmat-Incidents: Immediate Damage Assessment



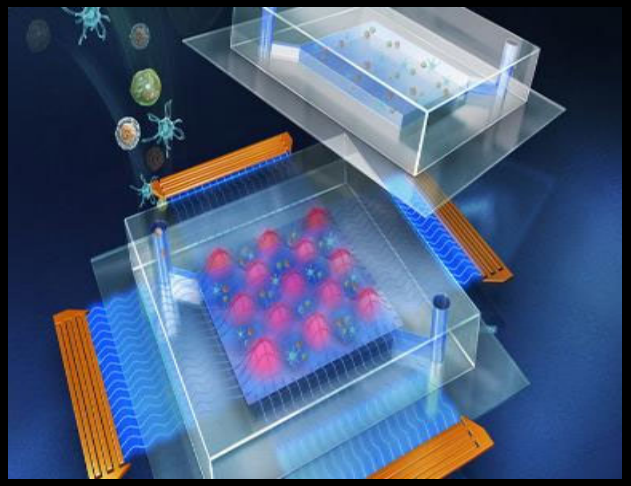
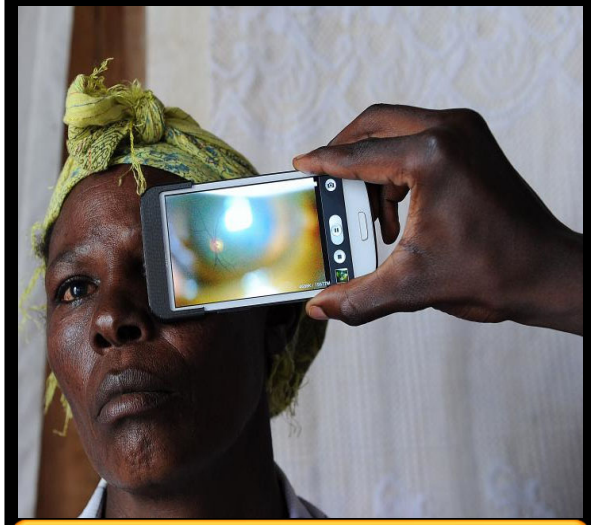
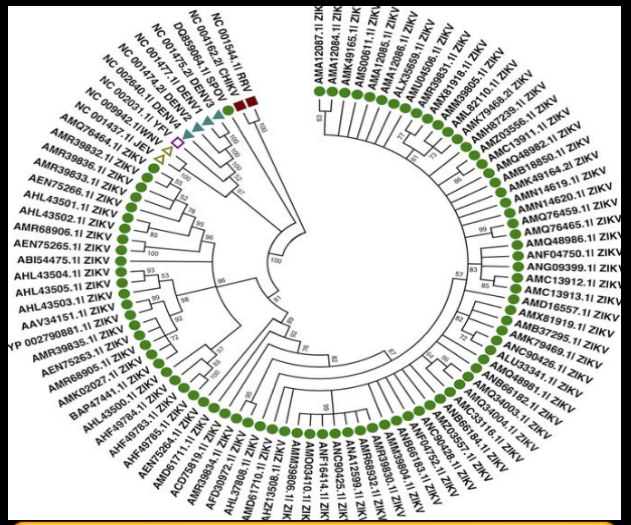
Bioincidents: An Unfolding (Rolling) Event - EDs and Farms Will Be the Front Line

The Evolution of a Bioincident

- detection (speed of alert)
- containment (stamp out at the source)
- spillover (sparks to ignite a fire)
- mitigation (smooth the curve and slow demand on resources)
  - contact tracing
  - slow the spread and ‘reduce the peak’
- maintenance of essential services
- surge capacity logistics and priorities for resource allocations
- reliable information and public trust in actions by authorities

Faster Detection Saves Lives:
The Primacy of Diagnostics in Biosurveillance and Preparedness Mobilization

Profile: signatures of infectious agents	Detect: rapid automated PON/POC diagnostics	Act: real-time situation awareness, decisions
		
		
surveillance sans frontières	genomics of pathogen evolution	dual-use research and engineered biothreats

COVID-19 Pandemic and Major Gaps in US Diagnostic and Containment Capabilities

- first official US death (1/29/20) but virus probably circulating from early December
- WHO Dx test rejected
- failure of alternate Dx test kits (2/4/20)
- no surge capacity for widespread Dx tests and track/trace programs
- tardy reachout to mobilize private sector/academic Dx test resources
- state/local PHS labs underfunded, under-resourced and not operational until 3/8/20

COVID-19 Pandemic and Major Gaps in US Diagnostic and Containment Capabilities

- lack of transparency and IHR reporting (12/19-1/20)
- Wuhan/Hubei lock down (1/23/20) but extensive flights to foreign countries for prior 2 weeks
- new lock down in Shulan (pop 600k; 5/21/20)
- ongoing global disinformation campaign

- reluctance to demand data from PRC (early 1/20)
- praise for PRC “extraordinary measures”
- slow declaration of PHEIC (1/30/20)


THE WEEK
THE BEST OF THE U.S. AND INTERNATIONAL MEDIA
Who's in charge?
The conflicts and confusion in Trump's coronavirus response
APRIL 17, 2020 VOLUME 20 ISSUE 971

Ugly but Predicted Realities

- media sensationalism and social media disinformation
- public confusion, panic, and erosion of trust
- pressure on governments to make illogical but politically expedient decisions
- in a severe outbreak the shock factor from any major level of fatalities will be unprecedented in modern peace times with unpredictable consequences for public responses and societal stability
- unpredictable unilateral decisions by other governments, restricting trade, travel and shipment of goods
- dislocation of supply chains might break down completely – national, international

Notice the Resemblance? Hygiene and Quarantine as the Only Effective Containment Absent Drugs or Vaccines

Bubonic Plague
Physician 15th Century

Ebola, Liberia
21st Century

COVID-19
PRC

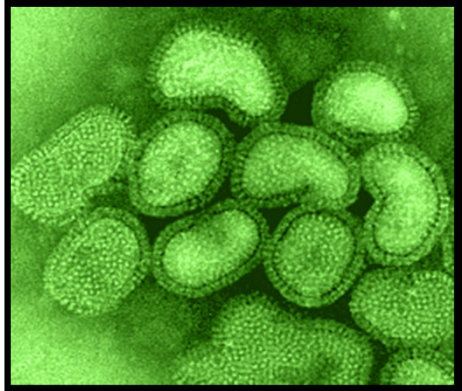
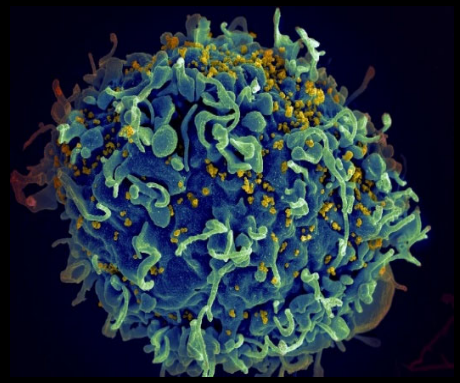
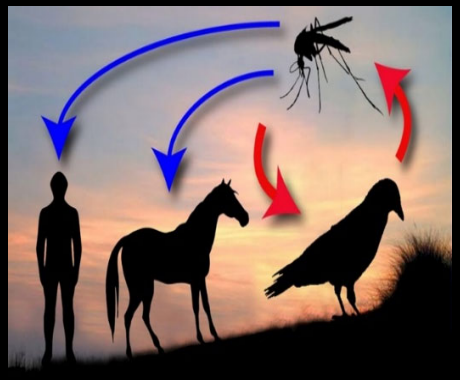
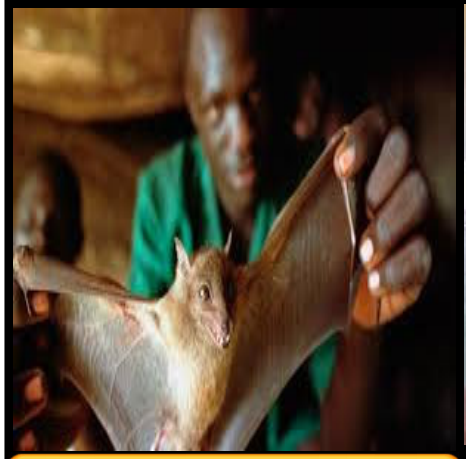
What's Out There?

A Global Inventory of Natural Microbial Threats to Humans and Vital Agriculture/Ecological Resources

The Predominance of Zoonoses as Emerging Infectious Disease Threats: The "One Health" Perspective

Natural Pathogens as Convenient Substrates for Engineering of New Vectors for Bioterrorism and Biowarfare

"One Health"- The Importance of Zoonotic Diseases as Human Health Threats: A Rich Reservoir for EIDs and Genetic Manipulation

pandemic (avian) influenza	HIV	West Nile virus	MERS- CoV
			
			
Ebola virus	bush meat food chain	Zika virus	what's out there?

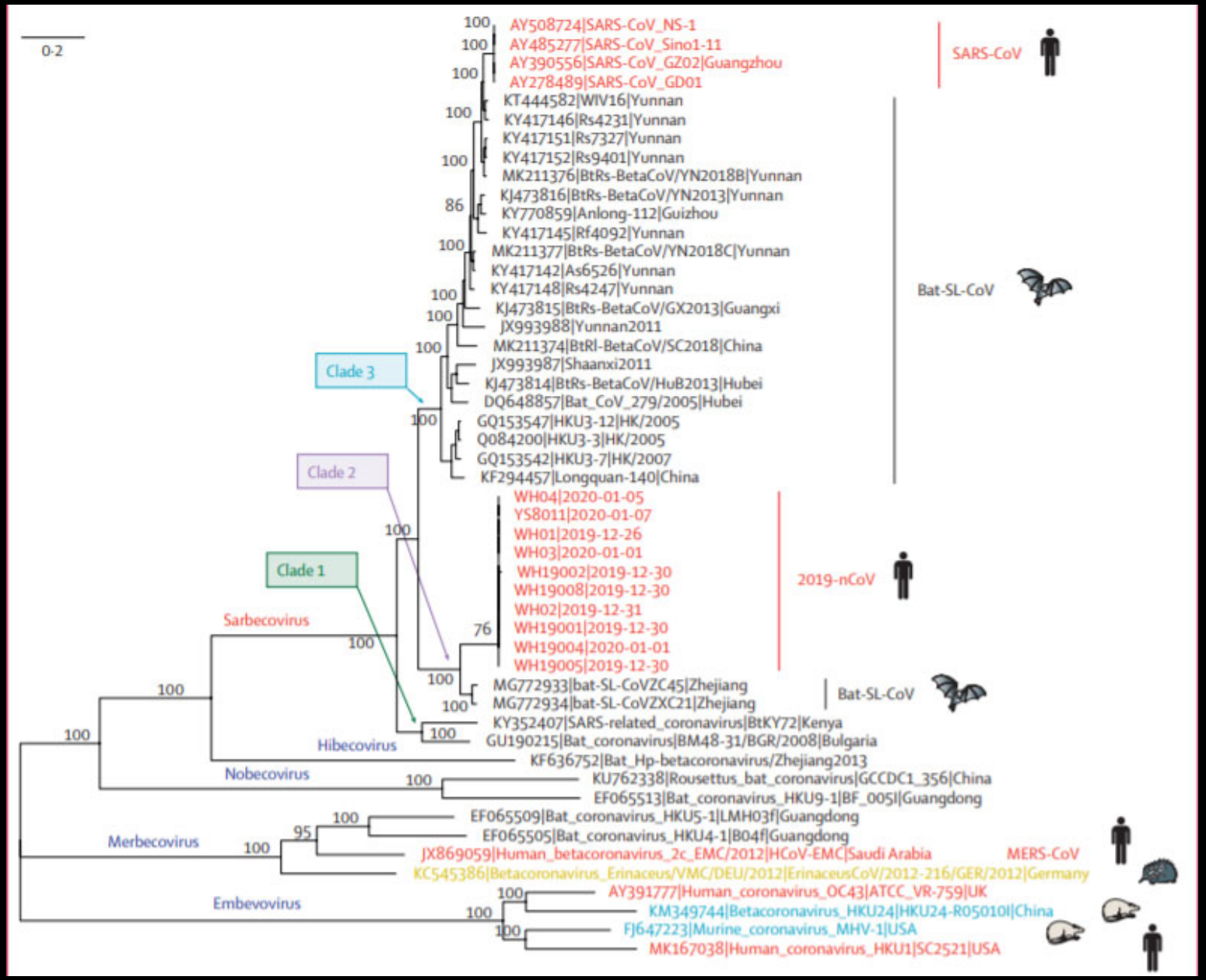
Urbanization and Mega-Cities in Developing Countries and the Increased Threat of Exotic Zoonotic Diseases

High Population Density With Inadequate Biosurveillance

Expanded Eco-niches and New Zoonotic Exposures/Risks

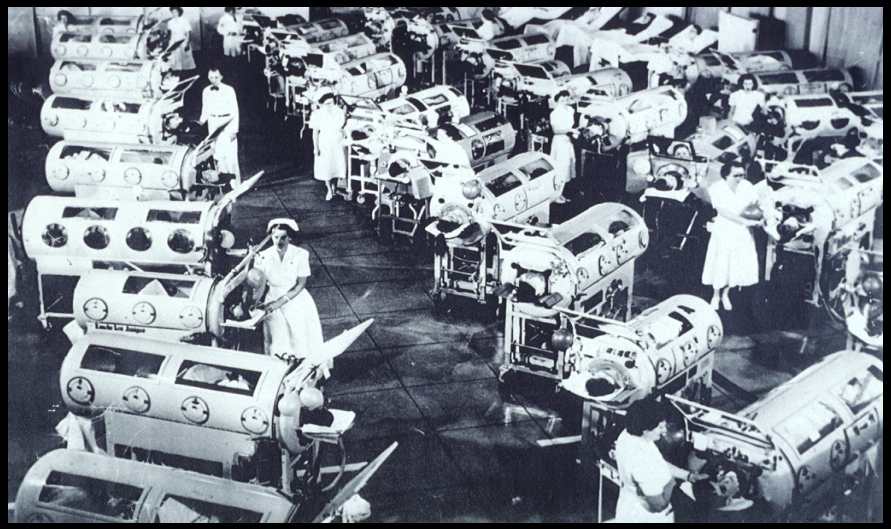
Major Gaps in Health Infrastructure and Disease Reporting

Genomic Analysis of SARS-CoV2 and other Betacoronaviruses



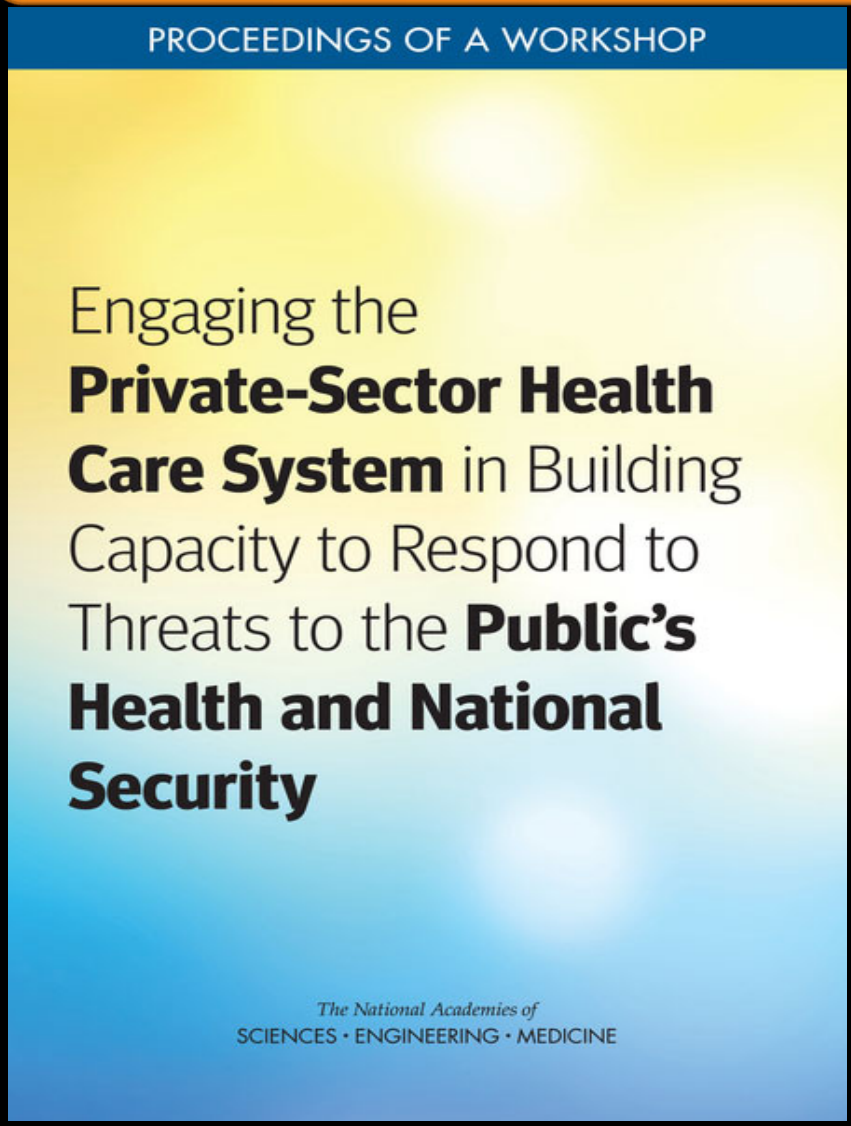
R. Lu et al. (January 29, 2020) Lancet

Comfort and Complacency: The Enemies of Vigilance and Preparedness

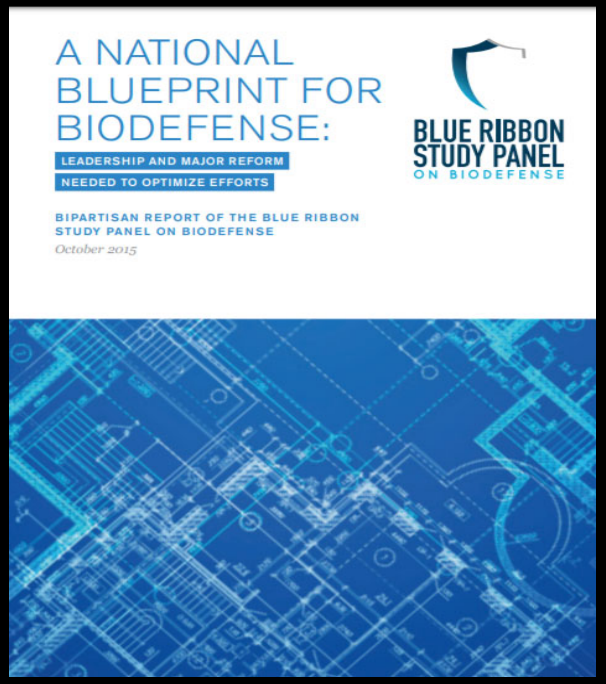


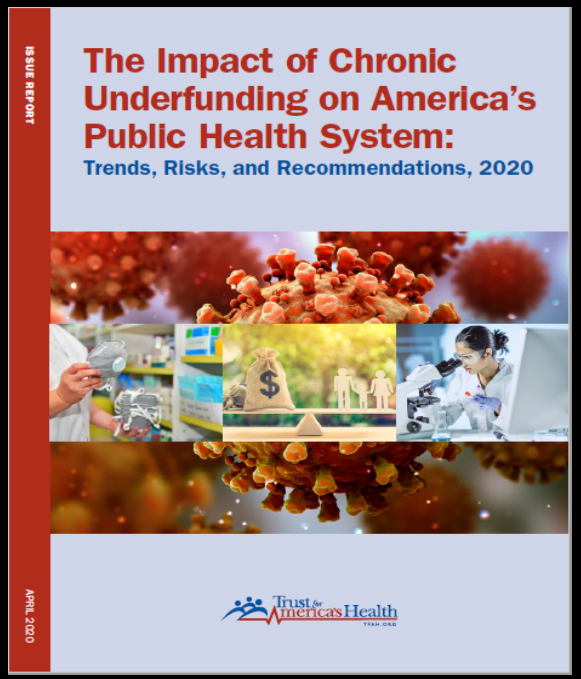
Who Pays for Preparedness?

The Obligate Role of Private-Public Partnerships in Biosecurity Policy

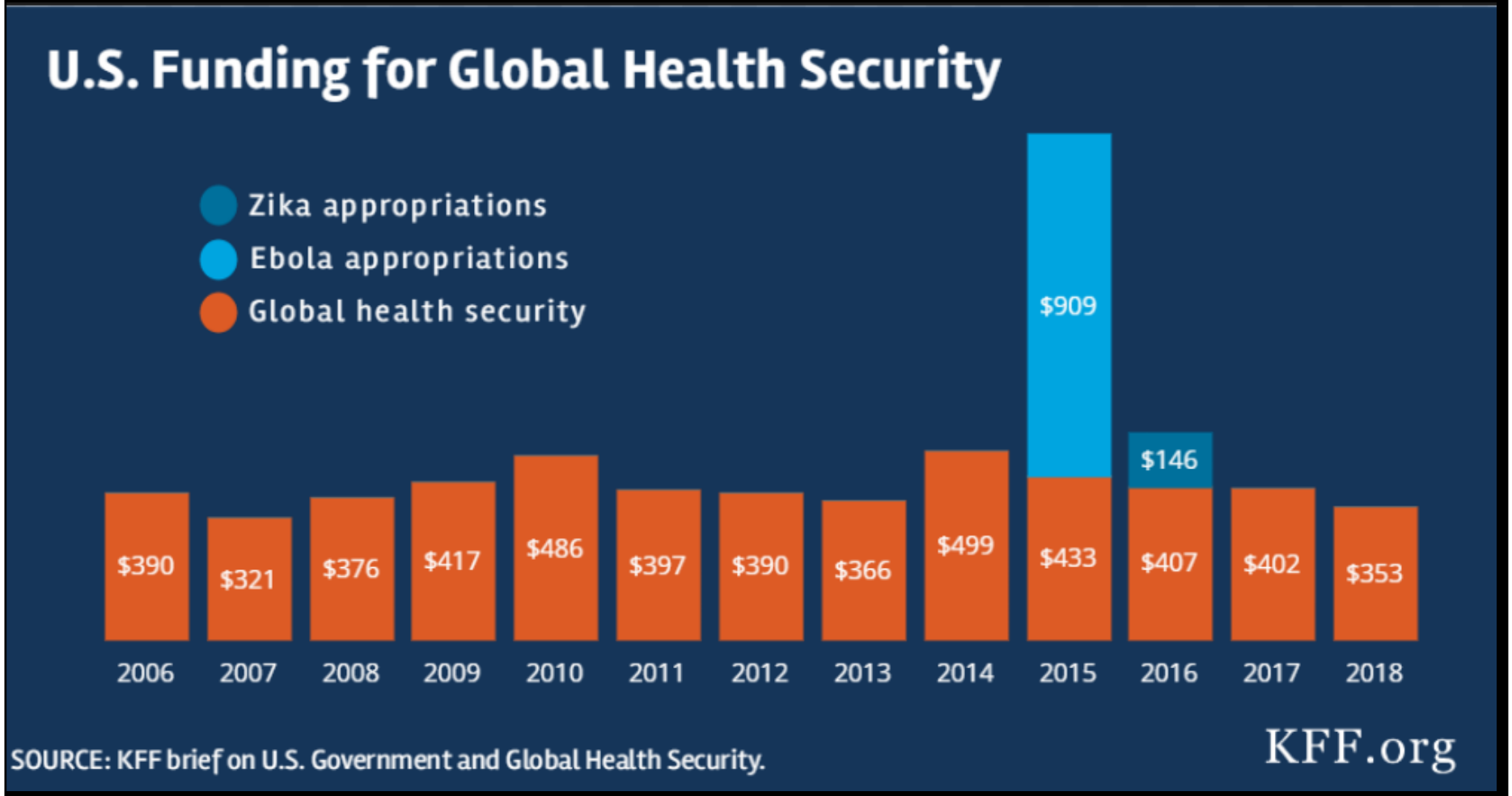


"Fits and Starts: Reactionary Biodefense"





The Endless Cycle:
From Complacency to Crisis and Back to Complacency



The Curse of Contemporary Governance: 'Quick Fixes' and the Retreat from Complexity

- society increasingly "cocooned" from complexity and risk
- pervasive and dangerous scientific illiteracy among legislative and policy makers about biosecurity
- "quick fixes", and unidimensional, short term policies
  - do not address long term, multidimensional complexities
  - predominance of national vs global perspectives

Molecular Diagnostics: The Orphan Technology in Precision Medicine, Public Health and Biosecurity

- most proximal and critical information for real-time situational awareness and decision-making
  - individual care to population health
  - global biosurveillance, threat assessment and preparedness
- market failures and inadequate incentives
  - public sector investment for public health/national security
  - complex multiOmics profiling as intellectual driver of precision medicine and anachronistic reimbursement policies

The Imperative for Proactive Actions for Robust Biosecurity

- need for higher priority of biosecurity in national security strategy and international engagement
- development of more sophisticated threat assessment capabilities
- strengthen and integrate surveillance, analysis deterrence capabilities in national security, IC, and public health
- greater investment in robust threat mitigation capabilities
  - obligate private sector engagement
  - logistics and operational integration (and training) for complex bioincident management
- agile oversight mechanisms and international harmonization

"Plus ça change, plus c'est la même chose"

"Politics is the art of the possible,
the calculated science of survival"

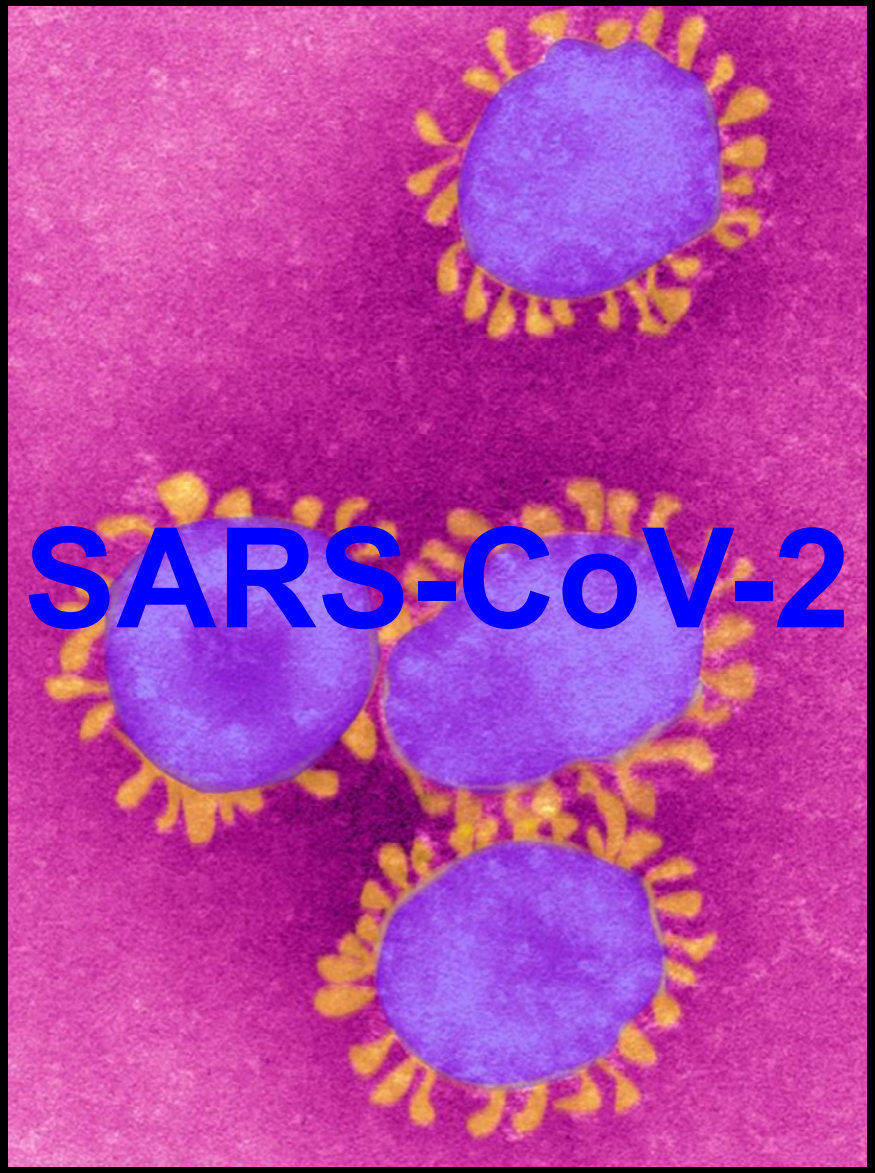
Prince Otto von Bismarck

"Survival owes little to the art of politics,
but everything to the calculated application
of science".

Professor Rudolph Virchow
(in reply)

Slides Available at

https://casi.asu.edu/?q=presentations



Agent-X