A Population Based Management Approach to Pandemics and Other Public Health Crises

WADEM webinar – July 14, 2021

Benjamin J. Ryan Ph.D, MPH
Clinical Associate Professor
Department of Environmental Science
E: benjamin_ryan@baylor.edu

Baylor University

Acknowledgement

Professor (Ret.) Frederick M. Burkle, Jr., MD

- Professor (Ret.) Senior Fellow and Scientist, Harvard Humanitarian Initiative, Harvard University, T.H. Chan School of Public Health, Cambridge, Massachusetts, USA
- Global Scholar, Woodrow Wilson International Center for Scholars, Washington, DC, USA

Presentation based on:

- Burkle, F., Bradt, D., & Ryan, B. (2020). Global Public Health Database Support to Population-Based Management of Pandemics and Global Public Health Crises, Part I: The Concept. Prehospital and Disaster Medicine, 1-36. DOI: https://doi.org/10.1017/S1049023X20001351
- Burkle, F., Bradt, D., Green, J., & Ryan, B. (2020). Global Public Health Database Support to Population-Based Management of Pandemics and Global Public Health Crises, Part II: The Database. Prehospital and Disaster Medicine, 1-15. DOI: https://doi.org/10.1017/S1049023X20001363

Overview

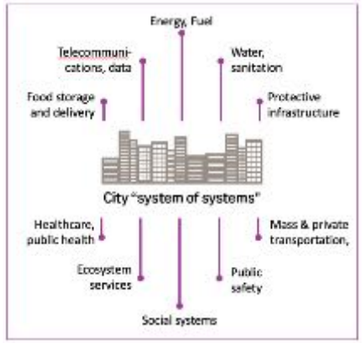
- Key Points
- Public Health Approach to Pandemics and Disasters
- Population Based Management Teams
- The Way Forward

Key points

- Globally everything needs to change and not in a piecemeal fashion!
- What we describe is the framework for global public health which is long overdue!
- The World Health Organization (WHO) under UN mandate needs to be in complete control, totally independent, well funded and staffed
- Newly trained population-based managers (PBMs) are required and need operational homes in CDCs representing every country equally and coordinated by WHO.
- PBMs based at these CDCs will have the responsibility to gather data daily, which will be immediately needed in any population affected crisis
  - Between crises they will use the data base to improve the public health response capacity
- Data is the life bread of pandemic management
  - Required data will be continually gathered and stored in the global public health database
  - Data will be controlled by PBMs assigned at the global CDCs
  - PBMs will be in charge once the pandemic occurs boosted by relationships established with multiple healthcare providers within their area of responsibility

Public Health Approach to Pandemics and Disasters

Systems of systems involved in a pandemic



Energy

Telecommunications

Water and sanitation

Supply chain

News and social media

Social systems

Public Health System

Retail, other economic activity

Public transport

Social systems

Public safety

Business

Food supply

Pandemic response by the public health system is dependent on systems such as these.

Systems such as these may be affected by the public health system's pandemic response.

Bhatia, S, Pruksapong, M, Ryan, B & Williams, P (2020). Resilience of local governments: A multi-sectoral approach to integrate public health and disaster risk management.

Social Determinants of Health

Dahlgren & Whitehead (1991) - https://www.aihw.gov.au/reports/australias-health/australias-health-2016/contents/determinants

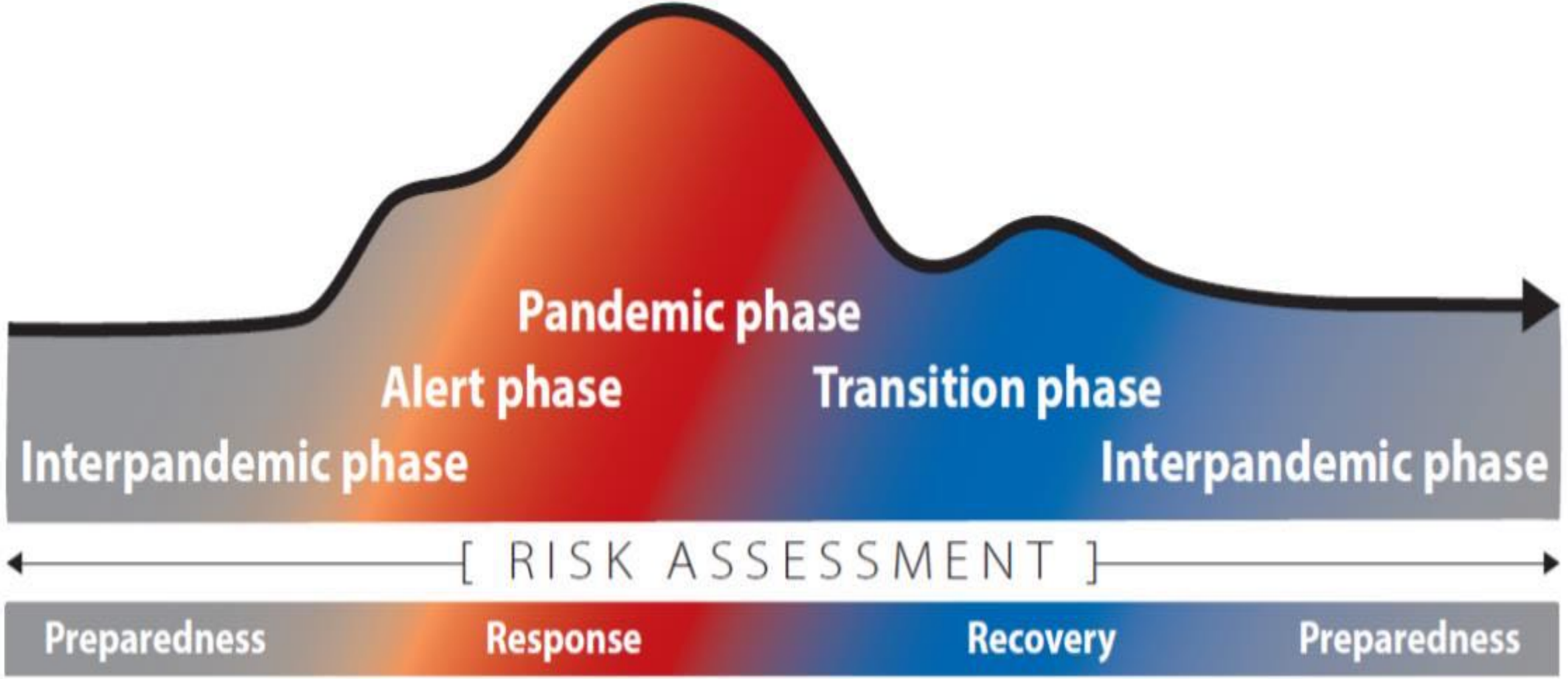
Maslow Hierarchy of Needs and Impact of COVID-19 Lockdown

Goal (Basic Need)	Examples of Requirements	Possible COVID-19 Lockdown Impact on Individuals and Society
1. Physiological needs	Breathing, homeostasis, water, sleep, food, sex, clothing, shelter, mobility	Less mobility, food access issues, and for some people shelter may be affected.
2. Safety needs	Employment, resources, property, health, stability, and security	Increased unemployment, reduced access to resources, and individual stability impacted due to uncertain future. Security issues may increase at household/domestic level.
3. Social needs	Love, affection, family, friends, relationships, and belongingness	Access to family and friends impacted.
4. Esteem needs	Recognition, respect, achievement, self-confident, and self-worth	Self-worth questioned as people become unemployed and have an uncertain future.
5. Self-actualization	Creativity, acceptance of facts, morality, and problem solving	Little to no impact.

Adapted from Ryan (2018).[24]

Ryan B, Coppola D, Canyon D et al (2020). COVID-19 Community Stabilization and Sustainability Framework: An Integration of the Maslow Hierarchy of Needs and Social Determinants of Health. Disaster Med Public Health Prep. 2020 Oct;14(5):623-629.

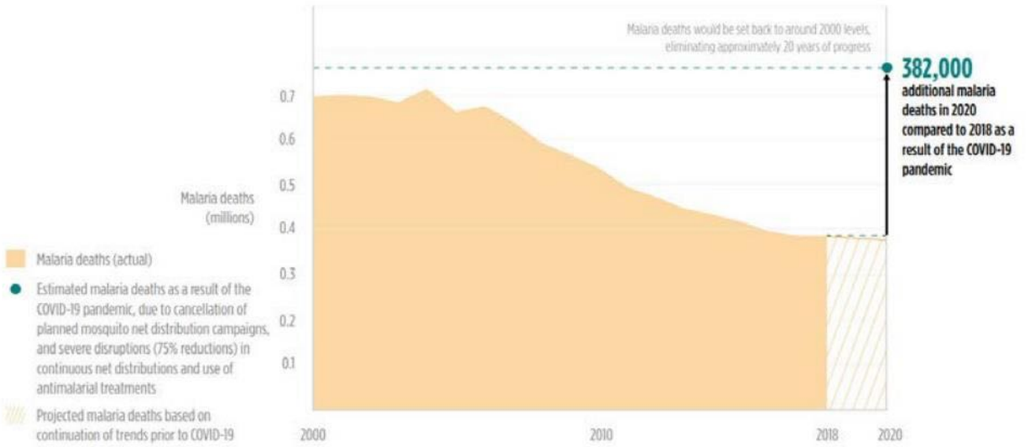
The continuum of global pandemic phases



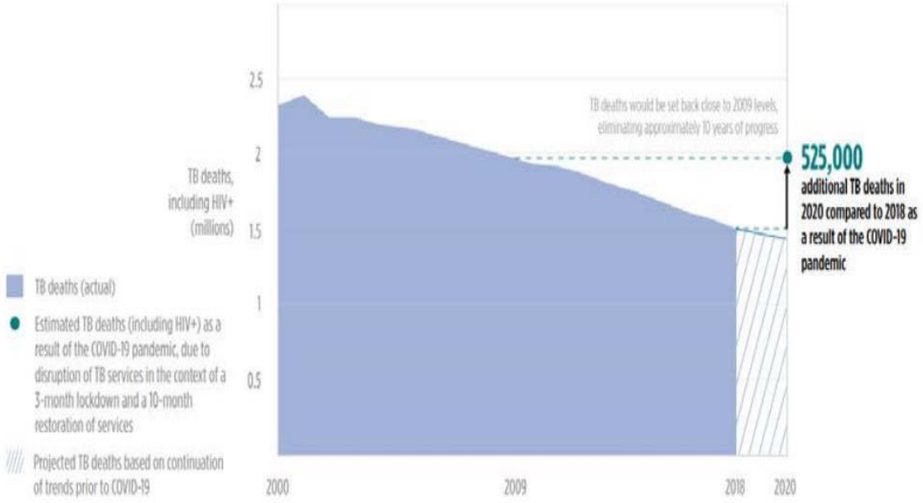
WHO (2017) https://www.who.int/influenza/preparedness/pandemic/PIRM_update_052017.pdf?ua=1

Effects of the COVID-19 Pandemic on HIV, TB and Malaria

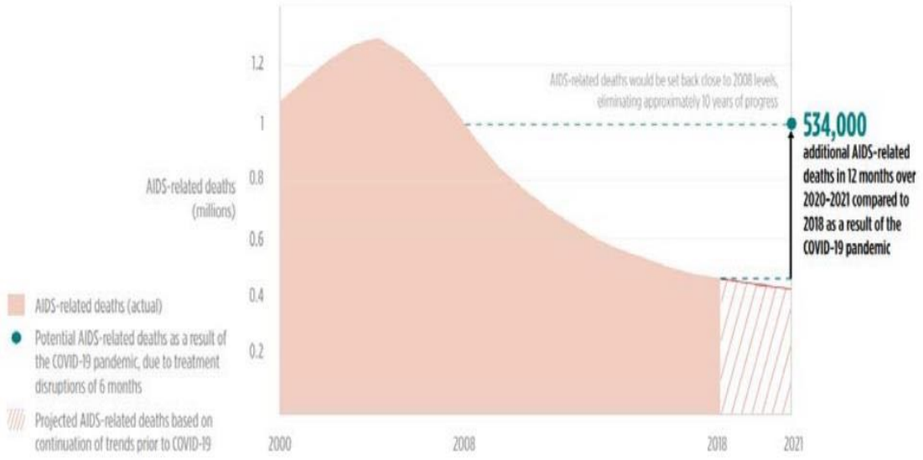
Potential increase in malaria deaths due to malaria service disruption in the context of the COVID-19 pandemic in sub-Saharan Africa



Potential increase in TB deaths due to TB service disruption in the context of the COVID-19 pandemic globally[4]



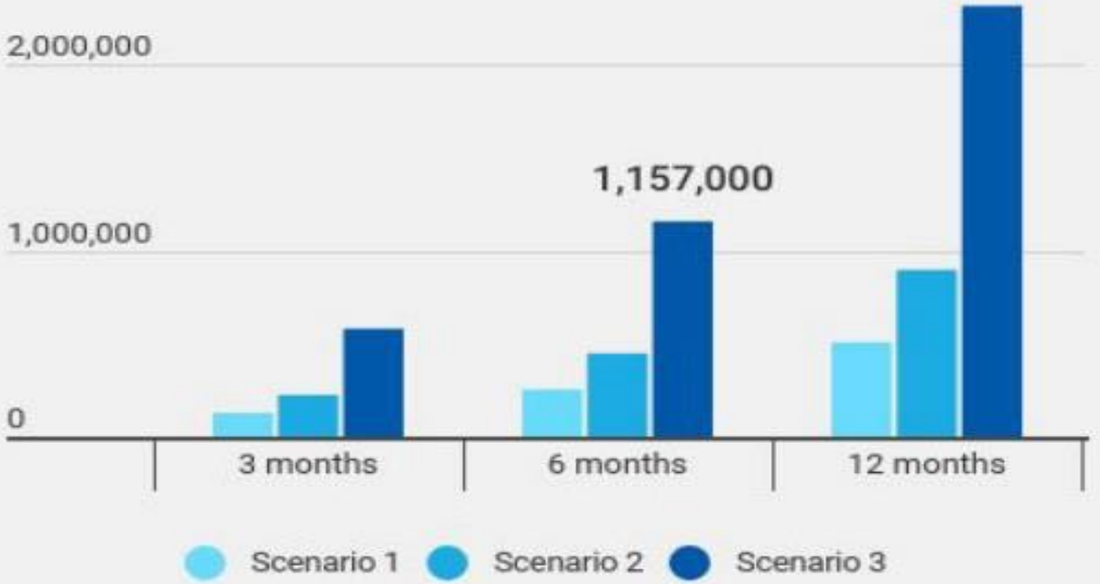
Potential increase in AIDS-related deaths due to HIV treatment disruption in the context of the COVID-19 pandemic in sub-Saharan Africa



Global Preparedness Monitoring Board (2020) https://apps.who.int/gpmb/annual_report.html

An additional **1.2 million children** and **56,700 mothers** could die in 6 months due to disruption in basic interventions, based on the worst-case scenario

Additional projected **under-5 deaths**, 118 low- and middle-income countries

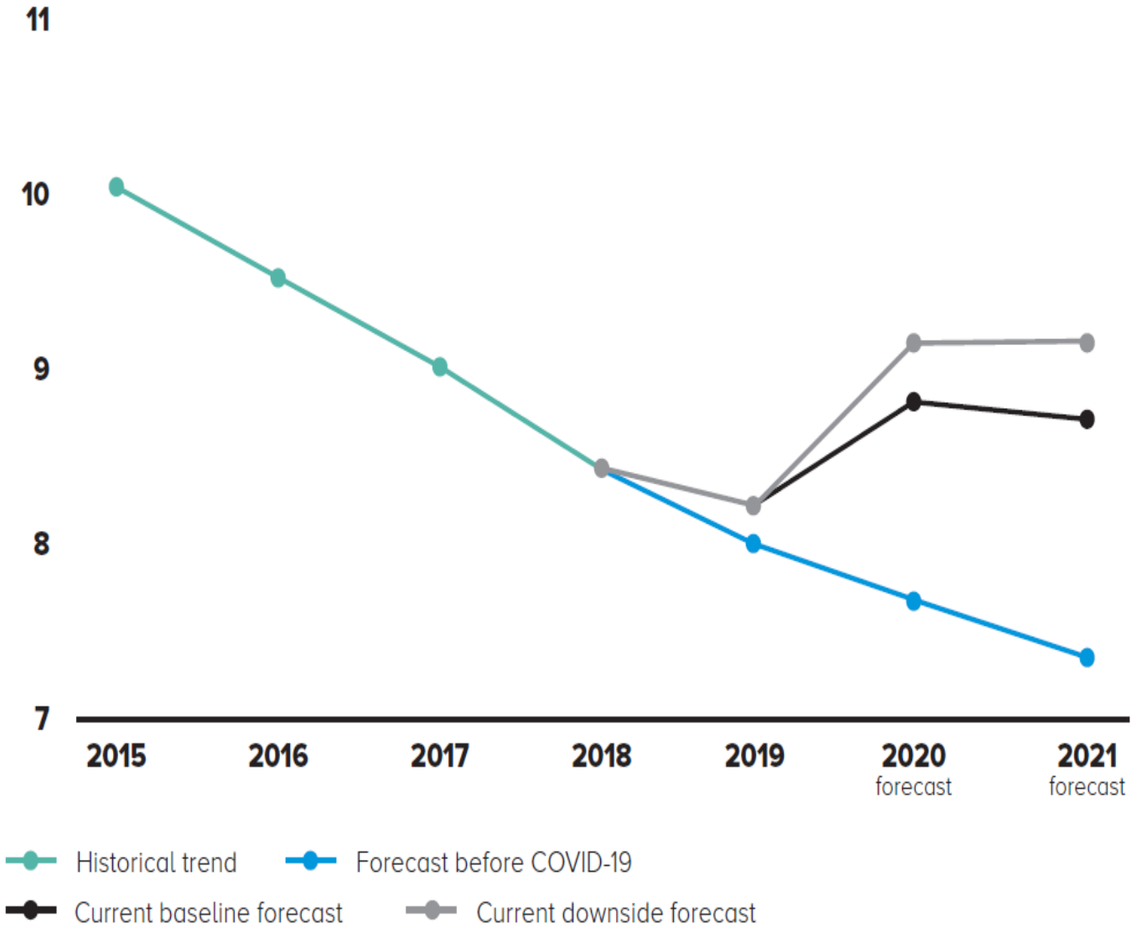


Additional projected **maternal deaths**, 118 low- and middle-income countries

Source: Roberton et al. 2020. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. The Lancet Global Health..

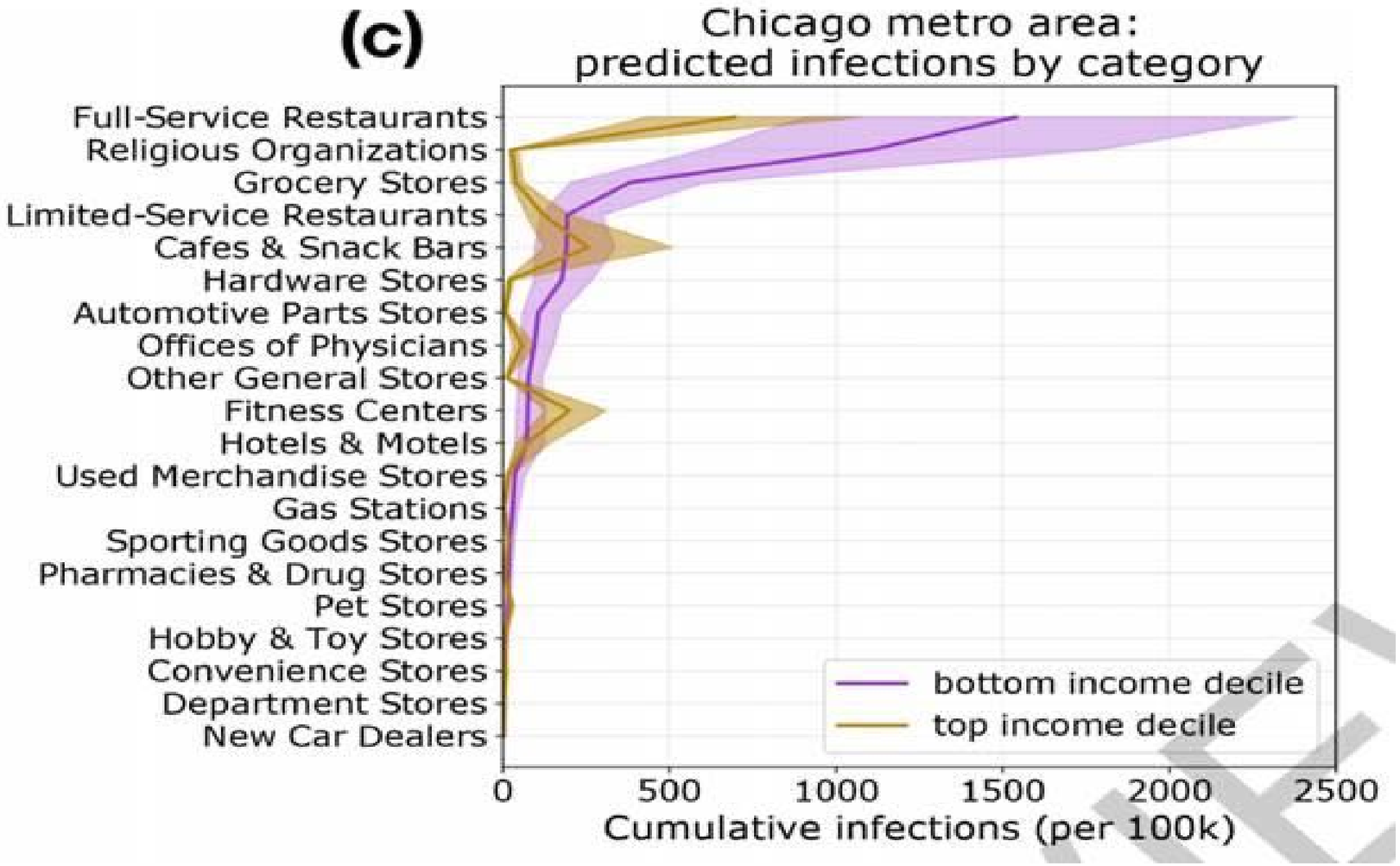
Flow-on impacts of the COVID-19 Pandemic

- May push close to 100 million more people into extreme poverty in 2020.
- Border restrictions and lockdowns slowed agricultural production and increased food insecurity worldwide.
- The World Bank estimates a US$10 trillion earning loss over time for the younger generation as a result of school closures and a global recession.
- It would take 500 years to spend as much on investing in preparedness as the world is losing due to COVID-19.



Proportion of people living below $1.90 a day, 2015-2019 nowcast, and forecast before and after COVID-19 (percentage) – Source: United Nations Statistics Division[4]

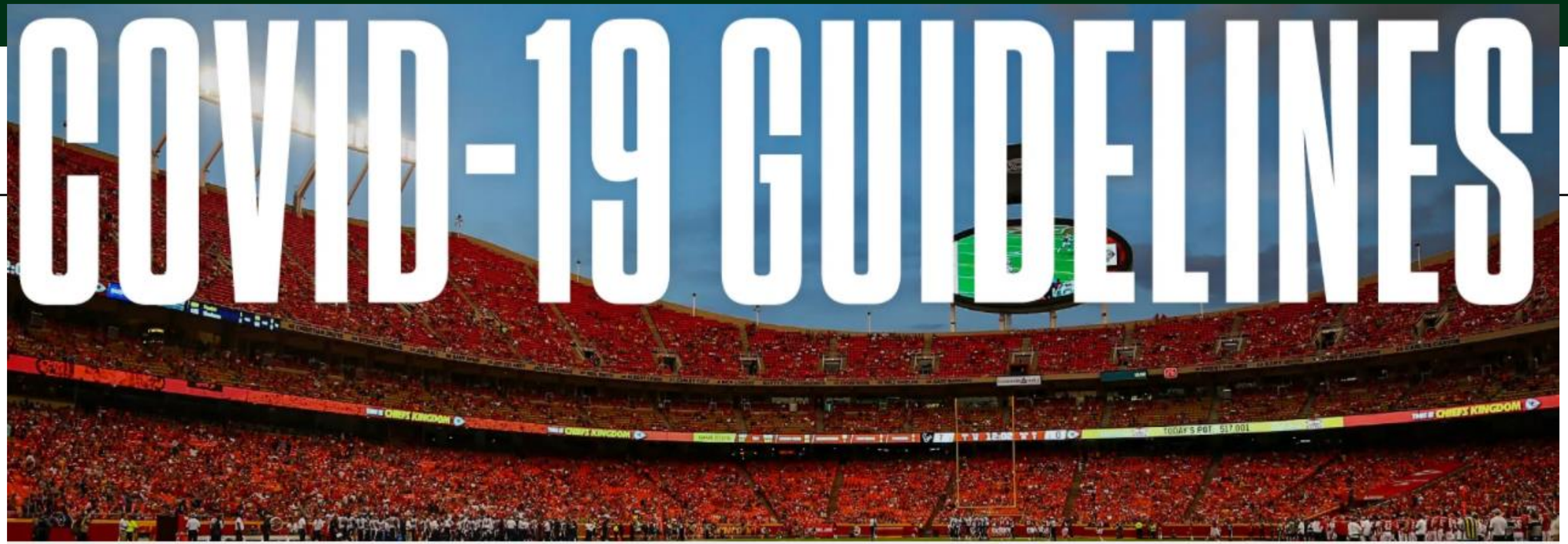
Global Preparedness Monitoring Board (2020) https://apps.who.int/gpmb/annual_report.html



- 20% maximum occupancy in the Chicago metro area cut down predicted new infections by more than 80% (with 42% of overall visits lost).
- 10% of places people visited accounted for 85% of the predicted infections.

Chang, S., Pierson, E., Koh, P. W., Gerardin, J., Redbird, B., Grusky, D., & Leskovec, J. (2020). Mobility network models of COVID-19 explain inequities and inform reopening. *Nature*, 1-8.

COVID-19 GUIDELINES



In response to the COVID-19 pandemic, our commitment remains to prioritize the safety of our fans, staff and players. Below you will find some of the notable steps being taken to support that effort. Under the guidelines of the National Football League, and with the approval of Kansas City Mayor Quinton Lucas, City of Kansas City Health Director Dr. Rex Archer and City of Kansas City EMS Medical Director Dr. Erica Carney, plans have been finalized for a reduced capacity including important health and safety protocols outlined in consultation with The University of Kansas Health System for fans who will attend games at Arrowhead Stadium.

Stay tuned to Chiefs.com for further updates to these guidelines.

SAFETY IS A TEAM SPORT!

Population Based Management Teams

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Population based management teams

- Interdisciplinary and multi-disciplinary teams
- Led by public health, the teams would include experts from critical care, infectious disease, epidemiology, environmental health, biostatistics, clinical medicine, nursing and pharmacy
- The team would be assisted by multidisciplinary expertise in anthropology, sociology, the law, industry, and technology
  - Reflecting the reality of current field demands and the society served
  - Health crisis management requirements would define the working relationships and the uncomfortable but real decision making.
- This approach recognizes no one authority or organization possesses all the resources and expertise required to mitigate pandemic risks
  - The rapid 2020 spread of COVID-19 led to singularly independent decision-making efforts of nations and jurisdictions within nations.

Global Public Health System and Population Based Management Teams

WORLD HEALTH ORGANIZATION
INTERNATIONAL HEALTH TREATY

WHO Regional Organizations

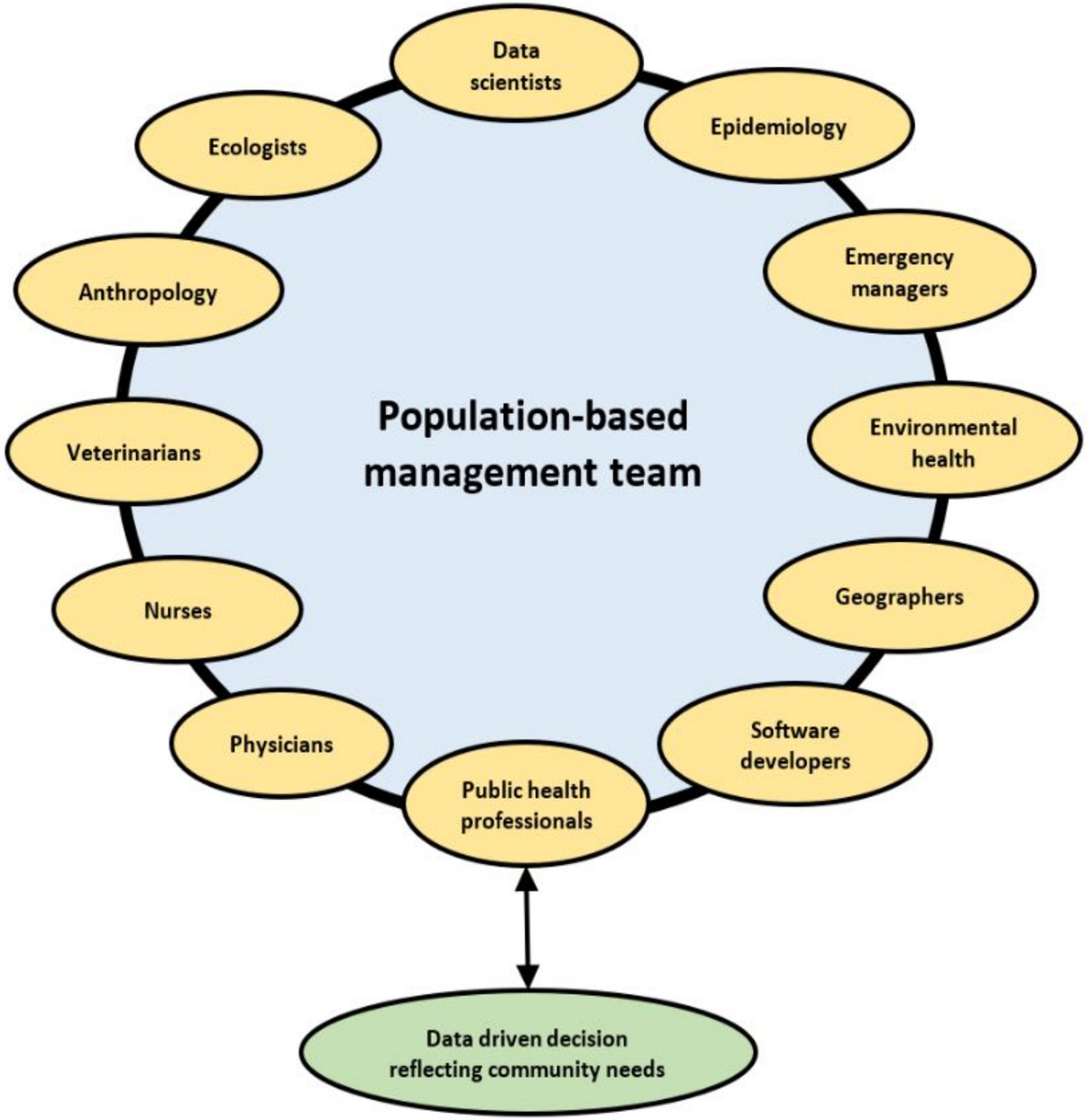
CENTERS FOR DISEASE CONTROL & PREVENTION

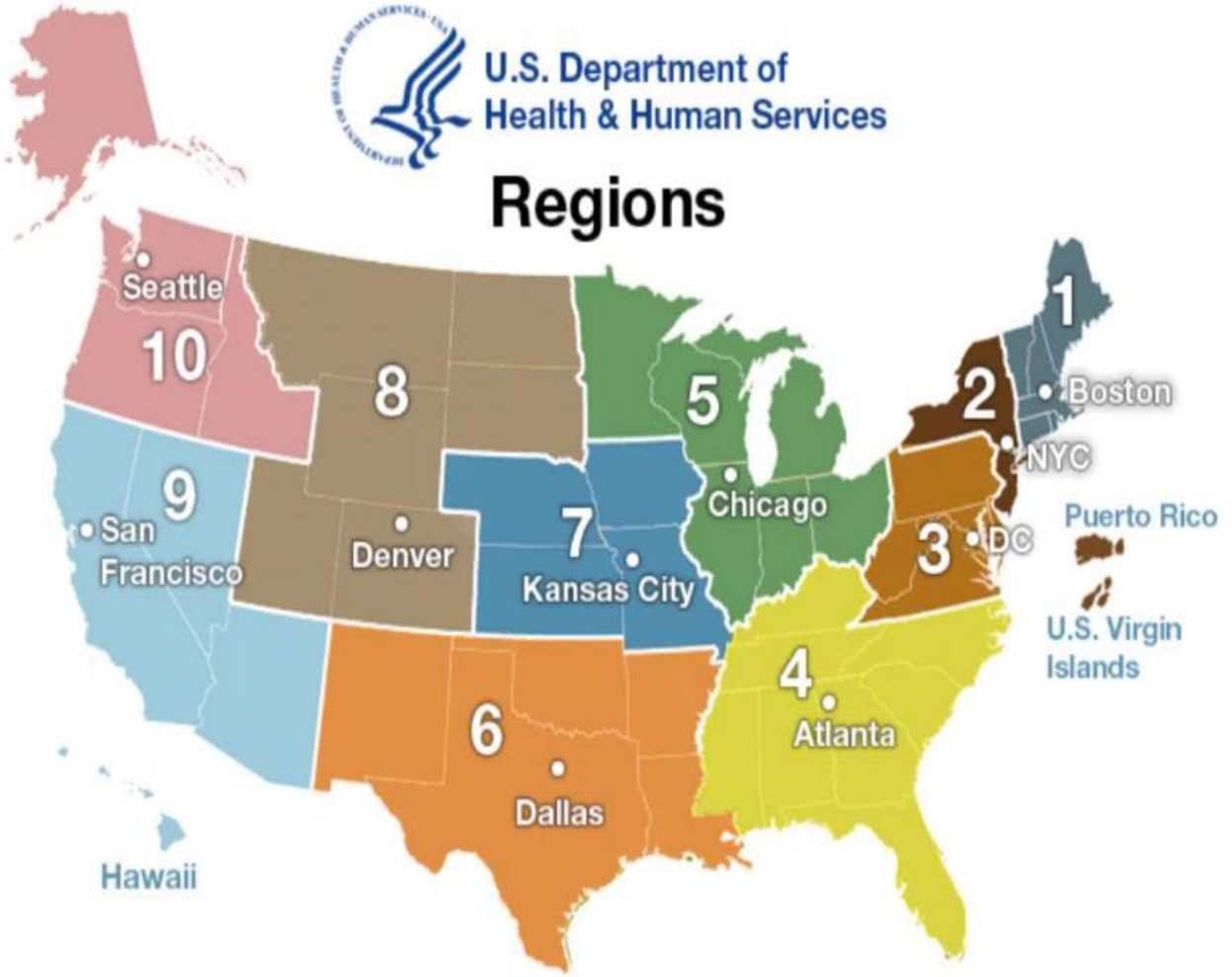
- ONE Per Nation, or
- ONE Per Region of Smaller Nations

POPULATION-BASED MANAGEMENT TEAMS

- ONE Per Country or Region
- In the United States One for Each of the 10 HHS/CDC Regions
- Multiple PBMTs Per Discretion of the Individual Country

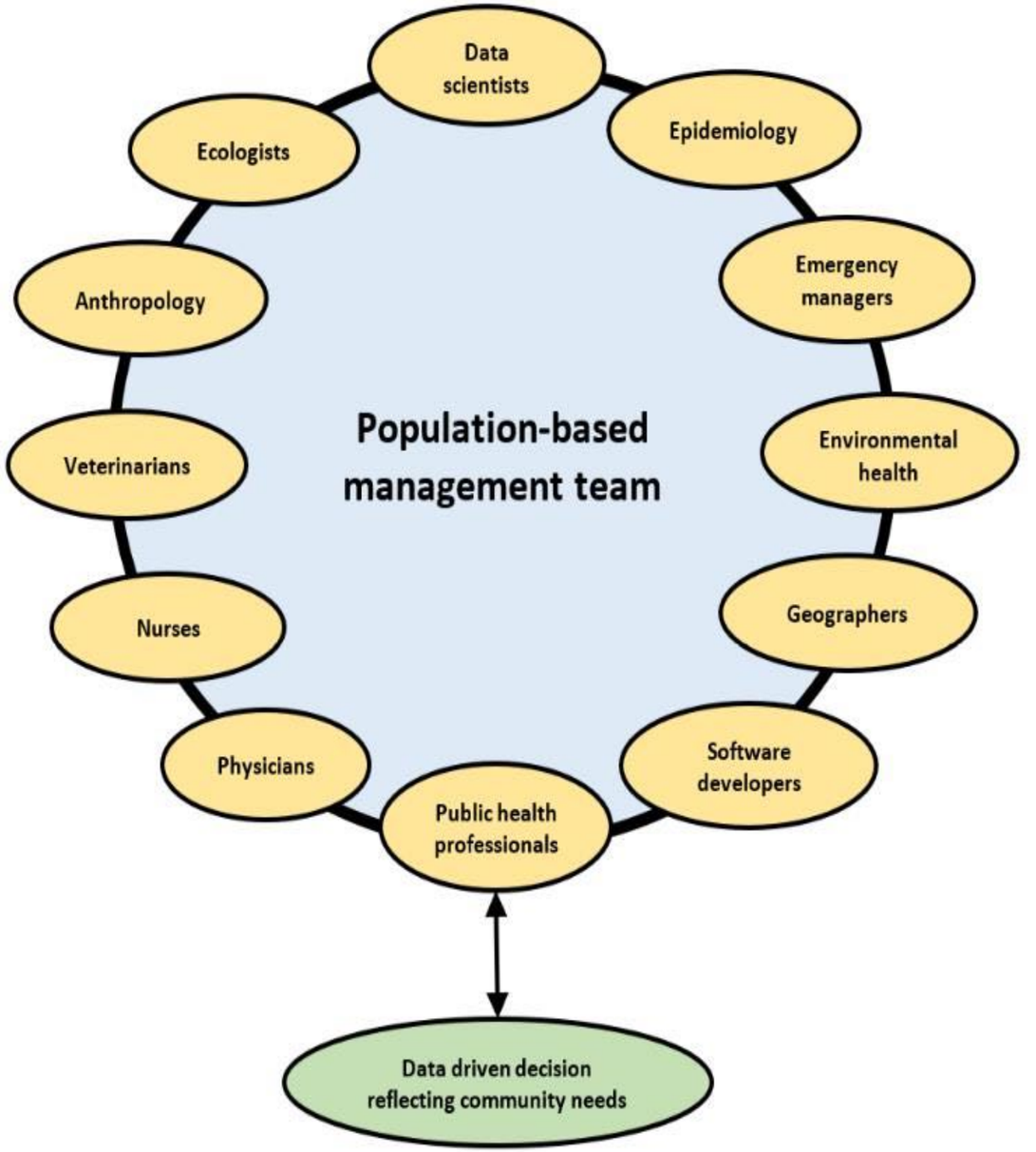
GLOBAL–PUBLIC–HEALTH–DATABASE





- Concept in practice –

Each US HHS/CDC Regional Office sponsors and supports a population-based management team



Operational Imperatives

- All pandemics share the following:
  - All individuals either have the disease or are susceptible
  - All require shared health care needs
  - All require some intervention
  - Pandemics may require sustained PH operational response lasting 12-24 months
- The cornerstones of PBM are working models in three major technical domains of pandemics:
  - How the virus spreads (e.g., incubation period, reproduction ratio, mitigation measure effectiveness)
  - Resource-management and decisional models providing epidemic data and resource availability (e.g., capture management awareness of available resources and thresholds)
  - Compartment model used to compute the infected population and the number of casualties of the pandemic

Core Databases

- Background Information
  - Describes the affected population pre-pandemic—demography, access to essential services, health status, and socioeconomic status
- Clinical Case and Virological Data
  - Encompasses case definitions, case identification and outcomes, and clinical dynamics (case-fatality rates, death rates, and time course to death)
- Public health control measures and consequences
  - Details of contact tracing, quarantine measures, travel restrictions, and all epidemic modelling

Data set pre-pandemic

A. **Population at Risk**

			M	F	Total
1.	Census				
	a.	< 1			
	b.	1-4			
	c.	5-14			
	d.	15-44			
	e.	≥ 45			
	f.	total			
2.	Demography				
	a.	race, ethnicity, religion			
	b.	languages			
	c.	socioeconomic status			
	d.	urban vs rural			
	e.	average family/household size			

B. **Settlements**

1. Locations
   a. community size, geographic separation
   b. access to transportation hubs and communication links
2. Population Mobility
   a. diurnal and seasonal occupational travel flows
   b. recreational and tourist travel flows
   c. migration flows
3. Community Density
   a. geographic separation of families within the settlement
4. Hazard Exposure (eg upcoming seasonal natural hazards)
5. Discrimination and Conflict within the Community
6. Emergency Preparedness
7. Known Coping Mechanisms

C. **Access to Essential Services**

1.	Public Utilities (infrastructure)			
	a.	% population with access to improved water		
	b.	% population with access to improved, unshared sanitation		
	c.	% population with electricity		
	d.	% population with cell phones		
2.	Health Services			
	a.	skilled health care workers (all)/10,000 p	(22)	
	b.	physicians/10,000 p		(0.2)
	c.	nurses/10,000 p	(1)	
	d.	midwives/10,000 p		(1)
	e.	community health workers/10,000 p		(10)
	f.	% population with provider coverage		(100%)
	g.	consultations/p/yr		(1)
	h.	immunization rates—measles vac in 1 y/o	(90%)	
	i.	hospital beds/10,000 p	(10 - 120)	
	j.	admissions/10,000 p		
3.	Underserved Areas (by location and type of service)			

D. **Health Status**

1.	Mortality and Oher Rates		
	a.	CBR	(10 – 50)
	b.	CMR	(5 - 25)
	c.	AGR	(%)
	d.	IMR	(3 - 200)
	e.	U5MR	(3 - 300)
	f.	MMR	(5 - 2,100)

2. Nutritional Status
   a. % infants with low birth weight (LBW) (7% with < 2.5 kg)
   b. % U5 with growth faltering (30%)
   c. % with micronutrient deficiencies (vitamins A-D; Fe, I)
3. Endemic Diseases and Comorbidities
   a. Chronic Illnesses and Conditions
      (1) hypertension
      (2) diabetes
      (3) obesity
      (4) disability
   b. Infectious Diseases
      (1) HIV prevalence
      (2) TB prevalence
   c. Other Major Diseases
4. Routine/Baseline Disease Surveillance Data
   a. Baseline infectious incidence rates
   b. Baseline hospital admission rates
   c. Baseline death rates ratios
5. Health Beliefs and Traditions
6. Sources of Care
   a. Health infrastructure
7. Referral System

E. **Macroeconomic Status**

1. Labor force occupations
2. Unemployment rate
3. GNI per capita ($US) ($700 - $70,000)
4. Inflation rate
5. % population in extreme poverty (< $1.90/d income)
6. Current health expenditures per capita ($30 – 10,000)

F. **Educational Status**

1. Adult literacy rate
2. Female literacy rate
3. Adolescent literacy rate

Clinical Case and Virological Data

Clinical and Virological Data:

A. **Clinical Data**

1. Case Definitions (suspected, probable, confirmed)
2. Severe Cases (admissions, ICU cases, ventilated cases)
   a. Age/gender/race data
   b. Comorbidities
   c. Clinical course, complications, and outcomes
   d. Data on use of antivirals, antibodies, and vaccines
   e. Discharge diagnoses
   f. Causes of death
3. Clinical Dynamics—population morbidity and mortality rates, age & gender-specific CFRs, time course to death
4. Hotspot Definitions—cases linked temporally or geographically triggering further outbreak investigation and/or control measures

B. **Virological Data**

1. Sentinel Site Testing
2. Confirmatory testing for new cases in the community meeting the surveillance definition (before sustained community transmission is identified)
   a. daily new positive cases
   b. 14 day running average
3. Confirmatory testing for hospital admissions and unexplained deaths that are compatible with the disease
4. Community seroprevalence testing once community transmission is established
5. On-demand individual testing (depending on resource availability, may be targeted at vulnerable groups)
6. Antiviral Sensitivity Testing

Modelling, Control Measures, and Impact

Modelling, Control Measures, and Impact:

A. **Epidemic Modelling Data**

1. Population sizes and subgroups at risk
2. Compartment models
3. Spot maps (geolocated plots of disease outbreaks)
4. Kinetics models of transmission dynamics—incubation period, reproduction ratio, contacts per case
5. Epidemic curves
6. Epidemic projections showing impact of non-pharmaceutical mitigation measures

B. **Public Health Control Measures**

1. Travel restrictions
2. Arrival testing
3. Contact tracing effectiveness
4. Quarantine requirements (site specification, duration, monitoring), social acceptance of quarantine measures, overall adequacy of quarantine
5. Social distancing recommendations
6. Mask recommendations
7. Restrictions on social gatherings
8. Lockdown onset, duration
9. Population sizes & community densities of populations affected

C. **Socio-Economic Impact Data**

1. Displacements
2. Unemployment rates
3. Evictions
4. Business closures
5. Direct costs in health care
6. Indirect costs of business losses
7. Government expenditures for unemployed persons and distressed businesses

Available digital technologies

Function	Technology	Early Adopters
Infection Screening	Digital thermometers, infrared thermal cameras, web-based tools	China, Iceland, Singapore, Taiwan
Contact Tracing	GPS, mobile phone apps, facial recognition technology	China, Germany, Singapore, South Korea
Quarantine and Isolation	GPS, mobile phone apps, surveillance of mobile devices for voluntary or involuntary tracking	China, Iceland, South Korea, Taiwan, Australia
Clinical Management	Lab test pooling, telemedicine, video-conferencing, AI algorithms for clinical outcome prediction	Australia, Canada, China, USA
Medical Logistics	Mobile apps for transactions, barcode scanners for commodities, robotics, and drones for delivery	US, China
Epidemic/Pandemic Tracking	Data dashboards, real-time data transmitted by smartphones and PDAs	China, Singapore, Sweden, USA

Local Case Study

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Case study – Baylor University
Waco, Texas, United States

- Baylor University, chartered in 1845 in Waco, Texas, United States
- Approximately 17,000 students who live on campus and in the community
- Baylor University is considered one of the major employers in the city of Waco and McLennan County
- In March 2020, there was recognition the university needed to find a way to safely reopen for the Fall 2020 semester
- This was to help students, staff, faculty, contractors and the Waco community navigate the challenges presented by COVID-19
- Established multidisciplinary teams
- This population-based team approach allowed small clusters to be rapidly addressed through testing, surveillance, tracing, isolation, and quarantine.
  - Supported by health protocols including face coverings, social distancing, and compliance monitoring
- As a result, in-person operations have been sustained from 1 August, 2020.

Population based approach at Baylor

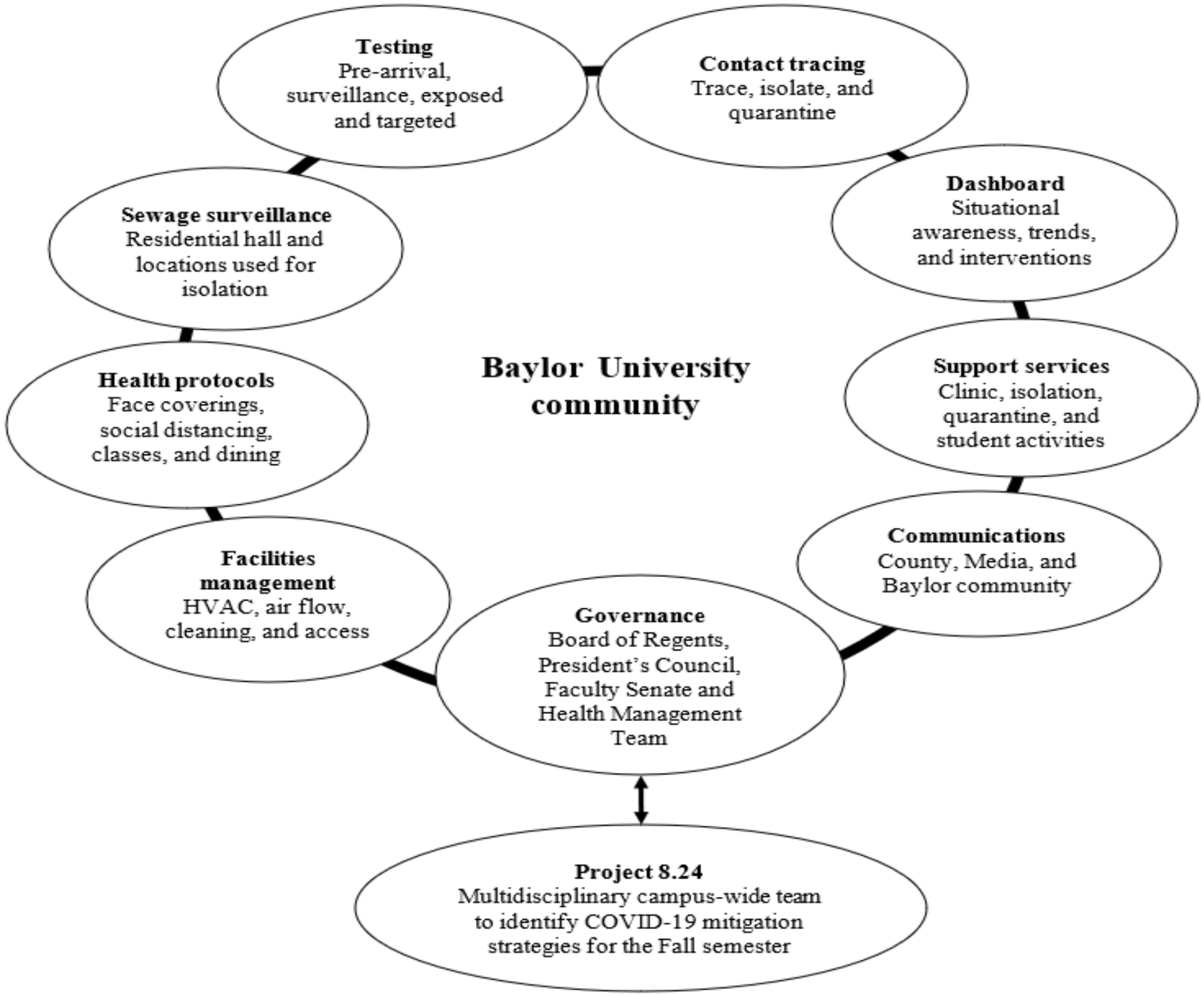


Figure 1 – Multisectoral systems approach to sustaining operations

Ryan, Muehlenbein, et al (2021).

Baylor University COVID-19 Dashboard

CURRENT STATUS

Currently Active Cases: 7

Isolation Beds Available: 100.0%

Last 7 Days

Cases: 5

Tests: 203

Positivity: 2.5 %

Since 08/01/2020

Cases: 1,733

Estimated Recoveries: 1,726

Tests: 65,225

Positivity: 2.7 %

Community Rate of Transmission

McLennan County R(t): 0.96

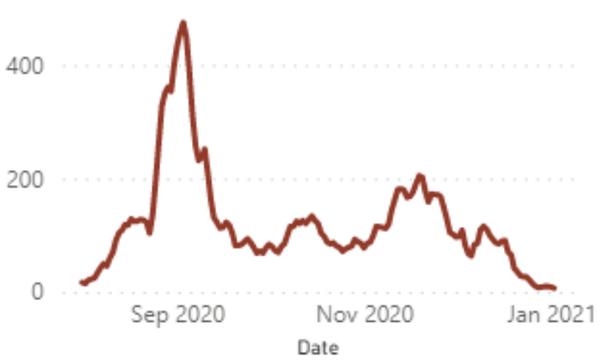
Texas R(t): 1.17

Select Semester for Charts: All

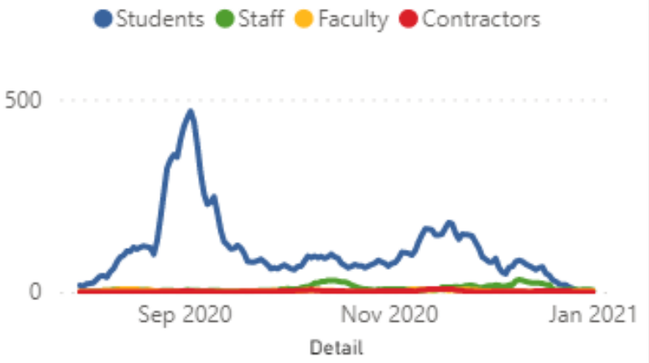
Useful Links

Data Definitions

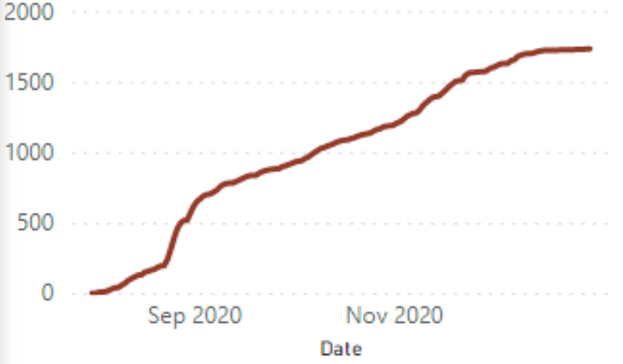
Total Active Cases



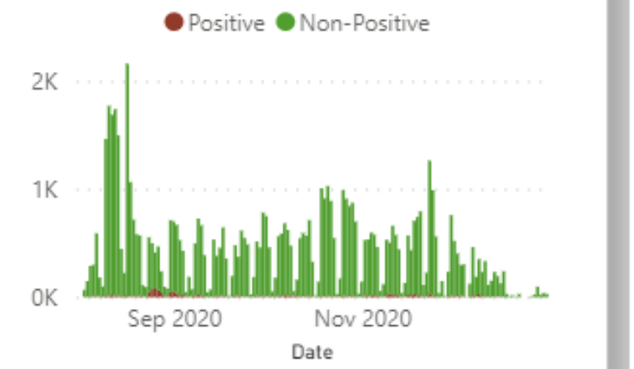
Active Cases by Status



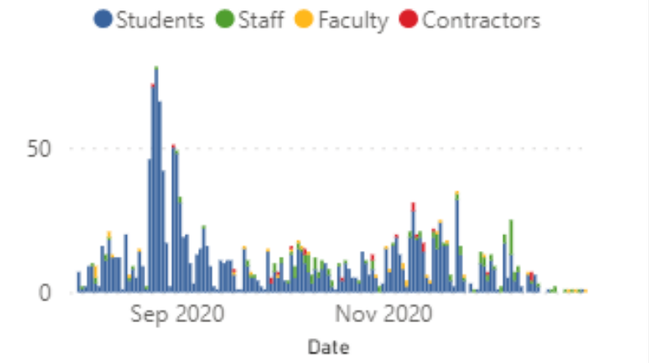
Cumulative Reported Cases



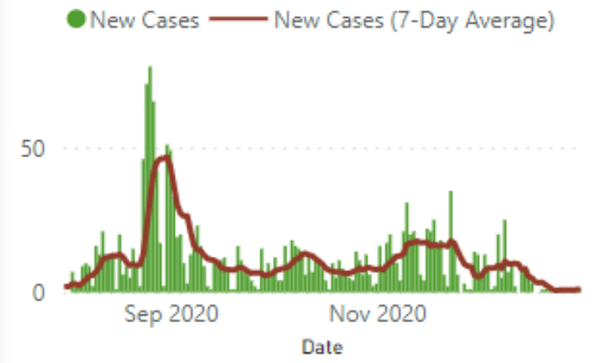
Testing Results (Daily)



New Cases by Status



Daily New Reported Cases



Hover over a chart and click the Focus Mode icon to enlarge

Last Updated: 1/1/2021 2:17:48 PM

The Way Forward

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Priorities for hospitals and public health systems

- Improve capabilities and capacities in surveillance and discovery at the local level
- Develop triage and management systems (with clear lines of authority) based on public health and epidemiologic requirements, capability, and capacity
  - Triage teams, categories, tags, rapid response, established operational priorities, resource-driven responsible management process
  - Link local-level surveillance systems with those at the national or regional level
- Use a triage and management system that reflects the population (cohort) at risk
- Develop an organizational capacity that uses lateral decision-making skills
  - Prehospital out-patient centers for triage-specific treatments, health information systems and resource-driven hospital-level protocols for a surge
- Standards of care should be set at the local to federal levels and spelled out in existing incident-management system protocols

WHO, Germany launch new global hub for pandemic and epidemic intelligence

5 May 2021 | Joint News Release | Geneva/Berlin | Reading time: 2 min (567 words)

- The WHO Hub for Pandemic and Epidemic Intelligence will be a global platform for pandemic and epidemic intelligence, creating shared and networked access to vital multi-sectoral data, driving innovations in data analytics and building the communities of practice needed to predict, prevent, detect, prepare for and respond to worldwide health threats.
- The WHO Hub will be a new global collaboration of countries and partners worldwide, driving innovations to increase availability and linkage of diverse data; develop tools and predictive models for risk analysis; and to monitor disease control measures and infodemics.
- The WHO Hub will enable partners from around the world to collaborate and co-create the tools and data access that all countries need to prepare, detect and respond to pandemic and epidemic risks.

The World Health Organization (WHO) and the Federal Republic of Germany will establish a new global hub for pandemic and epidemic intelligence, data, surveillance and analytics innovation. The Hub, based in Berlin and working with partners around the world, will lead innovations in data analytics across the largest network of global data to predict, prevent, detect prepare for and respond to pandemic and epidemic risks worldwide.

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Thank you

Questions / comments?

Benjamin J. Ryan Ph.D, MPH
Clinical Associate Professor
Department of Environmental Science
E: benjamin_ryan@baylor.edu I P: 254 710-2531

Baylor University