PANDEMICS AND THE GLOBAL RESPONSE

David Jay Weber, M.D., M.P.H., FSHEA, FIDSA, FRSM (London)
Distinguished Professor of Medicine, Pediatrics & Epidemiology
Associate Chief Medical Officer, UNC Hospitals
Medical Director, Hospital Epidemiology
University of North Carolina at Chapel Hill

Disclosures: Consultant - PDI, Germitec, Pfizer; Merck; Sanofi; Wellair

"emerging," "re-emerging," or "endemic"

Emerging = diseases that have not occurred in humans before or that occurred only in small numbers in isolated places.

"endemic"
a long term problem.
Never significantly declining
Eg. pneumonia

Re-emerging

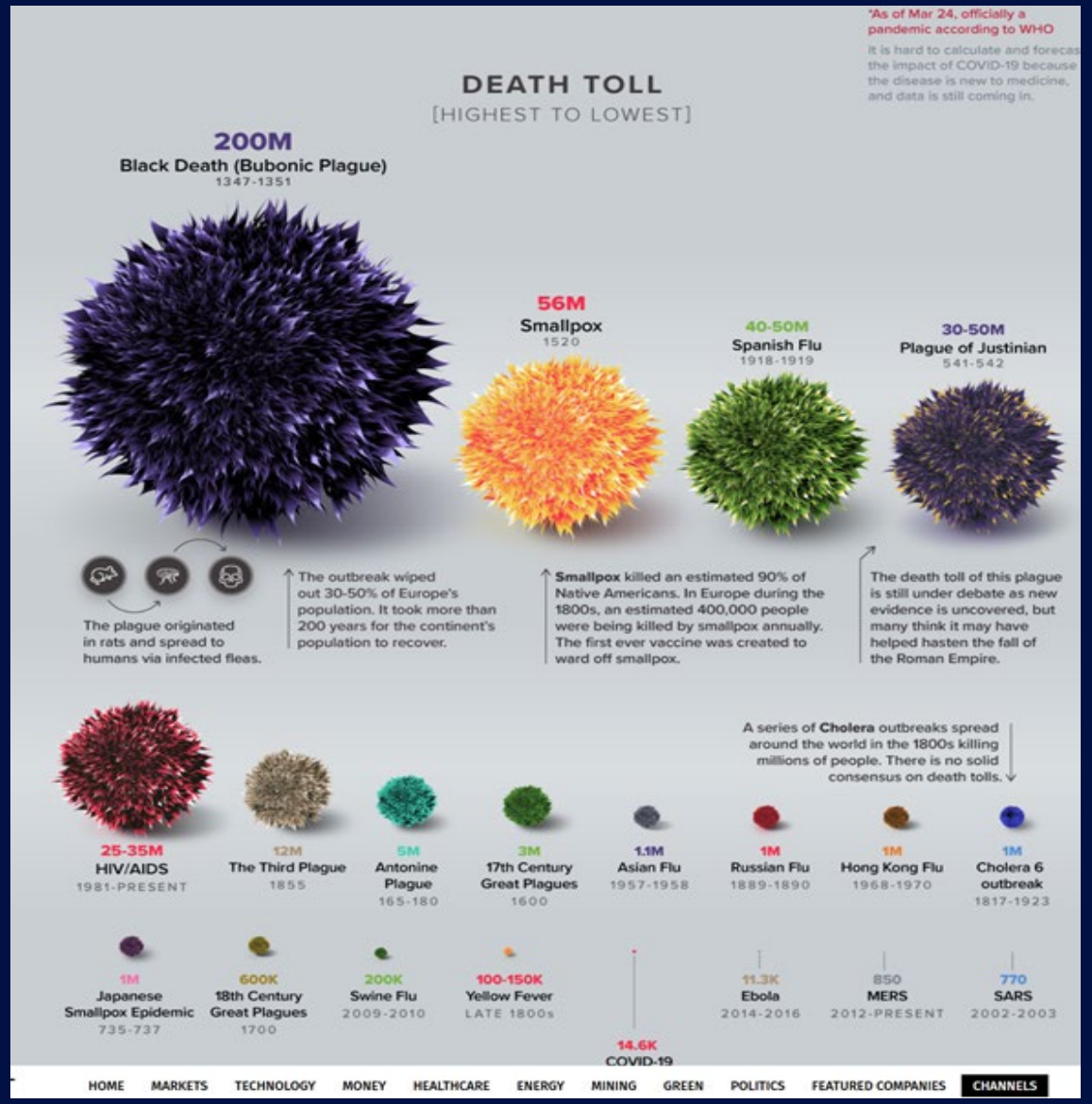
= diseases that once were major health problems globally or in a particular country, and then declined dramatically, but are again becoming health problems for a significant proportion of the population.

- Diseases thought to be adequately controlled making a “comeback” are “re-emerging”

HISTORY OF PANDEMICS

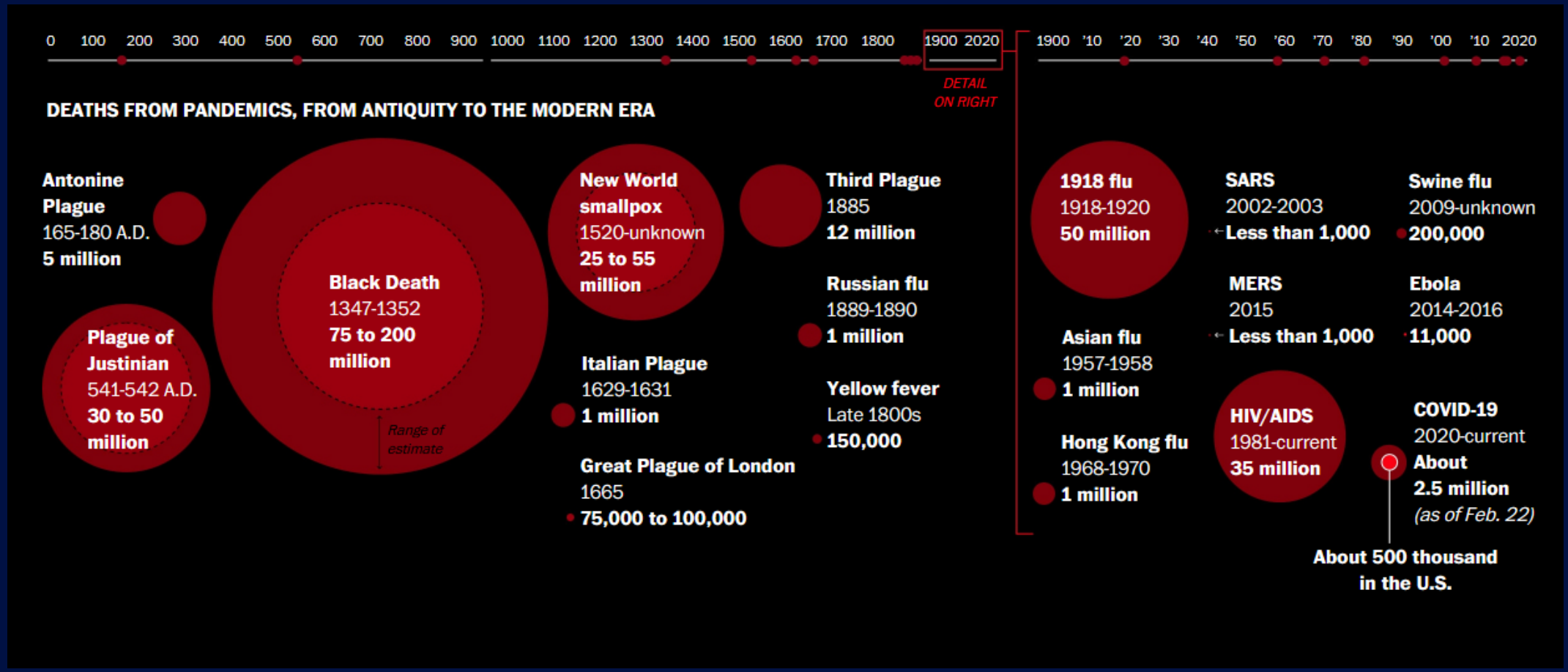
Name	Time period	Type / Pre-human host	Death toll
Antonine Plague	165-180	Believed to be either smallpox or measles	5M
Japanese smallpox epidemic	735-737	Variola major virus	1M
Plague of Justinian	541-542	Yersinia pestis bacteria / Rats, fleas	30-50M
Black Death	1347-1351	Yersinia pestis bacteria / Rats, fleas	200M
New World Smallpox Outbreak	1520 – onwards	Variola major virus	56M
Great Plague of London	1665	Yersinia pestis bacteria / Rats, fleas	100,000
Italian plague	1629-1631	Yersinia pestis bacteria / Rats, fleas	1M
Cholera Pandemics 1-6	1817-1923	V. cholerae bacteria	1M+
Third Plague	1885	Yersinia pestis bacteria / Rats, fleas	12M (China and In
Yellow Fever	Late 1800s	Virus / Mosquitoes	100,000-150,000 (U
Russian Flu	1889-1890	Believed to be H2N2 (avian origin)	1M
Spanish Flu	1918-1919	H1N1 virus / Pigs	40-50M
Asian Flu	1957-1958	H2N2 virus	1.1M
Hong Kong Flu	1968-1970	H3N2 virus	1M
HIV/AIDS	1981-present	Virus / Chimpanzees	25-35M
Swine Flu	2009-2010	H1N1 virus / Pigs	200,000
SARS	2002-2003	Coronavirus / Bats, Civets	770
Ebola	2014-2016	Ebolavirus / Wild animals	11,000
MERS	2015-Present	Coronavirus / Bats, camels	850
COVID-19	2019-Present	Coronavirus – Unknown (possibly pangolins)	14,500 (as of Mar 2 2020)

Note: Many of the death toll numbers listed above are best estimates based on available research. Some, such as the i of Justinian, are subject to debate based on new evidence.



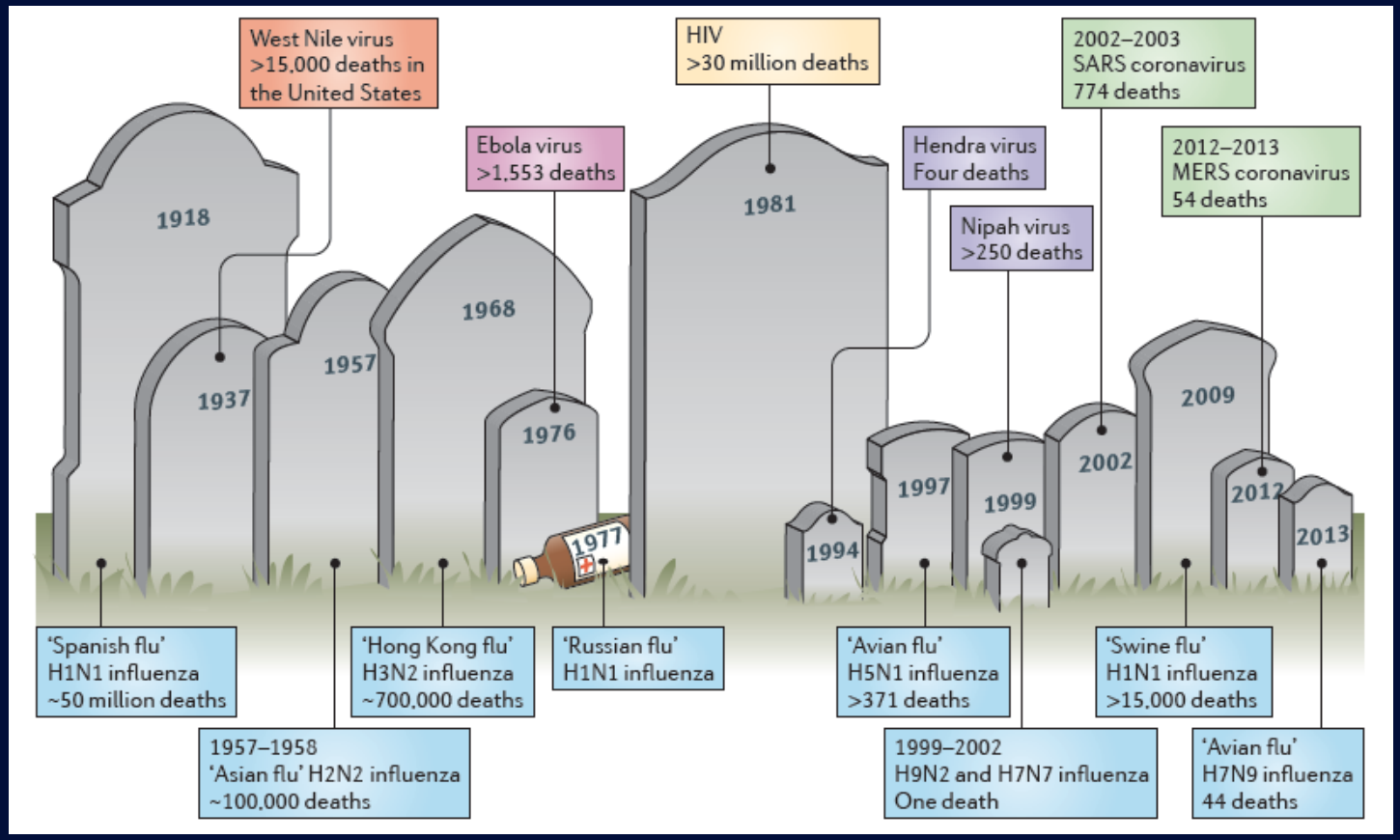
www.visualcapitalist.com/history-of-pandemics-deadliest

PANDEMICS OVER TIME



https://www.washingtonpost.com/graphics/2020/local/retropolis/coronavirus-deadliest-pandemics/?itid=hp_dontmiss

EMERGING ZOONOSES



Bean A, et al. Nature Rev 2013;13:851-61

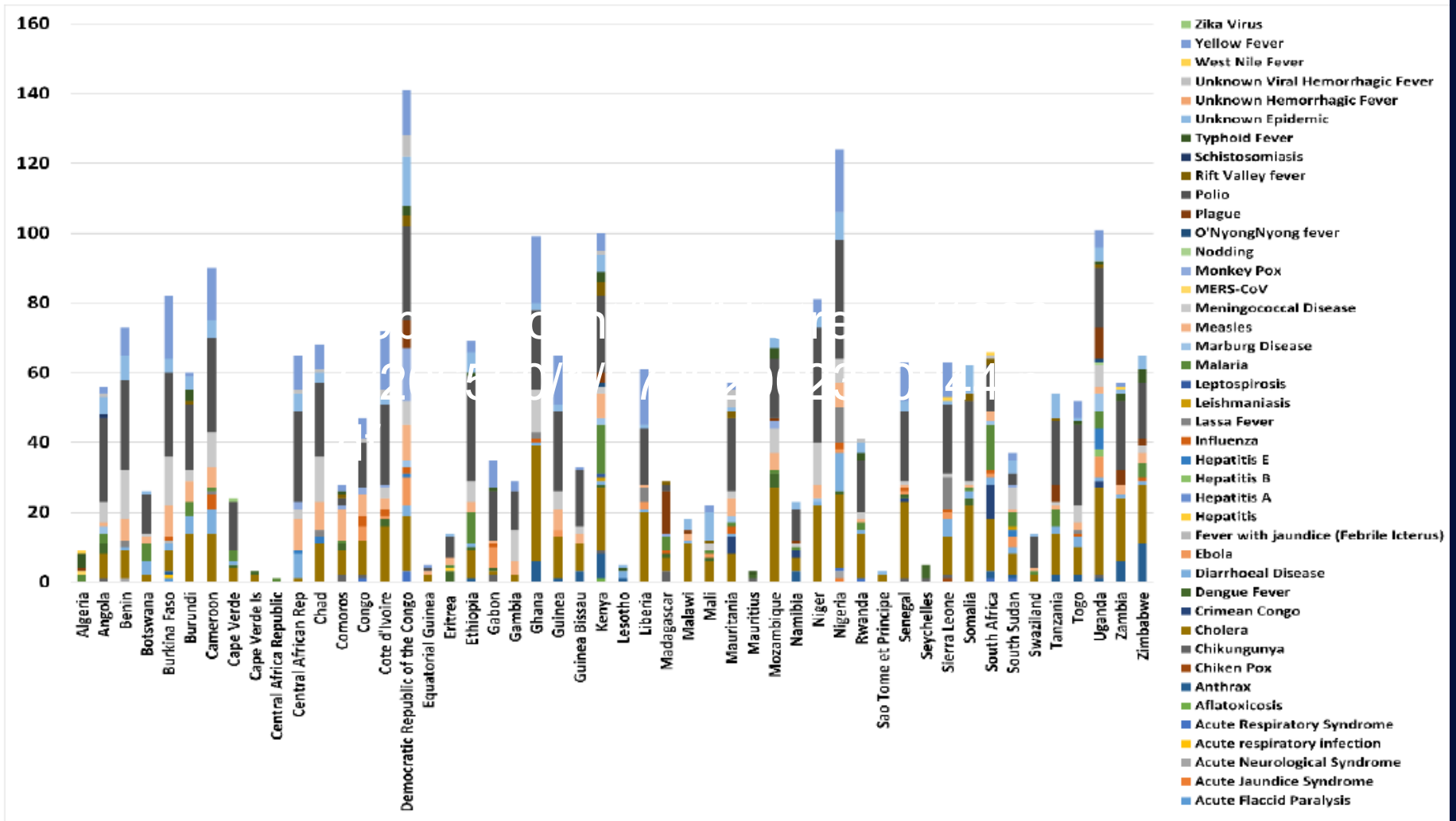
BASIC CONCEPTS IN DISEASE EMERGENCE

- Emergence of infectious diseases is complex
- Infectious diseases are dynamic
- Most new infections are not caused by genuinely new pathogens
- Agents involved in new and reemergent infections cross taxonomic lines
- The concept of the microbe as *the* cause of disease is inadequate and incomplete
- Human activities are the most potent factors driving disease emergence
- Social, economic, political, climatic, technologic, and environmental factors shape disease patterns and influence emergence
- Understanding and responding to disease emergence require a global prospective, conceptually and geographically
- The current global situation favors disease emergence

Wilson ME. Emerging Infectious Diseases 1995;1:39.

OUTBREAKS AND EPIDEMICS IN AFRICA, WHO, 1970-2016

Figure 1 A graph of all the outbreak and epidemic events by disease in the countries of the WHO African region

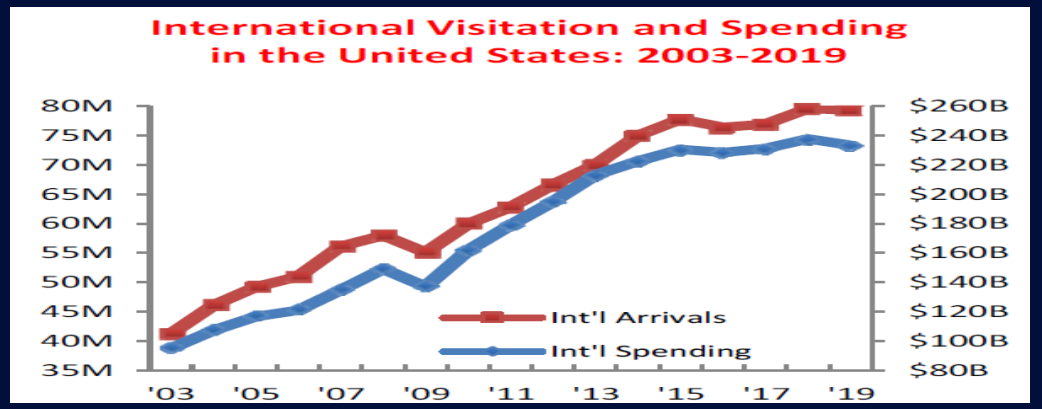


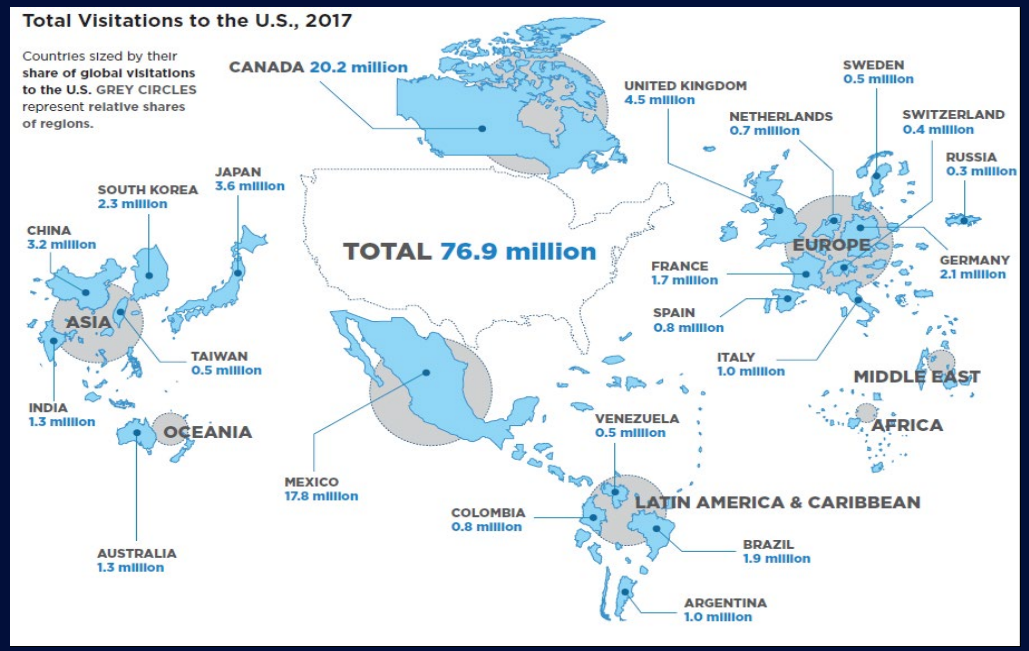
apps.who.int/iris/bitstream/10665/206560/1/97892902330844.pdf

VISITORS TO THE US, 2019

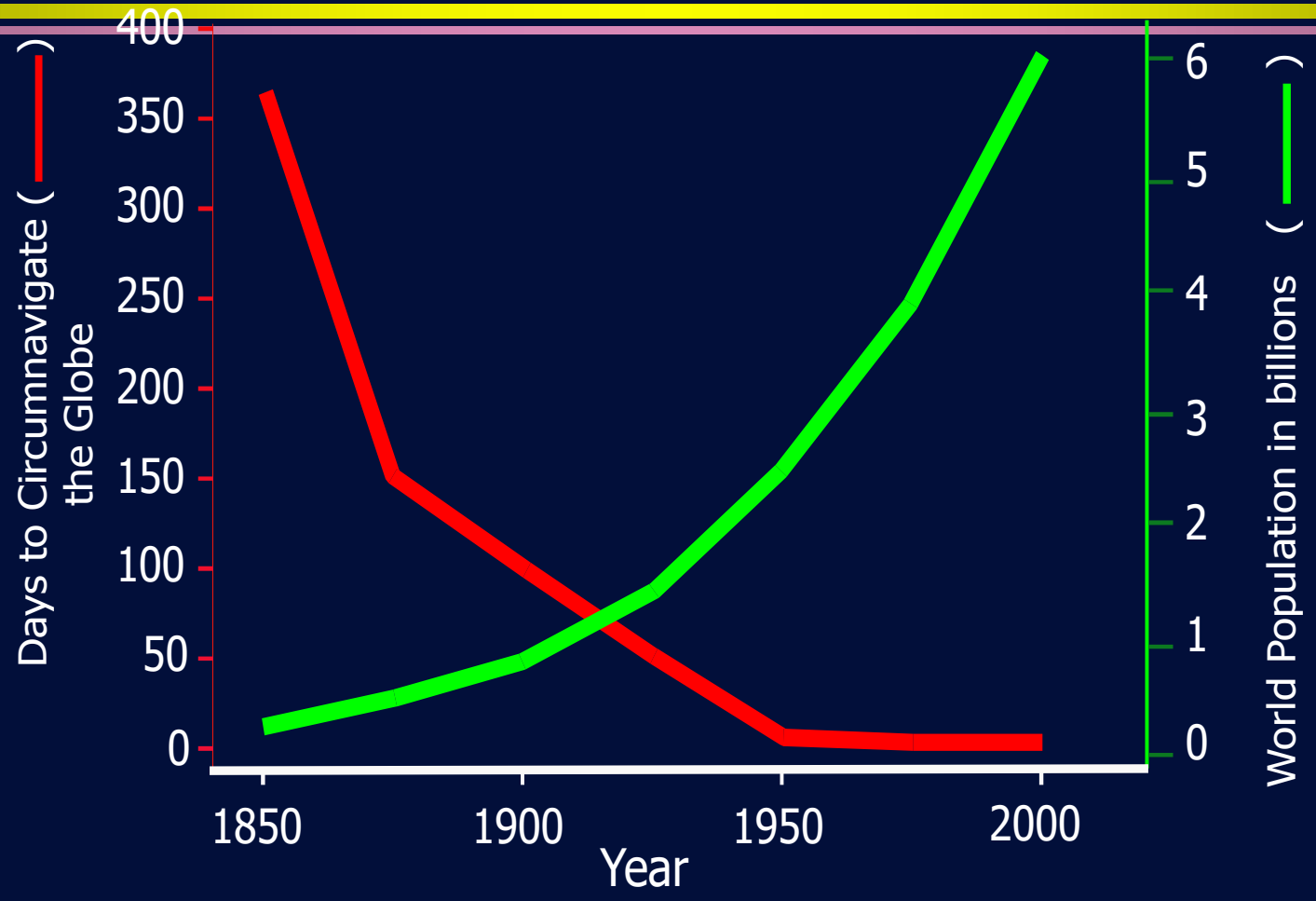
Country	Visitors (millions)
Canada	12.7
Mexico	18.1
UK	4.8
Japan	3.8
China	2.8
S. Korea	2.3
Brazil	2.1
Germany	2.1
France	1.8
India	1.5

https://travel.trade.gov/outreachpages/download_data_table/Fast_Facts_2019.pdf





Speed of Global Travel in Relation to World Population Growth



From: Murphy and Nathanson Sems. Virol. 5, 87, 1994

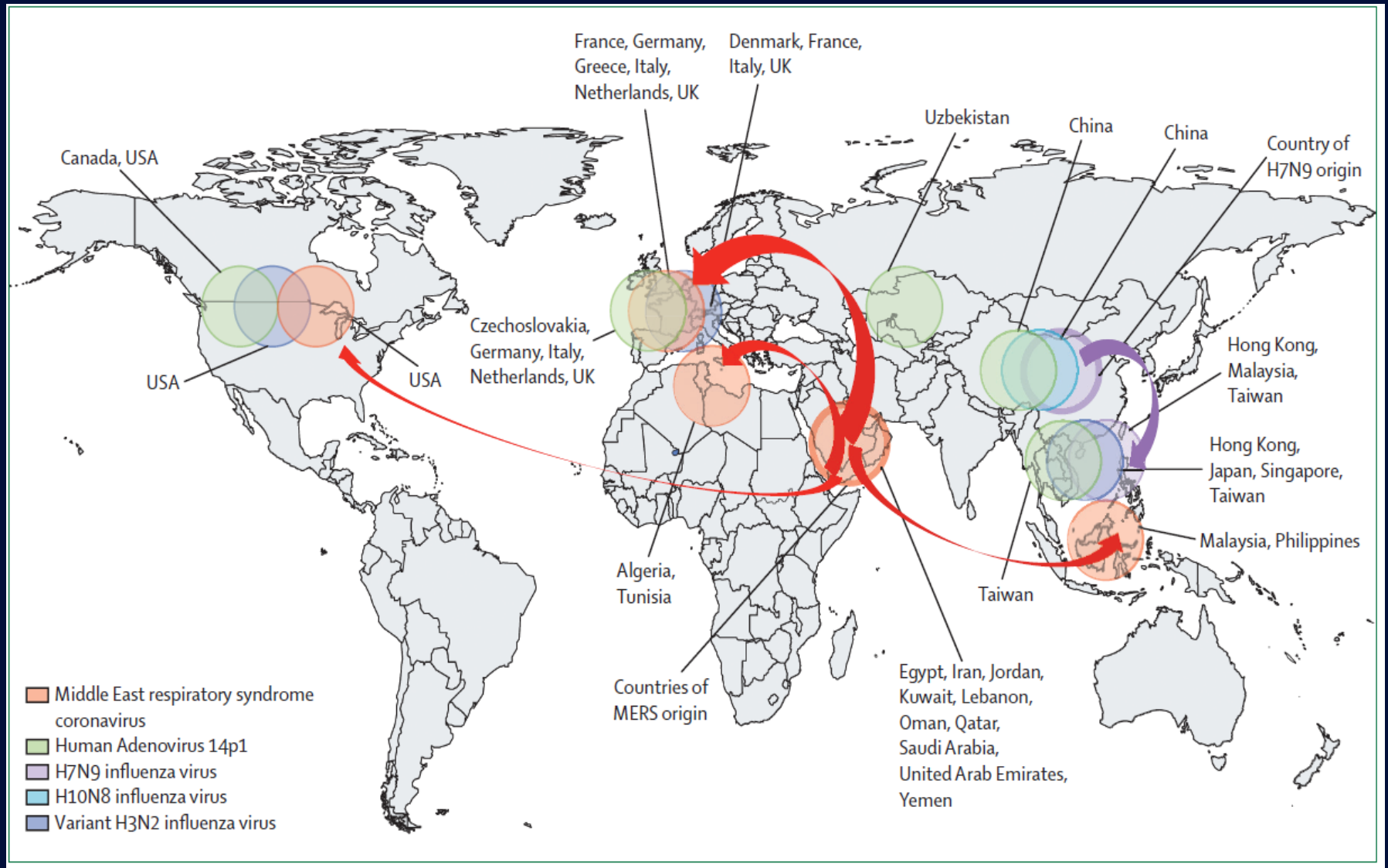
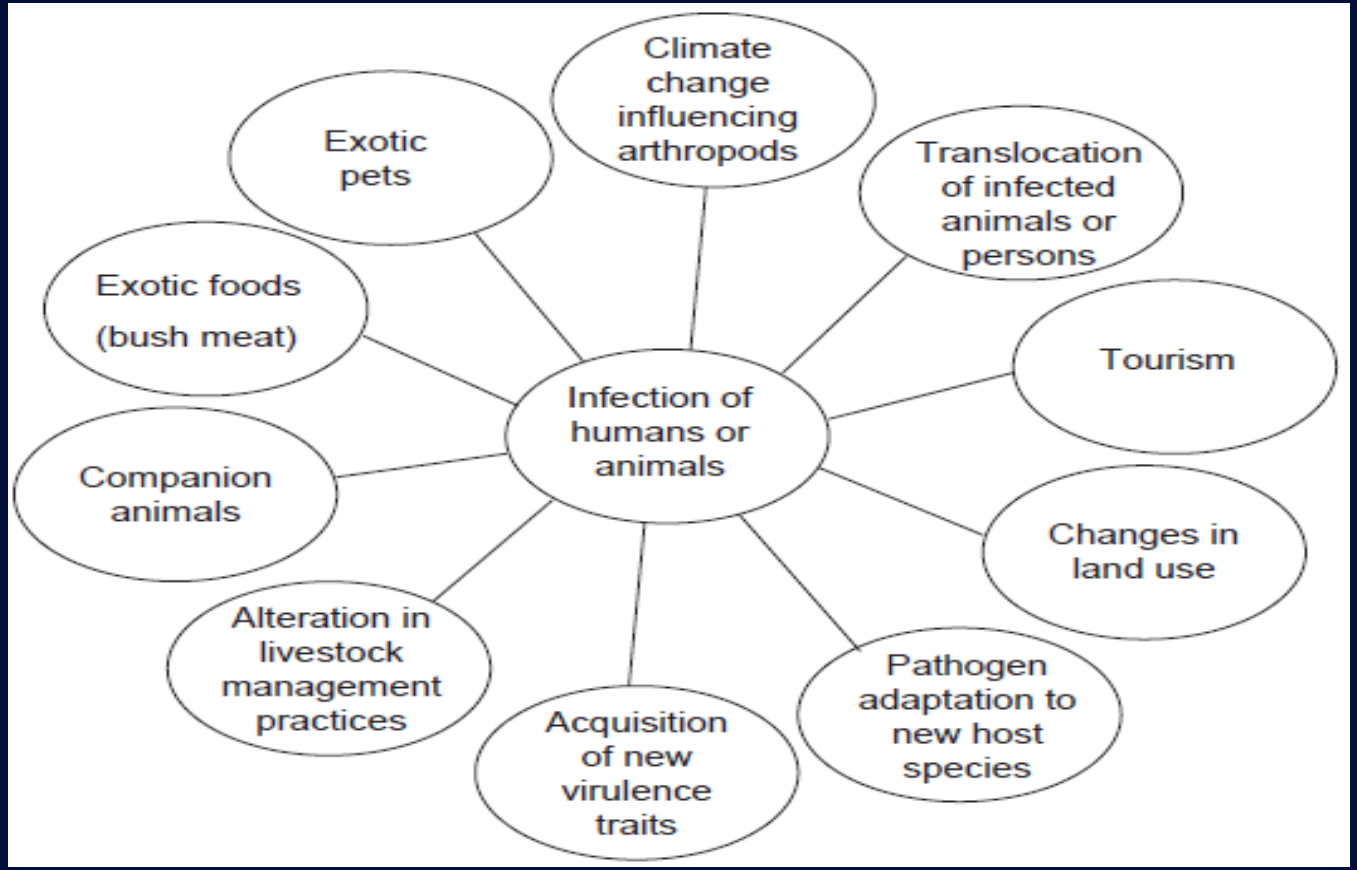


Figure: Geographical distribution of human cases of emerging respiratory viruses

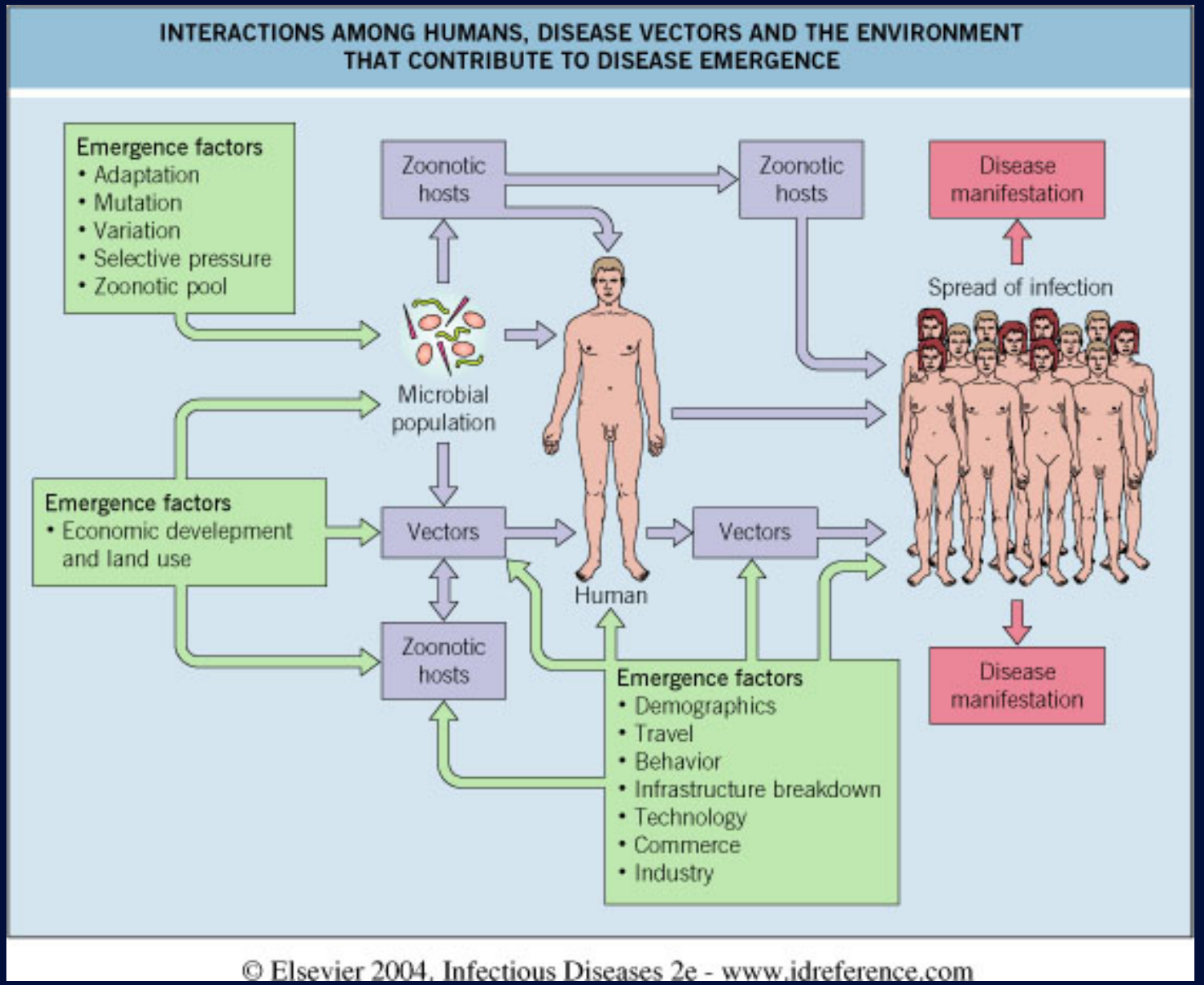
SOURCES OF EXOTIC DISEASES

- Travel
- Animal exposure (zoonotic diseases)
  - Exposure via travel, leisure pursuits (hunting, camping, fishing), occupation (farming), pets
- Bioterrorist agents
- Research
  - Exposure via laboratory work or animal care

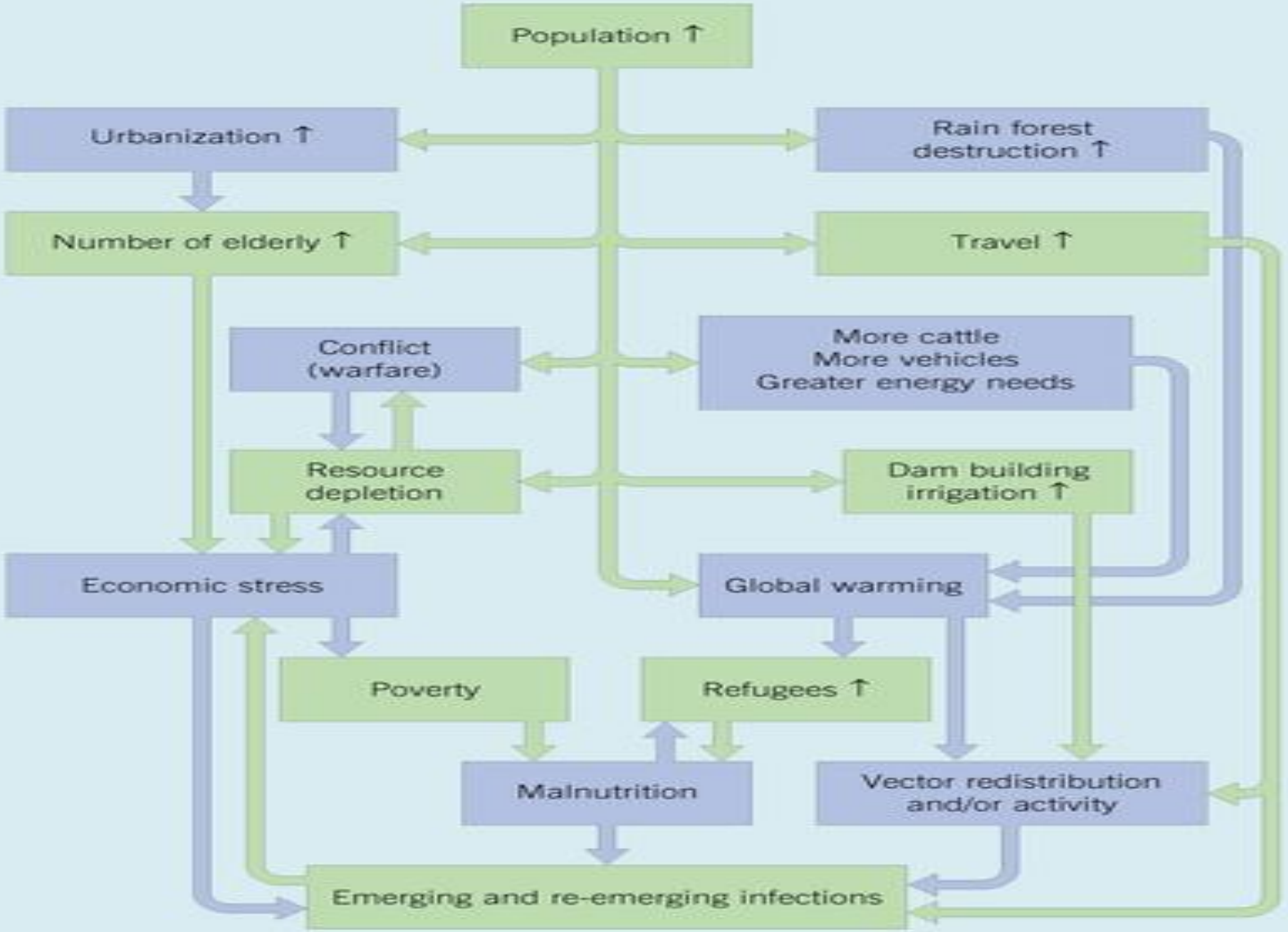
FACTORS INFLUENCING NEW AND REEMERGING ZOONOSES

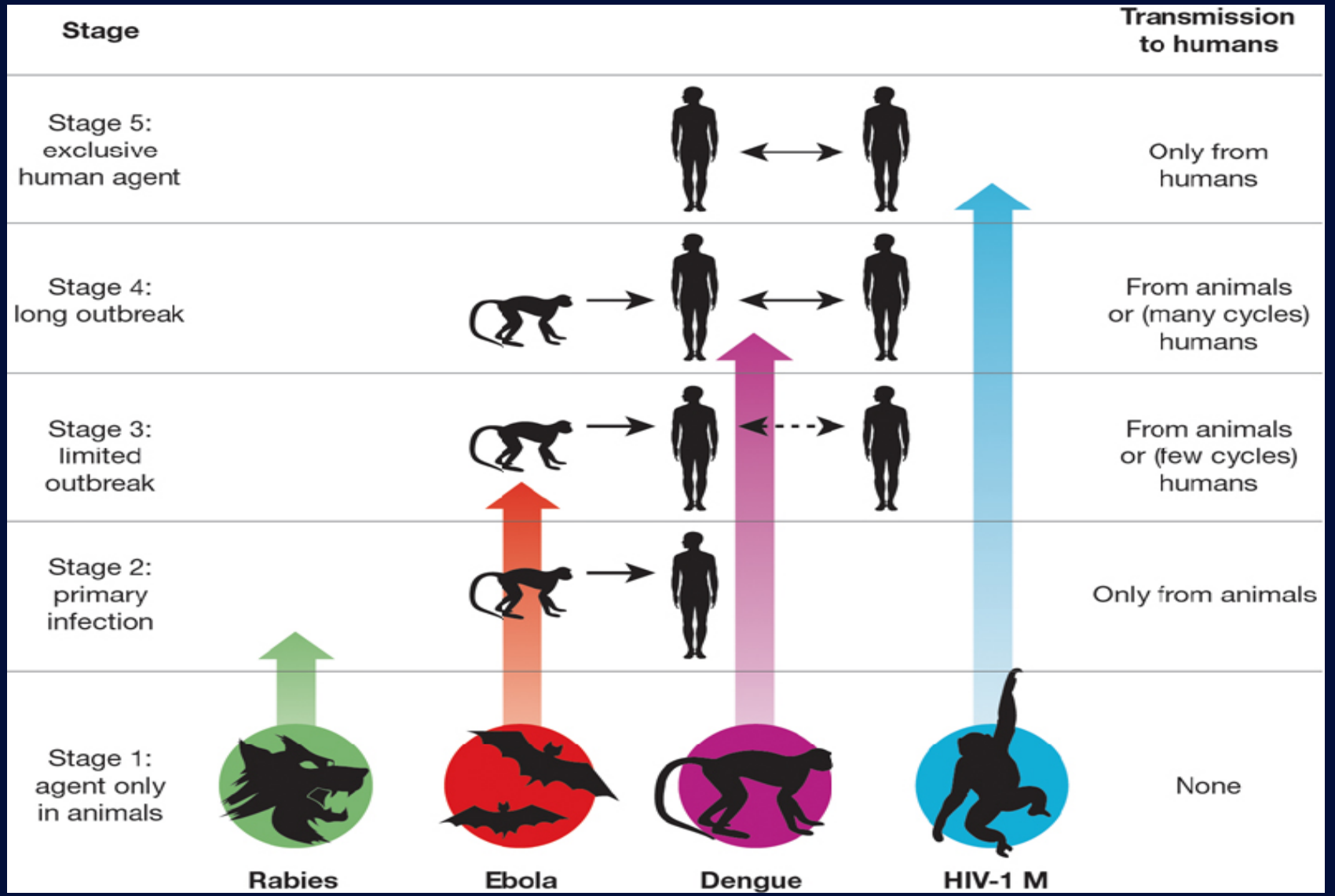


Cutler SJ et al. Emerg Infect Dis 2010;16:1-7


INTERACTIONS AMONG HUMANS, DISEASE VECTORS AND THE ENVIRONMENT THAT CONTRIBUTE TO DISEASE EMERGENCE
Emergence factors
• Adaptation
• Mutation
• Variation
• Selective pressure
• Zoonotic pool
Zoonotic hosts
Zoonotic hosts
Disease manifestation
Spread of infection
Microbial population
Human
Emergence factors
• Economic develepment and land use
Vectors
Vectors
Zoonotic hosts
Emergence factors
• Demographics
• Travel
• Behavior
• Infrastructure breakdown
• Technology
• Commerce
• Industry
Disease manifestation
© Elsevier 2004. Infectious Diseases 2e - www.idreference.com

INTER-RELATIONS OF SOME MAJOR VARIABLES IN EMERGING AND RE-EMERGING INFECTIONS





http://web.stanford.edu/group/parasites/ParaSites2012/Lassa%20Libby%20Burch/LassaEbolaMarburg_LibbyBurch_3-8-2012.htm

WHO LIST OF PRIORITY DISEASES, 2015

- Arenaviral hemorrhagic fevers (including Lassa Fever)
- Crimean Congo Haemorrhagic Fever (CCHF)
- Filoviral diseases (including Ebola and Marburg)
- Middle East Respiratory Syndrome Coronavirus (MERS-CoV)
- Other highly pathogenic coronaviral diseases (such as Severe Acute Respiratory Syndrome, (SARS)
- Nipah and related henipaviral diseases
- Rift Valley Fever (RVF)
- Severe Fever with Thrombocytopenia Syndrome (SFTS)
- Zika

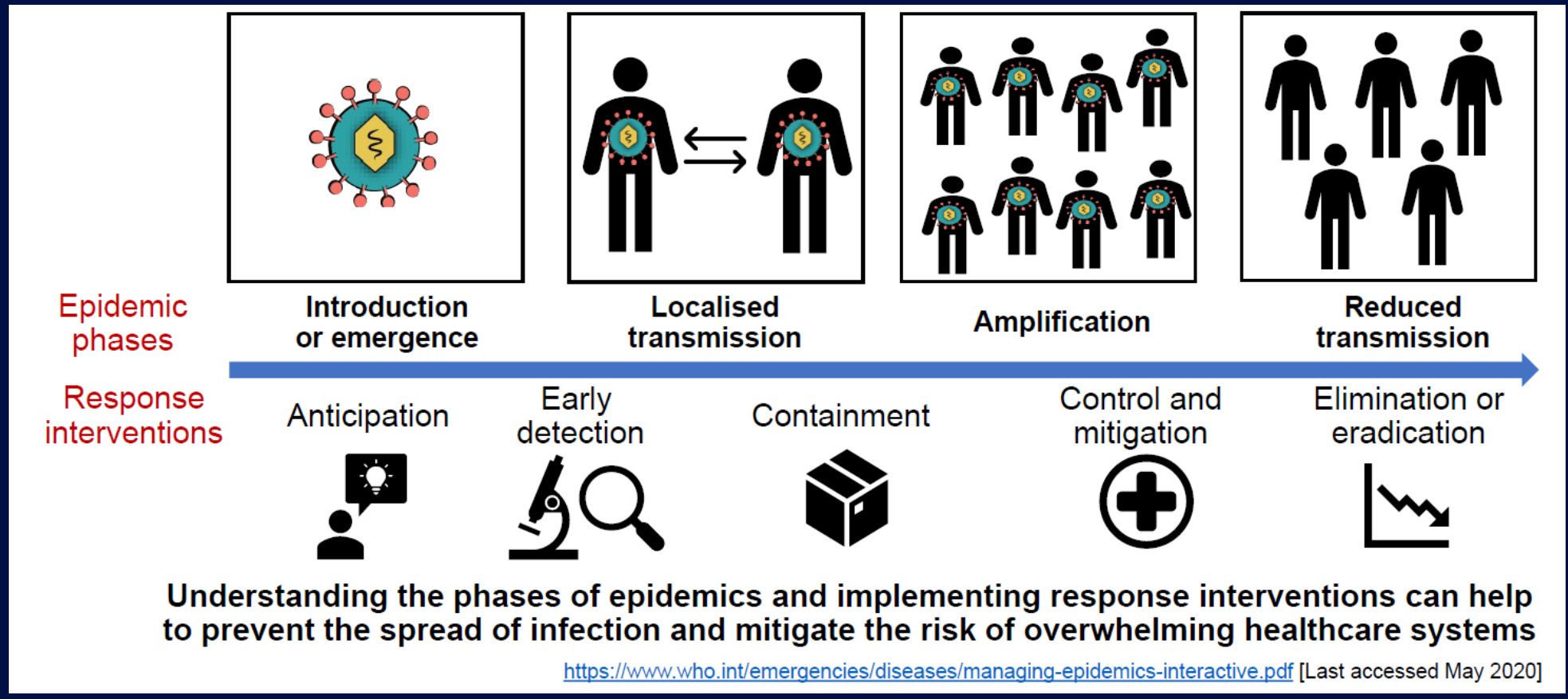
Table 1
Selected emerging diseases of infection control importance

Disease (initial location)	Cases (United States)	Outcome	Person-to-person transmission	Patient-to-HCP transmission	Infection control risk	Year
Legionnaires' disease	Unknown (thousands)	Endemic and epidemic	No	No	High	1976-present
HIV (Africa)	Millions (thousands)	Ongoing epidemic	Yes (blood exposure, organ transplantation, vertical, sexual)	Yes (blood exposure)	Moderate	1978-present
vCJD	Hundreds	Controlled	Yes (blood, theoretically via contaminated medical instruments)	No	Low	1996
West Nile fever	(Thousands)	Endemic	Yes (blood transfusions, vertical, organ transplantation)	No*	Low	1999
SARS (China)	~8,000 (8)	Controlled	Yes (droplet, contact, airborne?)	Yes	High	2003-2004
Monkeypox (Africa)	(37 confirmed, 10 probable)	Eliminated in United States	Yes (droplet, contact)	Yes†	High	2003
MERS (Middle East)	Thousands (2)	Controlled	Yes (droplet, contact)	Yes	High	2014-present
Ebola (West Africa)	Thousands (4)	Controlled United States, reduced Africa	Yes (contact, sexual)	Yes	High	2014-present

HCP, health care personnel; *MERS*, Middle East respiratory syndrome; *SARS*, severe acute respiratory syndrome; *vCJD*, variant Creutzfeldt-Jakob disease.
*Infection via a needlestick theoretically possible.
†No HCP developed infection during the U.S. outbreak but patient-to-HCP transmission described in Africa.

Weber DJ,…Sickbert-Bennett E. Am J Infect Control 2016;44:e91-e100

FOUR PHASES OF EPIDEMICS AND RESPONSE INTERVENTIONS



Understanding the phases of epidemics and implementing response interventions can help to prevent the spread of infection and mitigate the risk of overwhelming healthcare systems

https://www.who.int/emergencies/diseases/managing-epidemics-interactive.pdf [Last accessed May 2020]

KEY CONSIDERATIONS IN ASSESSING AND MANAGING THE THREAT OF AN EMERGING INFECTIOUS DISEASE

- Pathogen
  - Taxonomy (provides clues regarding transmission routes, environmental stability, germicide susceptibility)
  - Hosts
- Epidemiology
  - Locations of endemicity (i.e., locations in the world where sources or reservoirs reside)
  - Incubation period
  - Transmission routes
  - Infectivity (i.e., communicability)
  - Duration of infectivity
- Clinical
  - Symptoms
  - Signs
  - Risk factors for acquisition of infection
  - Morbidity
  - Mortality
  - Risk factors for morbidity and mortality
  - Diagnostic methods (sensitivity, specificity, biosafety)
  - Therapy (availability, efficacy, safety)

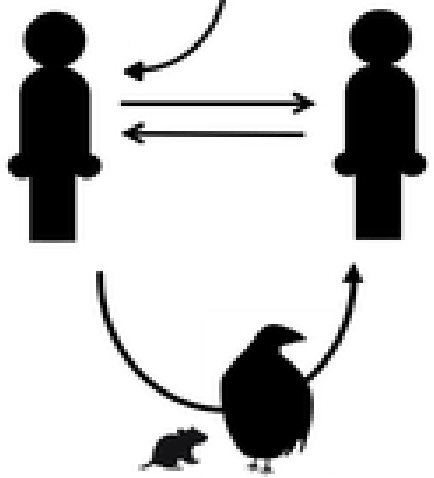
Weber DJ, et al. Am J Infect Control 2016;44:e91-100

Modes of Infectious Disease Transmission

A. General Transmission

Abiotic environmental factors

- Wind
- Water
- Inhalation of spores
- Entry into skin

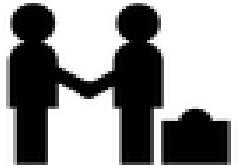


Animal vectors

- Mosquitoes (malaria, dengue)
- Fleas (bubonic plague)

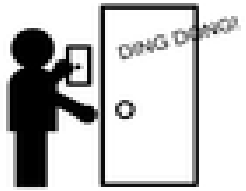
B. Human to Human Transmission

Direct Contact



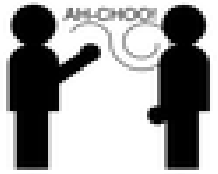
- Pathogen survives best inside the body
- Eg: HIV, Herpesviruses, Ebola

Indirect Contact



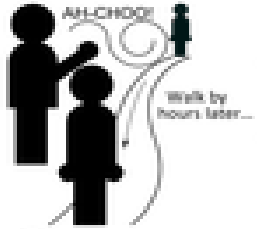
- Pathogen survives harsh environment
- Pick up pathogen from surface or air
- Eg Influenza, norovirus

Droplets



- Pathogens are in droplets, but do not survive long this way
- Eg: Ebola, *Bordetella pertussis*

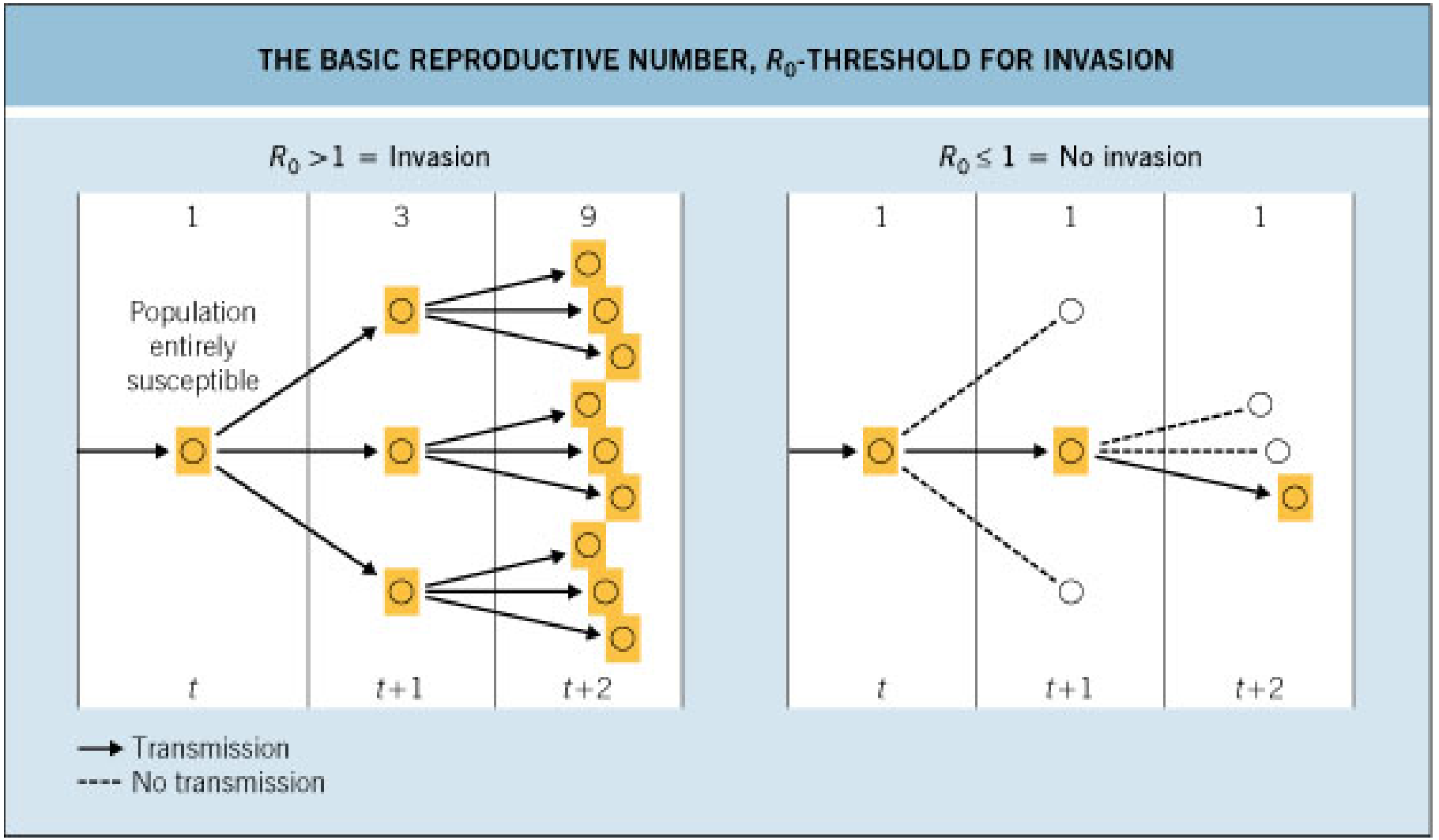
Airborne



- Pathogens aerosolized and stay infective
- Eg: Influenza, Tuberculosis

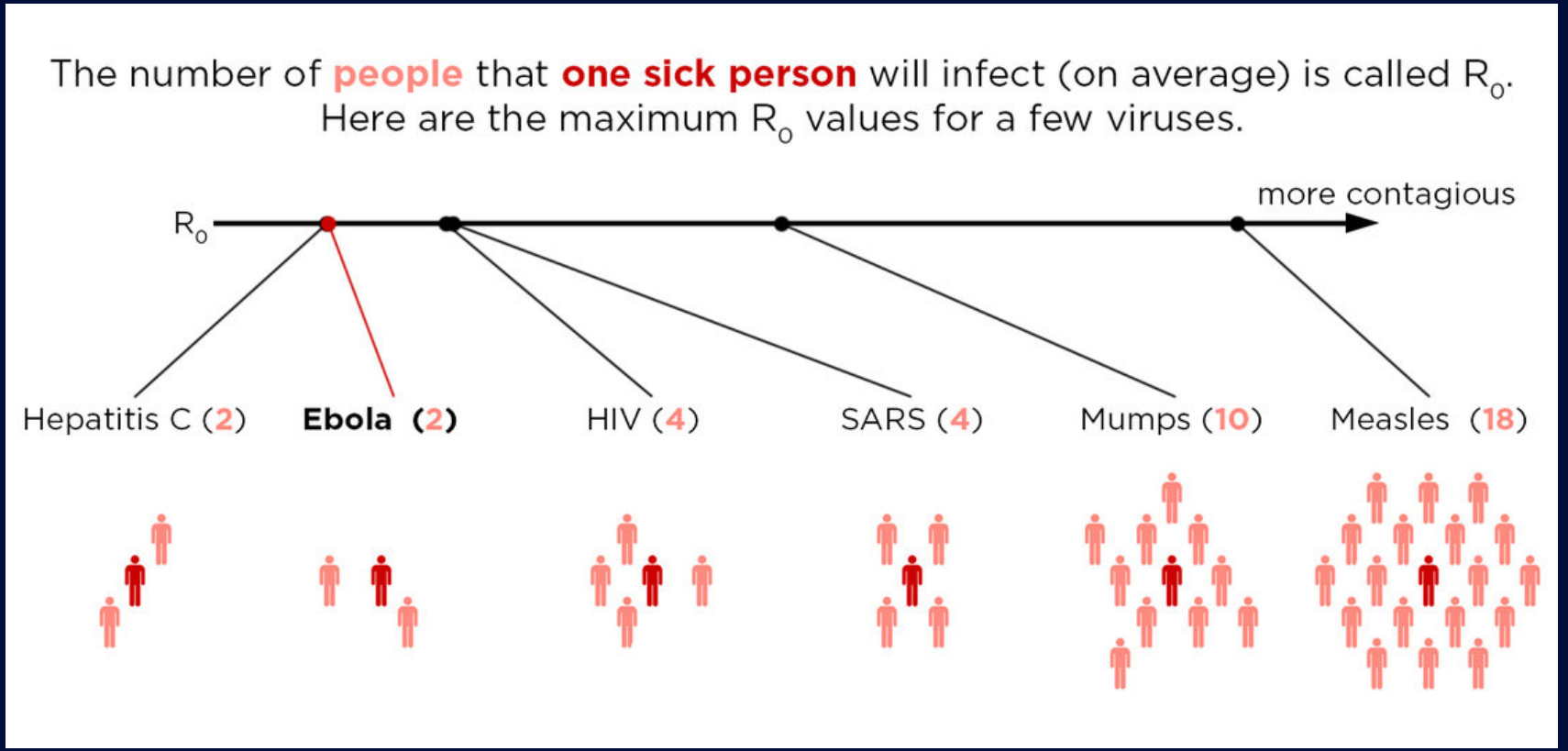
Fecal - Oral

- Through contaminated water or food
- Eg: Cholera, Norovirus, Shigella



© Elsevier 2004. Infectious Diseases 2e - www.idreference.com

HOW CONTAGIOUS ARE DIFFERENT INFECTIOUS DISEASES



http://www.npr.org/blogs/health/2014/10/02/352983774/no-seriously-how-contagious-is-ebola

KEY CONSIDERATIONS IN ASSESSING AND MANAGING THE THREAT OF AN EMERGING INFECTIOUS DISEASE

- Infection Prevention
  - Environmental survival
  - Germicide susceptibility
  - Isolation recommendations
  - Recommended personal protective equipment
  - Pre-exposure prophylaxis (availability, efficacy, safety)
  - Postexposure prophylaxis (availability, efficacy, safety)
  - Recommended biosafety level in the laboratory
  - Recommended waste disposal (liquids and solids
- Managing a pandemic
  - Sensitive and specific (ideally rapid) diagnostic test
  - Early identification of patients
  - Protecting our healthcare personnel (PPE, donning, doffing)
  - Sufficient staff, inpatient/ICU beds, ventilators
  - Managing shortages

Weber DJ, et al. Am J Infect Control 2016;44:e91-100

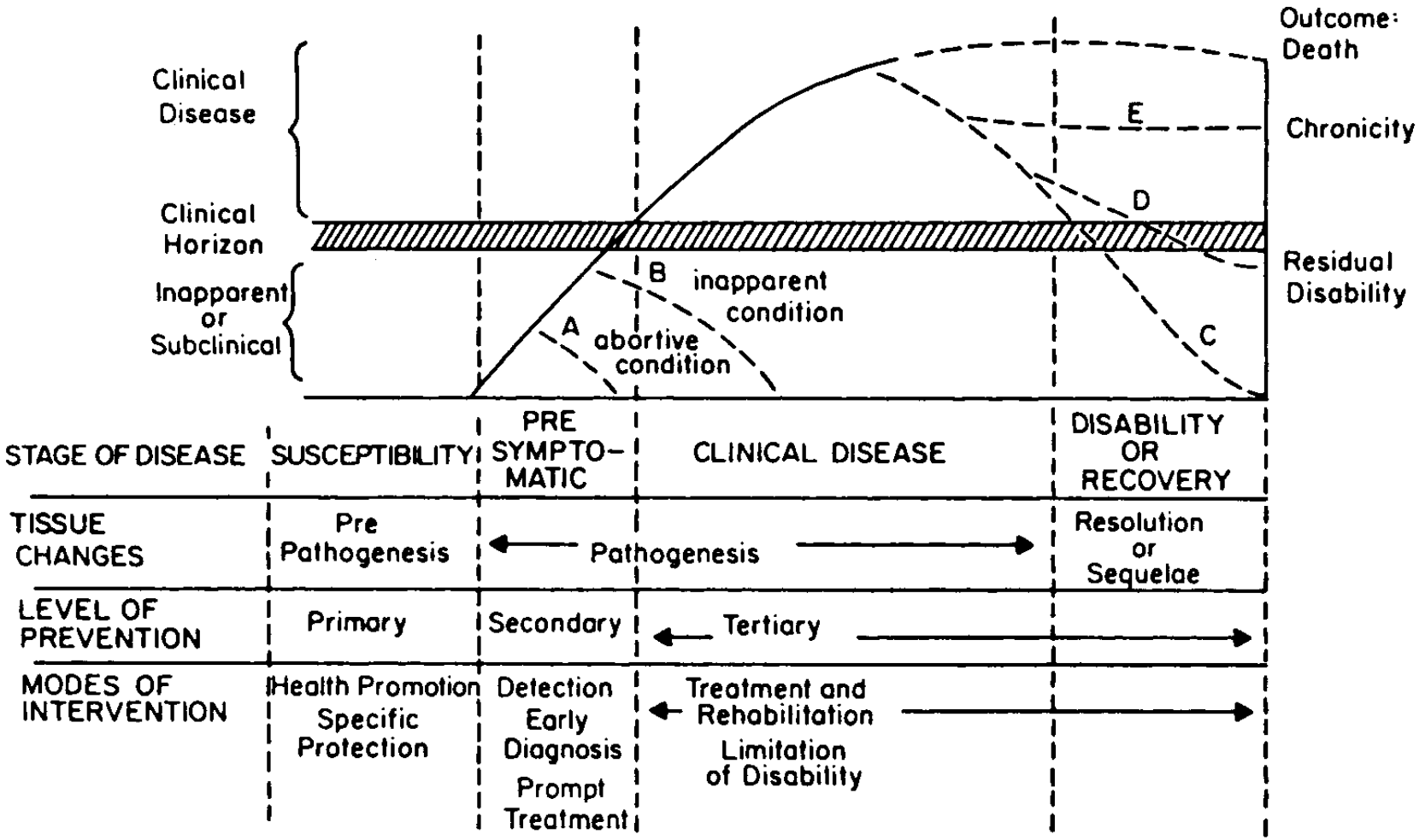
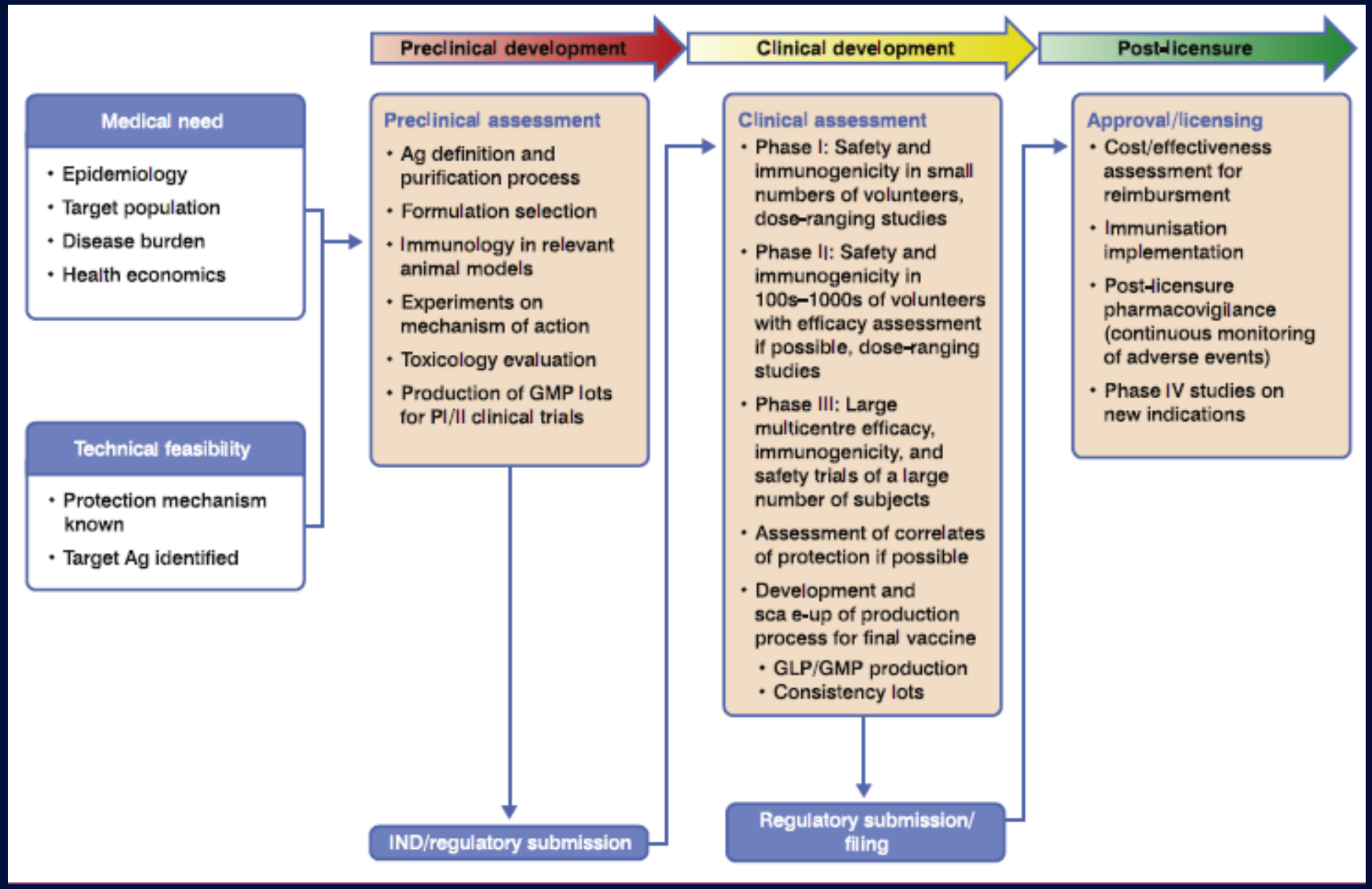
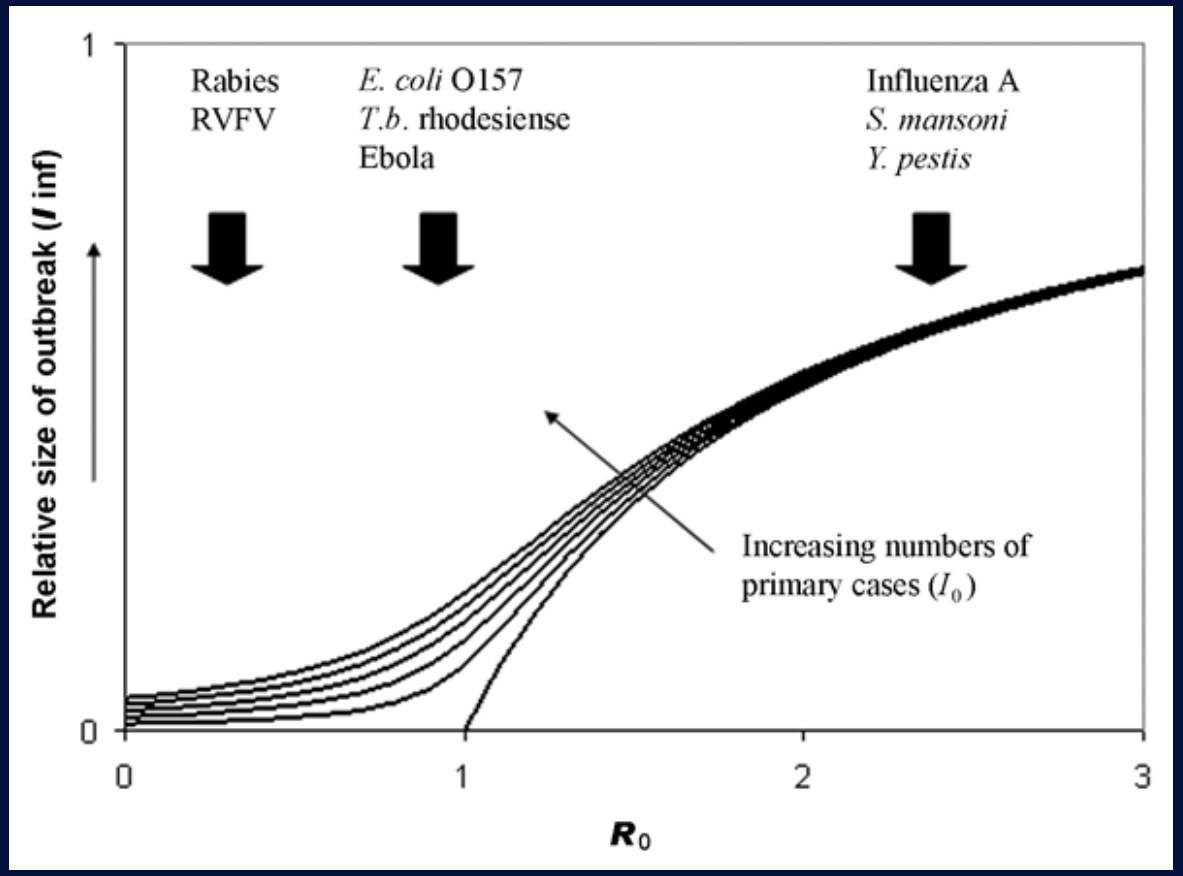


Figure 1–10. Schematic representation of the natural history of infection.
Source: Adapted from Mausner and Kramer 1985.



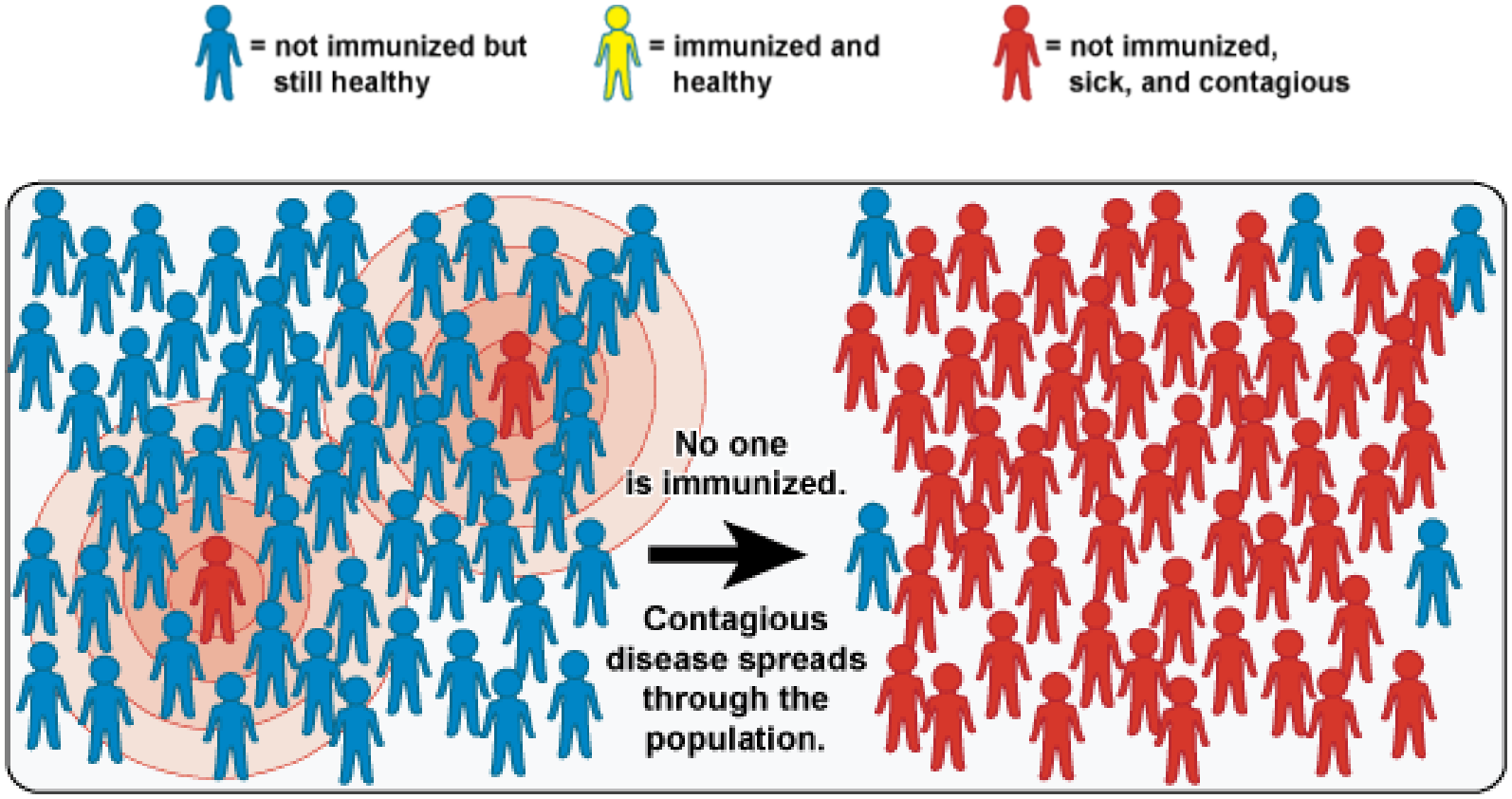
Leroux-Roels G, et al. Prospectives in vaccinology 2011;1:115

IMPORTANCE OF REPRODUCTIVE NUMBER



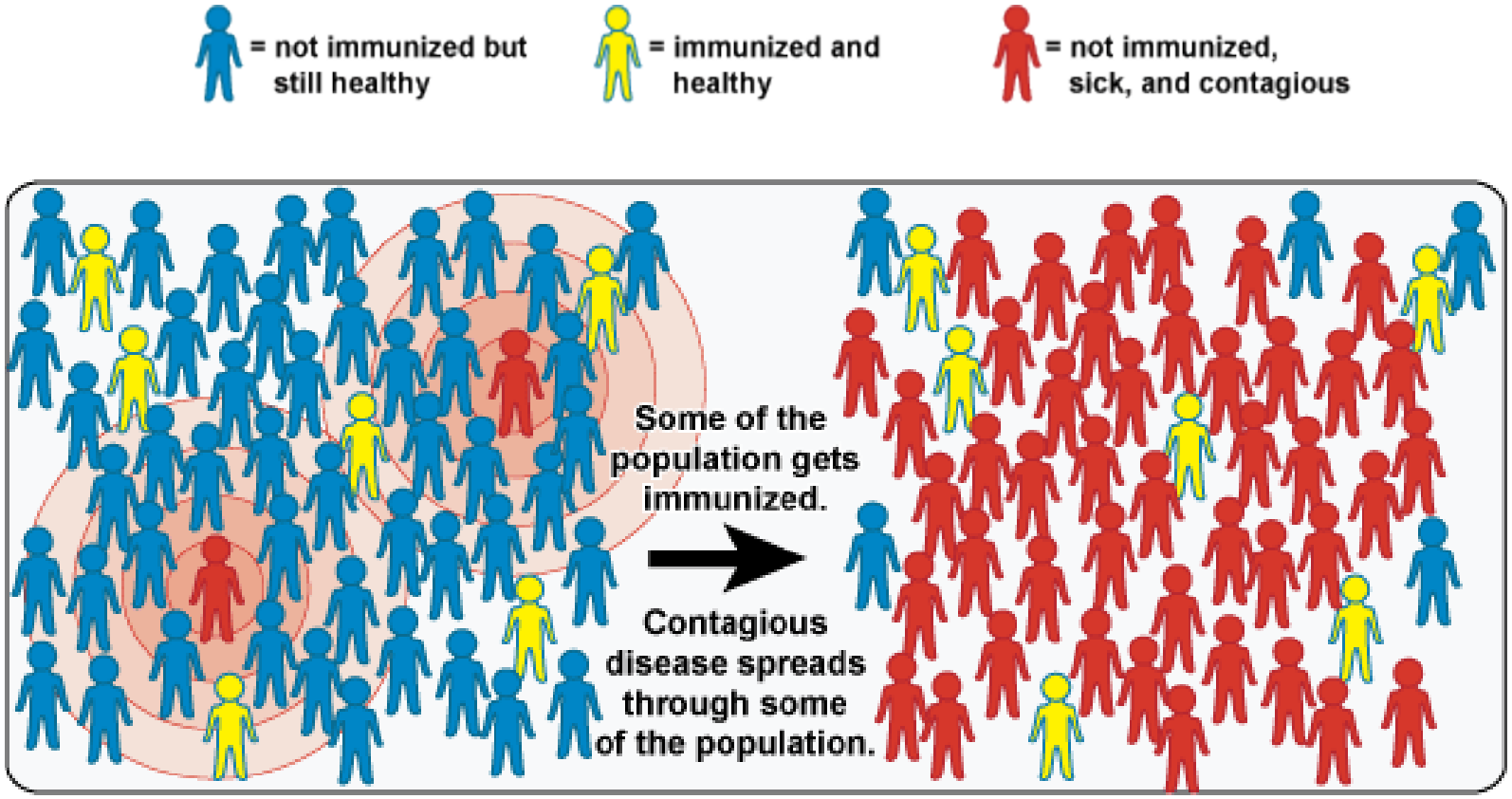
Woolhouse MEJ, Gowtage-Sequeria S. EID 2005;11:1842

COMMUNITY PROTECTION (HERD IMMUNITY)



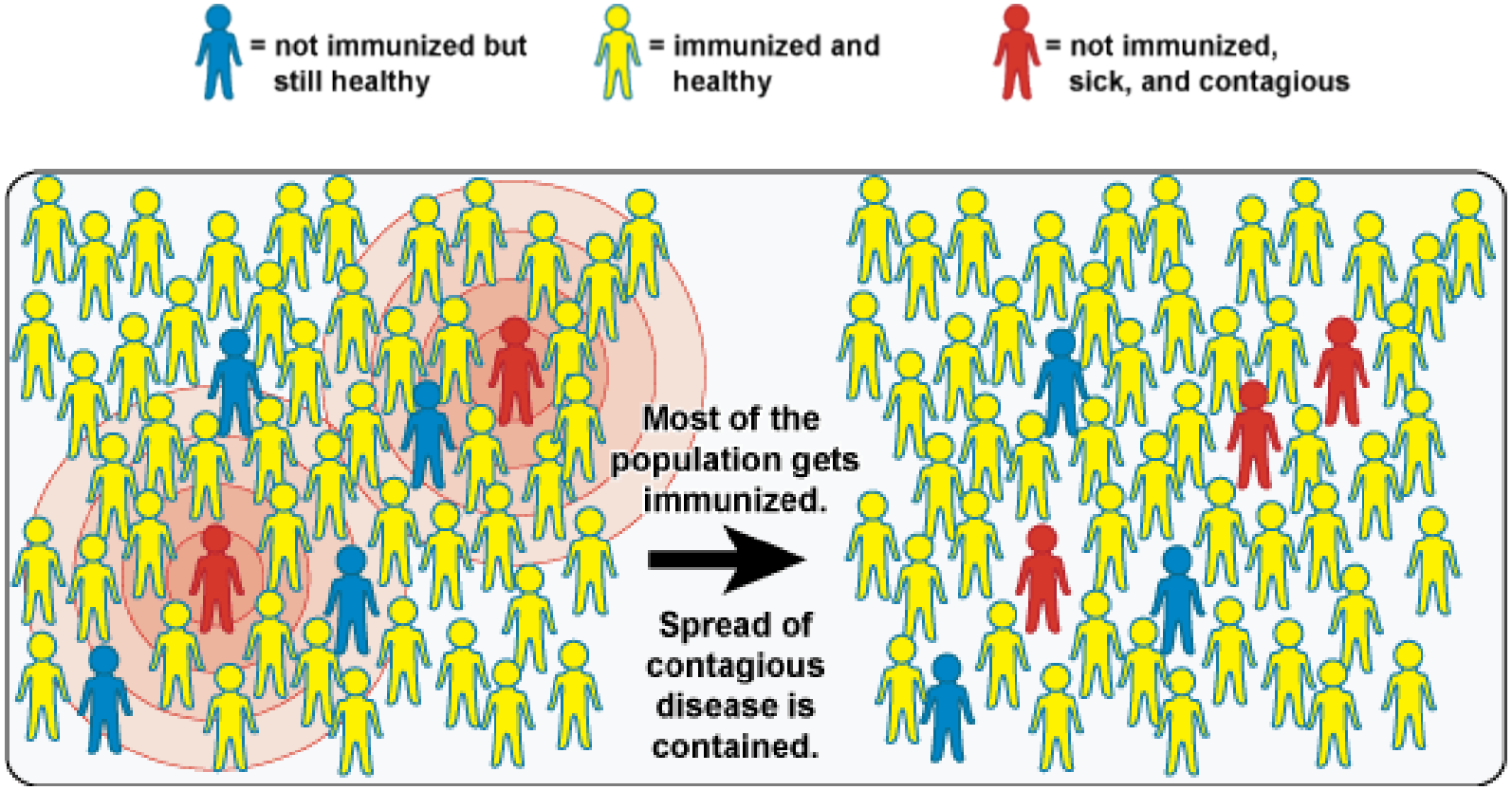
National Institute of Allergy and Infectious Diseases. *Community immunity*. niaid.nih.gov/topics/pages/communityimmunity.aspx. Accessed March 19, 2012.
Courtesy: National Institute of Allergy and Infectious Diseases.

COMMUNITY PROTECTION II (HERD IMMUNITY)

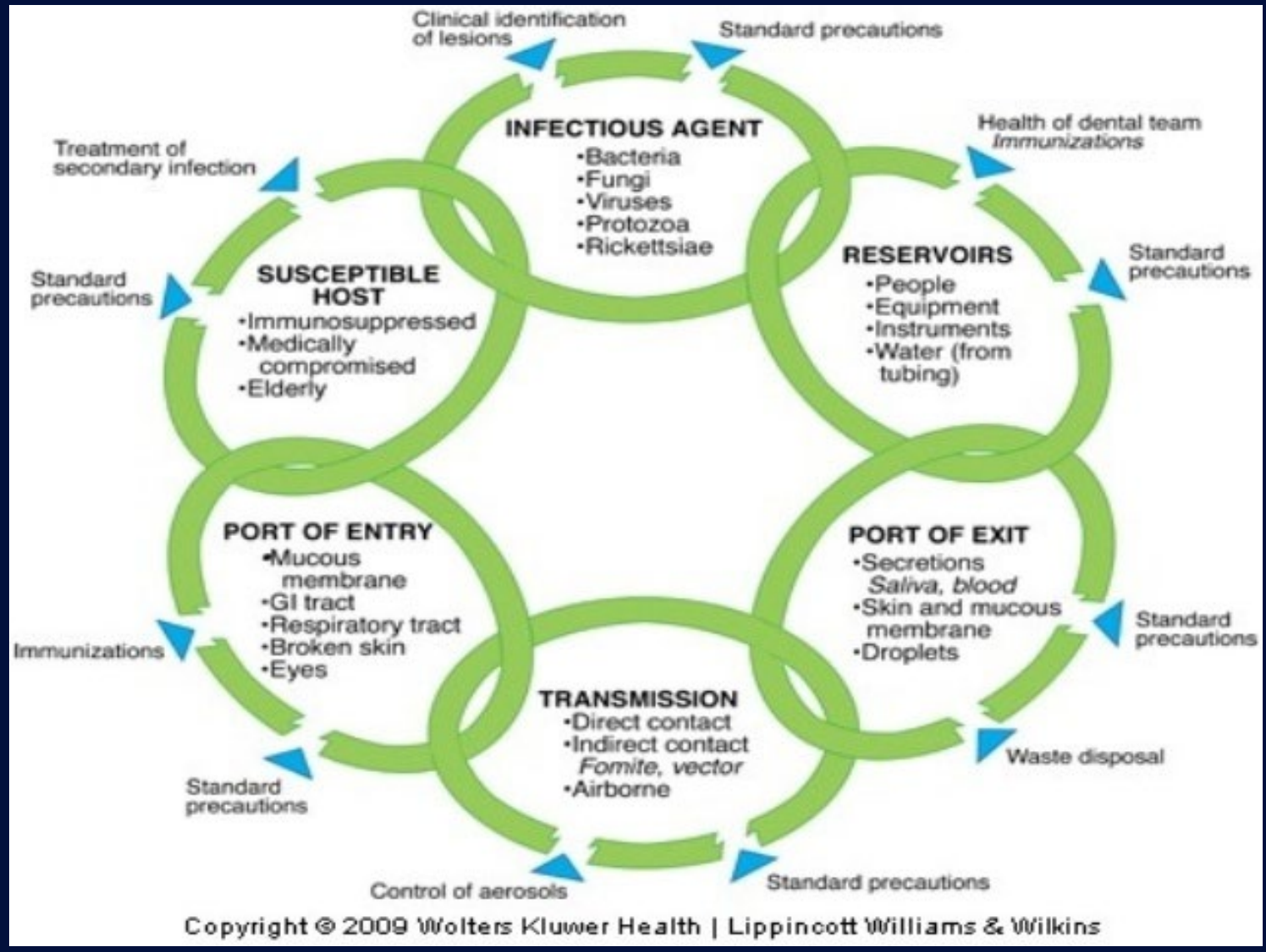


National Institute of Allergy and Infectious Diseases. *Community immunity*. niaid.nih.gov/topics/pages/communityimmunity.aspx. Accessed March 19, 2012.
Courtesy: National Institute of Allergy and Infectious Diseases.

COMMUNITY PROTECTION (HERD IMMUNITY) III



National Institute of Allergy and Infectious Diseases. *Community immunity*. niaid.nih.gov/topics/pages/communityimmunity.aspx. Accessed March 19, 2012.
Courtesy: National Institute of Allergy and Infectious Diseases.


Clinical identification of lesions
Standard precautions
INFECTIOUS AGENT
•Bacteria
•Fungi
•Viruses
•Protozoa
•Rickettsiae
Health of dental team
Immunizations
Treatment of secondary infection
RESERVOIRS
•People
•Equipment
•Instruments
•Water (from tubing)
Standard precautions
Standard precautions
SUSCEPTIBLE HOST
•Immunosuppressed
•Medically compromised
•Elderly
PORT OF ENTRY
•Mucous membrane
•GI tract
•Respiratory tract
•Broken skin
•Eyes
PORT OF EXIT
•Secretions
Saliva, blood
•Skin and mucous membrane
•Droplets
Immunizations
Standard precautions
TRANSMISSION
•Direct contact
•Indirect contact
Fomite, vector
•Airborne
Waste disposal
Standard precautions
Control of aerosols
Standard precautions
Copyright © 2009 Wolters Kluwer Health | Lippincott Williams & Wilkins

PREVENTING TRANSMISSION OF AN INFECTIOUS DISEASE REQUIRES UNDERSTANDING THE CHAIN OF TRANSMISSION

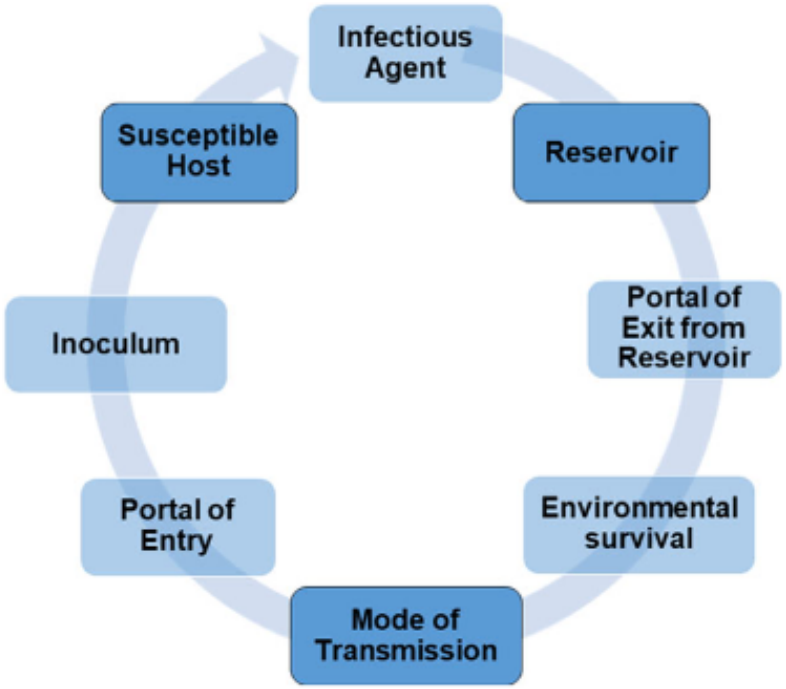


Fig. 1. The chain of transmission. Transmission from one individual to another requires completion of each step in the chain of transmission. Beginning with an infectious agent in a reservoir (eg, human, animal, or inanimate object/surface), the infectious agent must exit the reservoir through portal of exit; survive in the environment; and be transmitted by contact, droplet, or airborne routes (or a combination thereof); and enter as susceptible host through a portal of entry (eg, eyes, nose, mouth, wound) at an inoculum sufficient to establish infection.

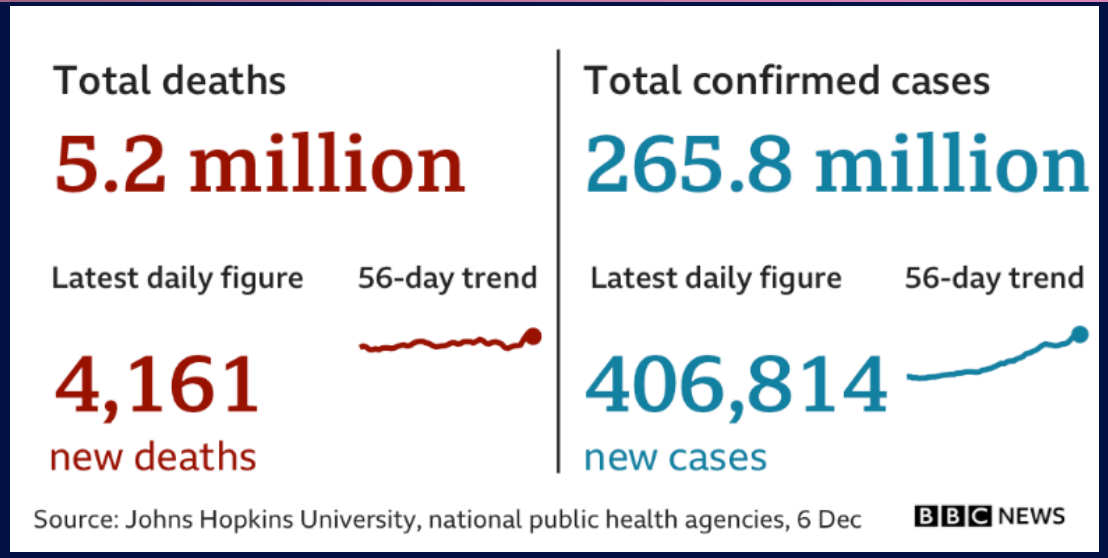
Shenoy ES, Weber DJ. ICHE 2021;42:457-460

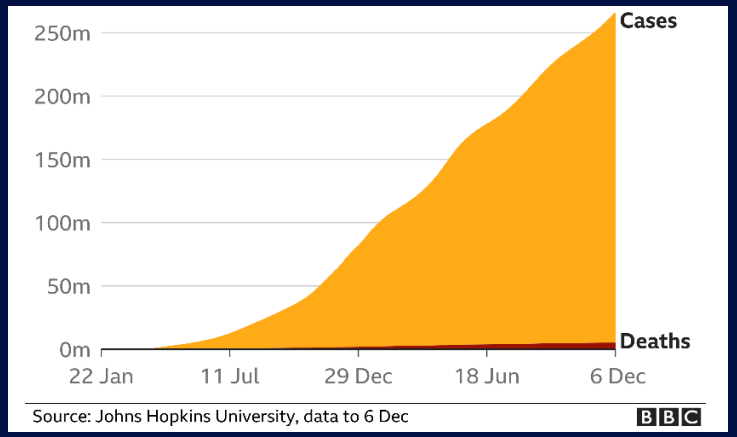
Table 1. Comparison of Pathogens Primarily Transmitted by Contact with Body Fluids (eg, Ebola virus) Versus Respiratory Droplets and Droplet Nuclei (eg, SARS-CoV-2)

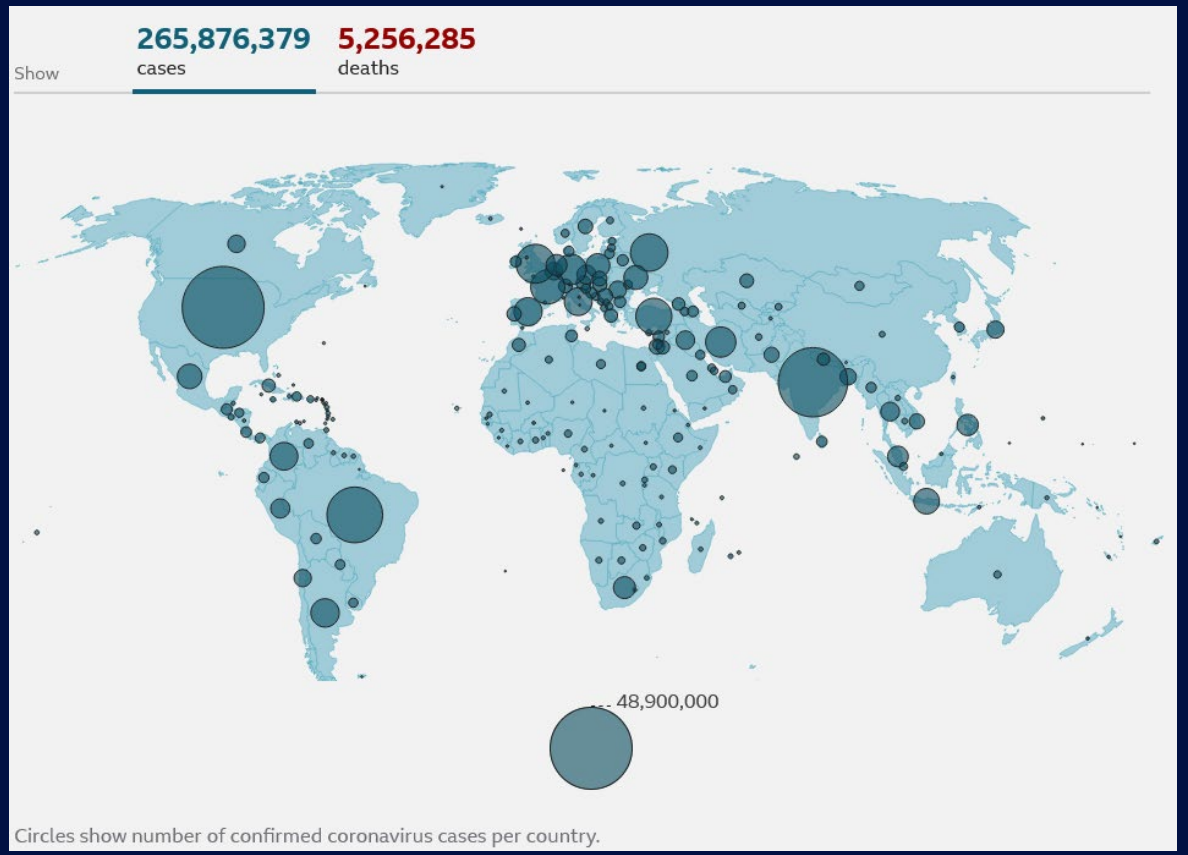
Variable	Ebola Virus	SARS-CoV-2
Microbiology		
Year identified	1976	2019
Family	Filaviridae	Coronaviridae
Genome	RNA	RNA
Coat	Enveloped	Enveloped
Epidemiology		
Prevalence	Repeated outbreaks	Pandemic
Reservoir	Bats	Bats; research ongoing to identify additional potential reservoirs
Intermediate host	Primates and other animals	None demonstrated
Primary mode of transmission	Direct Contact: Contact with infectious body fluids	Respiratory droplets
Other modes of transmission	Indirect contact (ie, contaminated surfaces, devices), sexual, blood transfusion	Direct and indirect contact (ie, contaminated surfaces, devices)
Basic reproductive rate (R_0)	1.5–2.0[23]	1.8–3.6[24]
Asymptomatic and presymptomatic transmission	No	Yes
Incubation period	6–12 d (range, 2–21)	2–14 d
Case fatality rate	˜50% (range, 25%-90%)	~15% among hospitalized patients
Treatment	Monoclonal antibody combination (atoltivimab, maftivimab, and odesivimab-ebgn)	Remdesivir, bamlanivimab
Infection prevention		
Nosocomial transmission involving HCP (HCP-to-HCP, HCP-to-patient, patient-to-HCP)	Yes	Yes
Laboratory biosafety level	BSL-4	BSL-2 (routine diagnostic testing); BSL-3 (virus isolation in cell culture)
Survival on surfaces	Hours to a few days	Hours to a few days
Antiseptic	60%–90% alcohol-based product	60%–90% alcohol-based product
Disinfectant	EPA, emerging virus claim (List "N")	EPA, emerging virus claim (List "N")
Special handling of used linens, patient waste	Yes	No
PPE worn by HCP (CDC)	1. Single-use (disposable) fluid-resistant gown that extends to at least mid-calf or single-use (disposable) fluid-resistant coveralls without integrated hood 2. Single-use (disposable) full face shield 3. Single-use (disposable) face mask 4. Single-use (disposable) gloves with extended cuffs. Two pairs of gloves should be worn. At a minimum, outer gloves should have extended cuffs.[25]	1. N95 respirator (or equivalent or higher-level respirator) or facemask (if a respirator is not available) 2. Eye protection (ie, goggles or a face shield that covers the front and sides of the face) 3. Single use (disposable), clean, nonsterile gloves 4. Single use (disposable) isolation gown or cloth gown.[26]
Pre-exposure prophylaxis	Vaccine	Vaccine
Postexposure prophylaxis	None approved for postexposure prophylaxis	None

Note. BSL, biosafety level; EPA, US Environmental Protection Agency; HCP, healthcare personnel.

COVID-19 AROUND THE WORLD



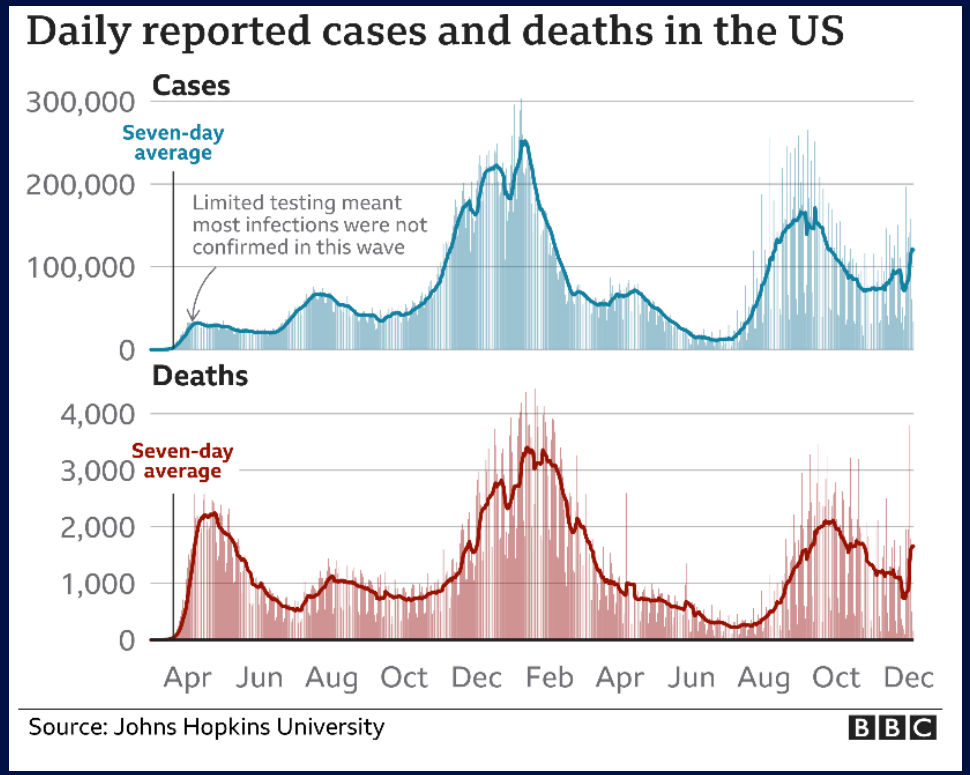




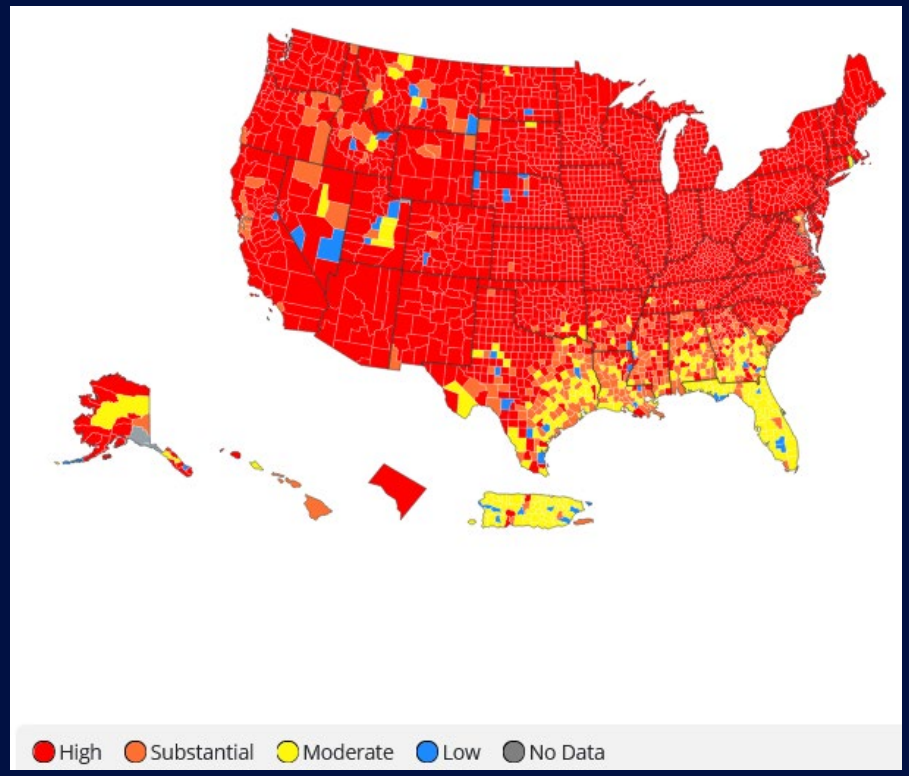
https://www.bbc.com/news/world-51235105

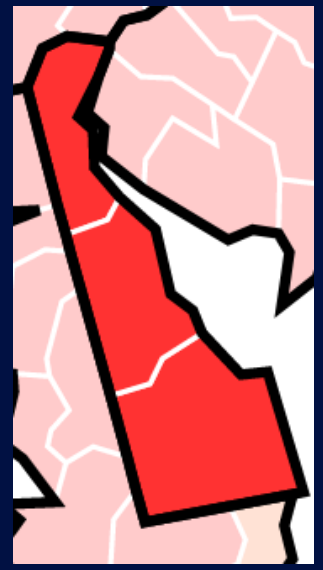
CURRENT EPIDEMIOLOGY OF COVID-19, US, CDC

10 Dec (7 days ave.): Cases ~118,515 (+37%); deaths ~1,092 (+28%); hospitalizations, 7,441 (+16%)



https://www.bbc.com/news/world-51235105



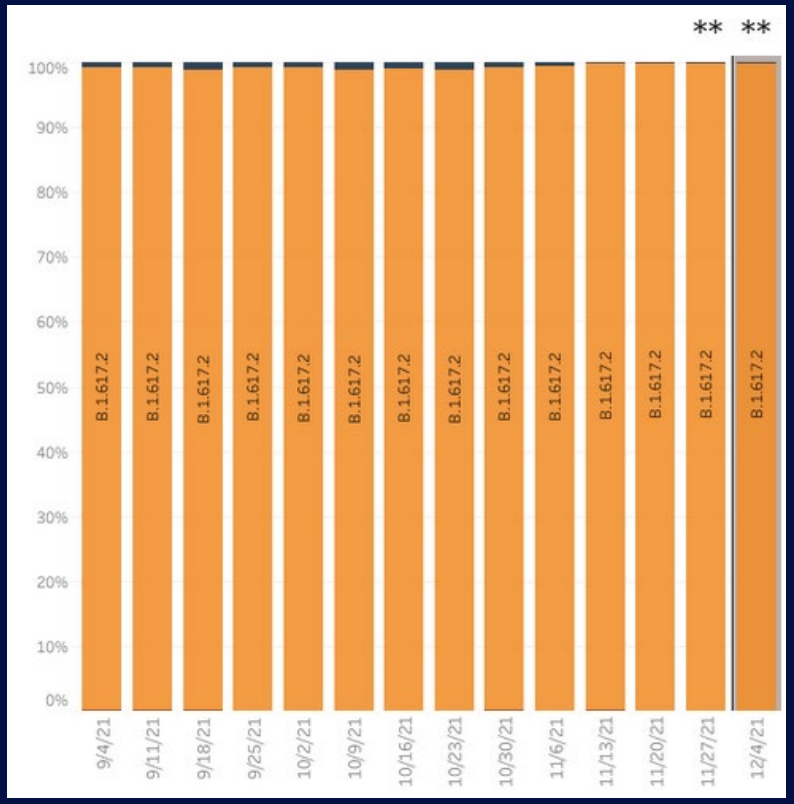


Dec. 10 (7 day metrics)
Cases: 3,989
8-9.9% positive
Hosp admits, ~32

https://covid.cdc.gov/covid-data-tracker/#county-view

WHATS DRIVING THE CURRENT COVID-19 CASES

- Exponential increase in Delta variant (>98% of US cases)
- Delta: Increased transmissibility, increased virulence, decreased protection from vaccines for symptomatic infection (but good protection against severe disease)
- Vaccine hesitancy and resistance
- Resumption of Fall activities and holidays
- Reinfections after COVID-19 and breakthrough infections in fully vaccinated
- Political resistance to COVID-19 mitigation strategies (e.g., masks) and COVID-19 fatigue
- Delta variant may also cause more severe disease
  - Canada: Higher odds of hospitalization [aOR 2.20 (CI 1.93-2.53)], ICU admission [aOR 3.87 (CI 2.98-4.99)], and death [aOR 2.37 (CI 1.50-3.30)][1]
  - Singapore: Higher odds of oxygen requirement, ICU admission, or death [aOR 4.90 (CI 1.43-30.78)] and pneumonia [aOR 1.88 (CI 0.95-3.76)[2]
  - Scotland: Higher odds of hospitalization [HR 1.85 (CI 1.39-2.47)][3]
- Current threat = Omicron: reported >40 countries, ~25 states; escape from most mABs and natural immunity; reduced coverage by vaccines

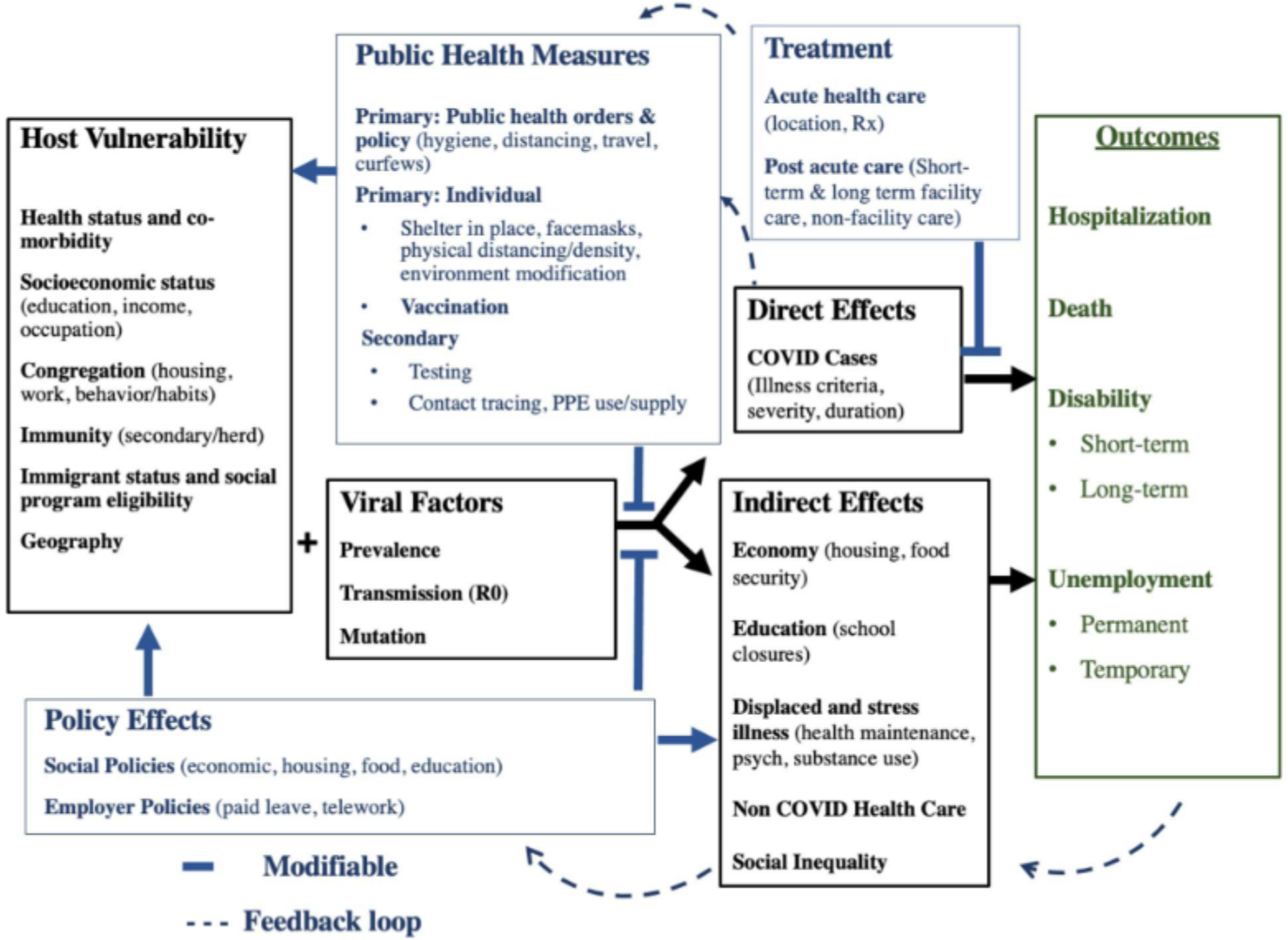


USA

WHO label	Lineage #	US Class	%Total	95%PI
Delta	B.1.617.2	VOC	99.9%	99.8-99.9%
	AY.1	VOC	0.1%	0.0-0.1%
	AY.2	VOC	0.0%	0.0-0.0%
Omicron	B.1.1.529	VOC	0.0%	0.0-0.0%
Other	Other*		0.1%	0.0-0.1%

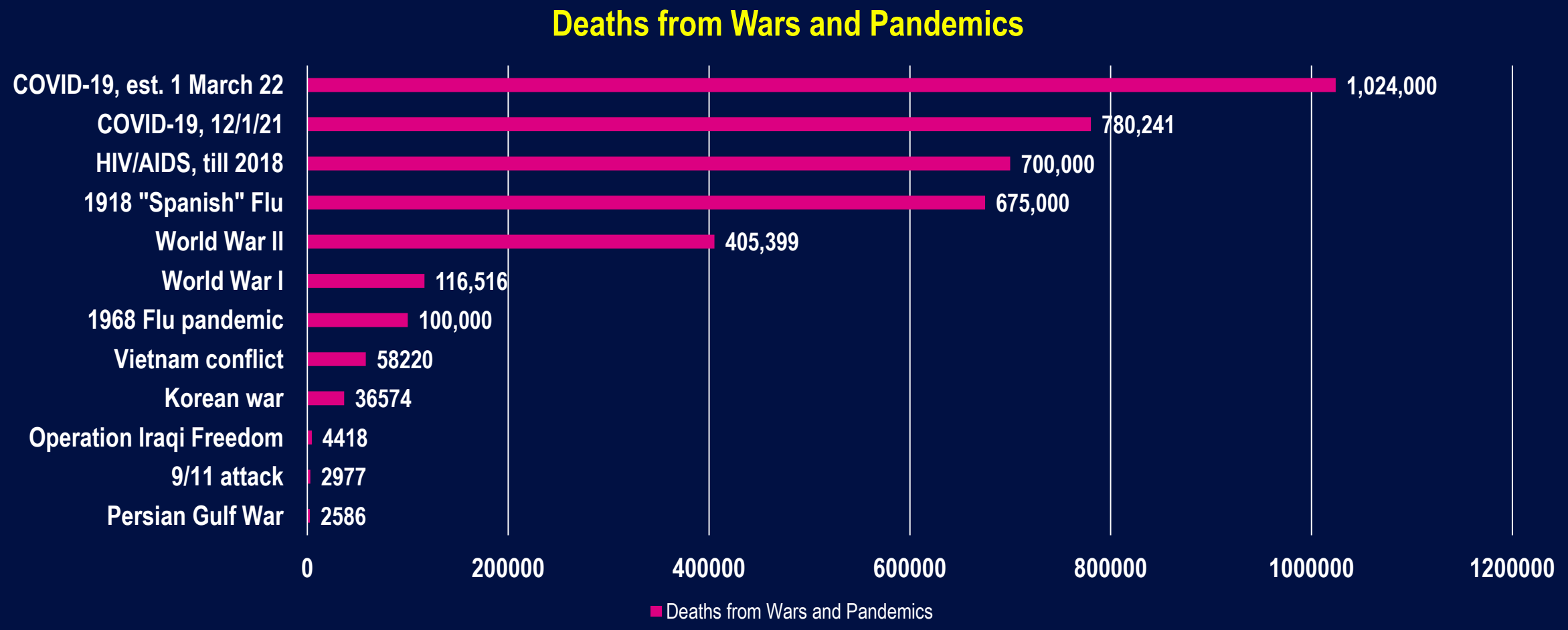
https://covid.cdc.gov/covid-data-tracker/#variant-proportions

Figure 1: Conceptual Framework of Factors Affecting the Pandemic's Trajectory



Credit: COVID-19 Task Force Epidemiology Working Group, National Academy of Social Insurance

Deaths from COVID-19 and Other Pandemics and Wars, US



COVID-19 deaths, 8/31/21, source: https://coronavirus.jhu.edu/map.html

COVID-19 estimates (21/1/21: https://covid19.healthdata.org/united-states-of-america?view=cumulative-deaths&tab=trend

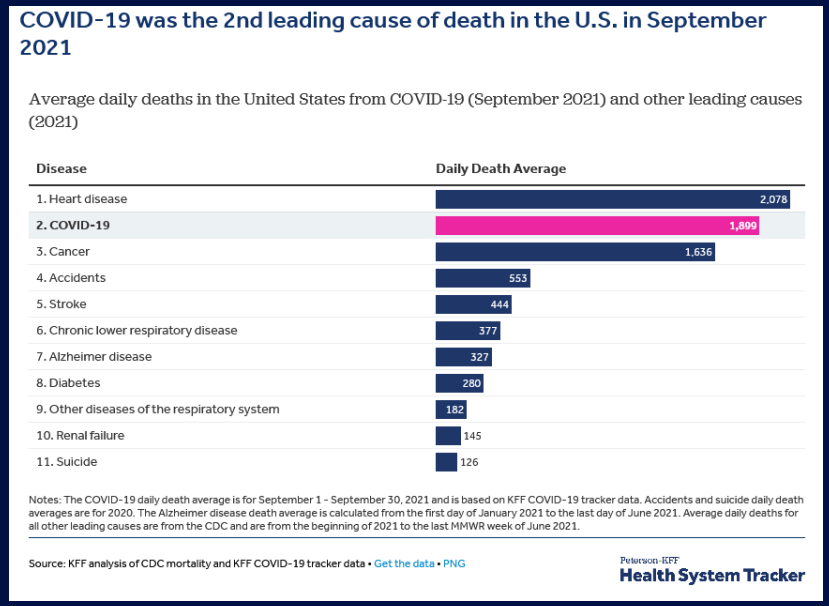
Leading Causes of Death, US, 2015-2020

Cause of death	No. of deaths by year					
	2015	2016	2017	2018	2019	2020
Total deaths	2 712 630	2 744 248	2 813 503	2 839 205	2 854 838	3 358 814
Heart disease	633 842	635 260	647 457	655 381	659 041	690 882
Cancer	595 930	598 038	599 108	599 274	599 601	598 932
COVID-19[b]						345 323
Unintentional injuries	146 571	161 374	169 936	167 127	173 040	192 176
Stroke	140 323	142 142	146 383	147 810	150 005	159 050
Chronic lower respiratory diseases	155 041	154 596	160 201	159 486	156 979	151 637
Alzheimer disease	110 561	116 103	121 404	122 019	121 499	133 382
Diabetes	79 535	80 058	83 564	84 946	87 647	101 106
Influenza and pneumonia	57 062	51 537	55 672	59 120	49 783	53 495
Kidney disease	49 959	50 046	50 633	51 386	51 565	52 260
Suicide	44 193	44 965	47 173	48 344	47 511	44 834

[a] Leading causes are classified according to underlying cause and presented according to the number of deaths among US residents. For more information, see the article by Heron.[4] Source: National Center for Health Statistics. National Vital Statistics System: mortality statistics (http://www.cdc.gov/nchs/deaths.htm). Data for 2015-2019 are final; data for 2020 are provisional.

[b] Deaths with confirmed or presumed COVID-19, coded to *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* code U07.1 as the underlying cause of death.

TOTAL DEATHS: US, ~723,000
World, ~4,890,000

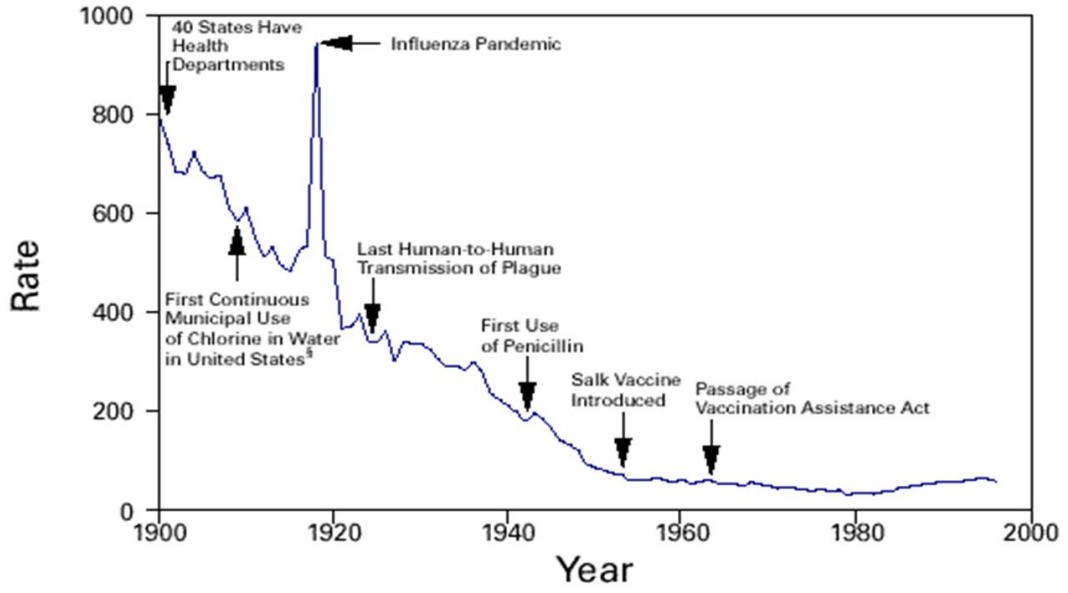


Number dying each day: Heart disease, 2,000; cancer 1,600; COVID-19 Sept, 1,899

Ahmad FB, Anderson RN. JAMA ;325:1829-30;
https://www.healthsystemtracker.org/brief/covid19-and-other-leading-causes-of-death-in-the-us/

IMPACT OF 1918-19 INFLUENZA AND COVID-19 PANDEMICS ON DEATH RATES AND LIFE EXPECTANCY, US

FIGURE 1. Crude death rate* for infectious diseases — United States, 1900–1996†



*Per 100,000 population per year.
†Adapted from Armstrong GL, Conn LA, Pinner RW. Trends in infectious disease mortality in the United States during the 20th century. JAMA 1999:281;61–6.
§American Water Works Association. Water chlorination principles and practices: AWWA manual M20. Denver, Colorado: American Water Works Association, 1973.

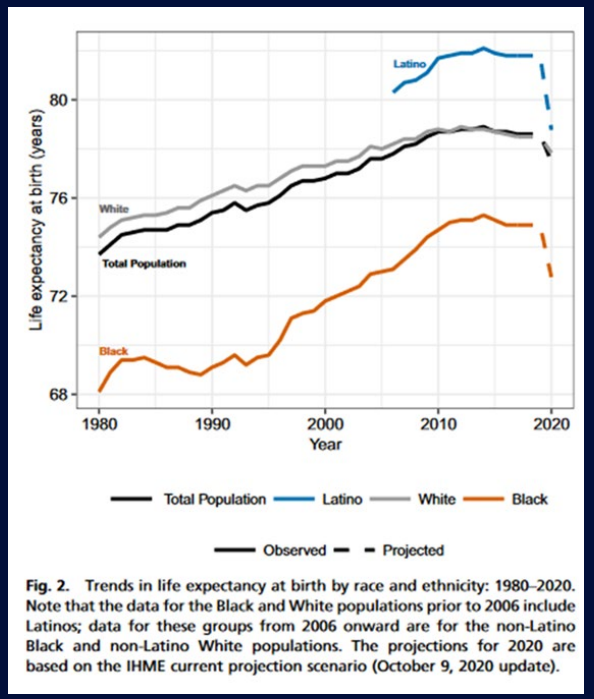


Fig. 2. Trends in life expectancy at birth by race and ethnicity: 1980–2020. Note that the data for the Black and White populations prior to 2006 include Latinos; data for these groups from 2006 onward are for the non-Latino Black and non-Latino White populations. The projections for 2020 are based on the IHME current projection scenario (October 9, 2020 update).

Andrasfay T, Goldman N. PNAS 2021;118:No. 5 e2014746118

Table 3. Summary of the direct, indirect, and overall effects of the COVID-19 pandemic in the United States in 2020.

	Excess Mortality	Life Expectancy Loss	YLL
Direct Effects	313171	1.35 (1.35, 1.35)	5,340,469 (5,068,888, 5,627,895)
Indirect Effects	62064 (-180791, 304917)	0.32 (-0.94, 1.64)	2,022,086 (-3472687, 8041802)
Overall Effect	375235 (132380, 618088)	1.67 (0.41, 2.99)	7,362,555 (1,596,202, 13,669,696)

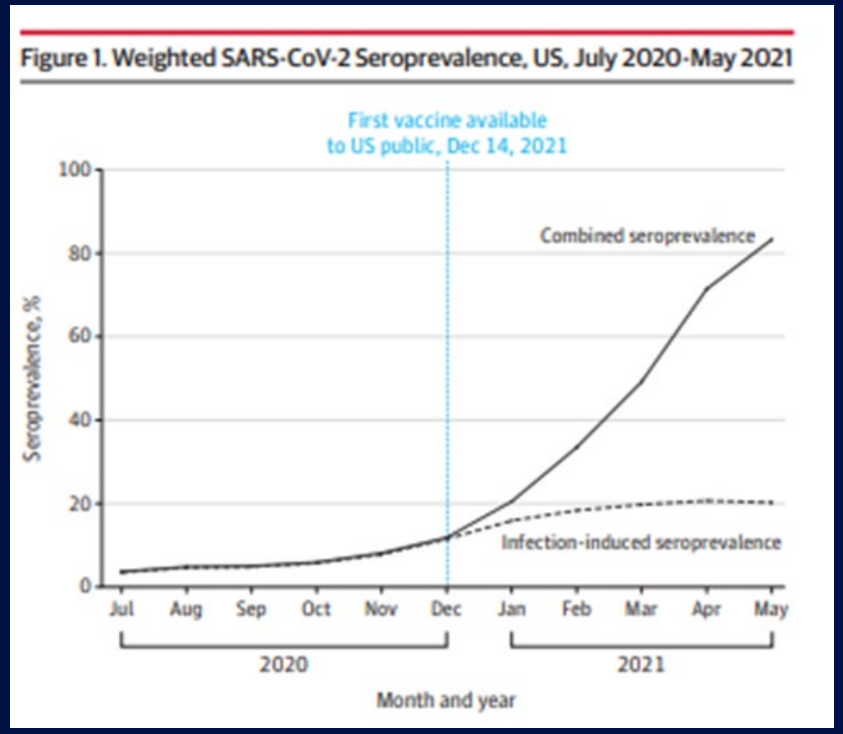
Values in parentheses represent the 95% prediction interval.

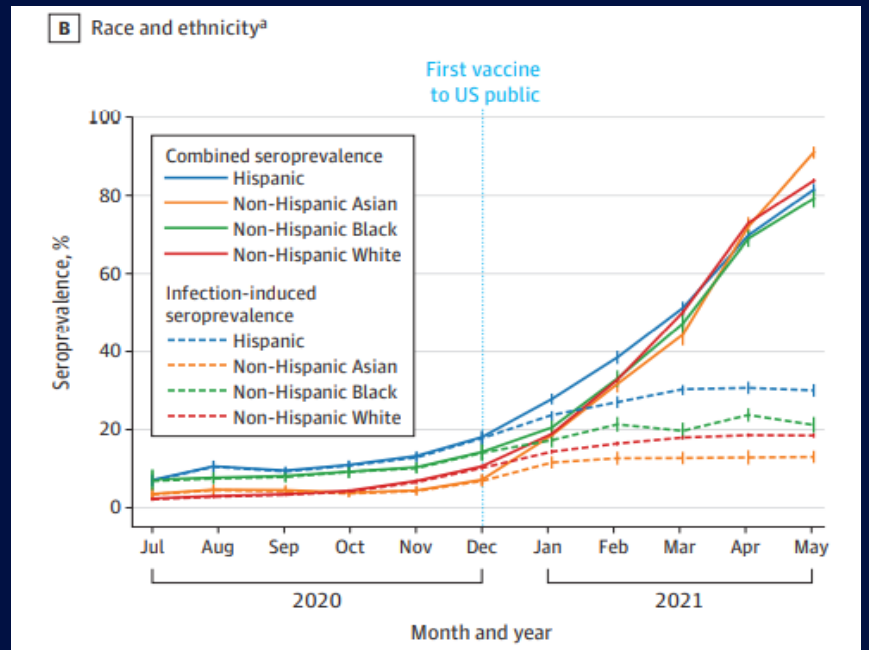
Chan EYS, et al. PLoS One 2021;1 September

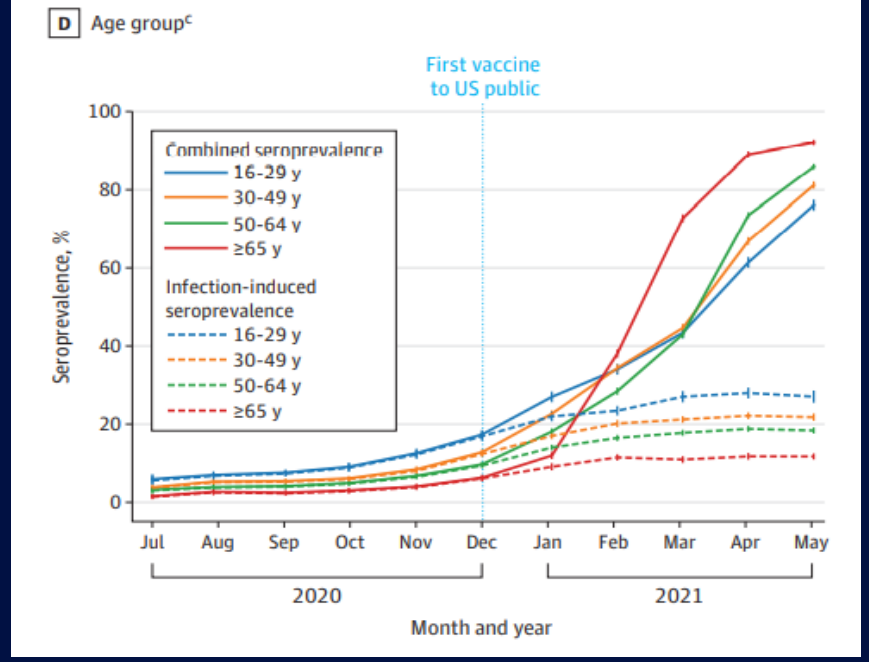
SARS-CoV-2 SEROPREVALANCE, US

- Goal: Assess SARS-CoV-2 seroprelavence based on blood donations, 7/20-5/21
- Methods: Repeated cross-sectional study that included 1,443,519 blood donation specimens from a catchment area representing 74% of the US population
- Results: Estimated SARS-CoV-2 seroprevalence weighted for differences between the study sample and general population increased from 3.5% in July 2020 to 20.2% for infection-induced antibodies and 83.3% for combined infection- and vaccine-induced antibodies in May 2021. Seroprevalence differed by age, race and ethnicity, and geographic region of residence, but these differences changed over the course of the study

Jones JM, et al JAMA 2021;2 Sept.







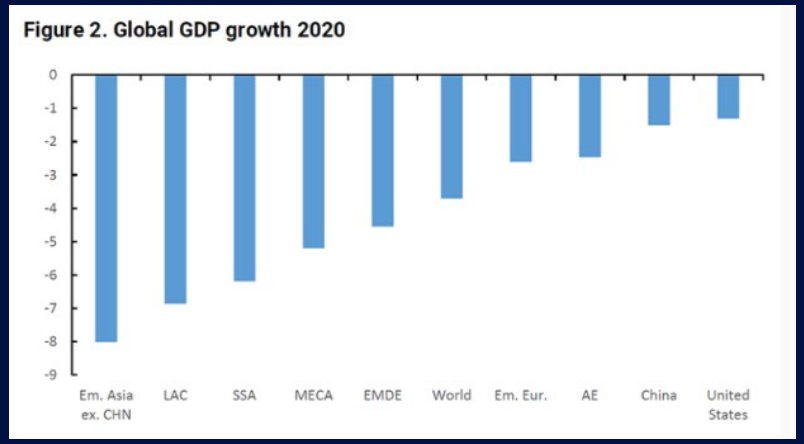
The Impact of Coronavirus on Households Across America, Robert Wood Johnson Foundation, SEPTEMBER 2020

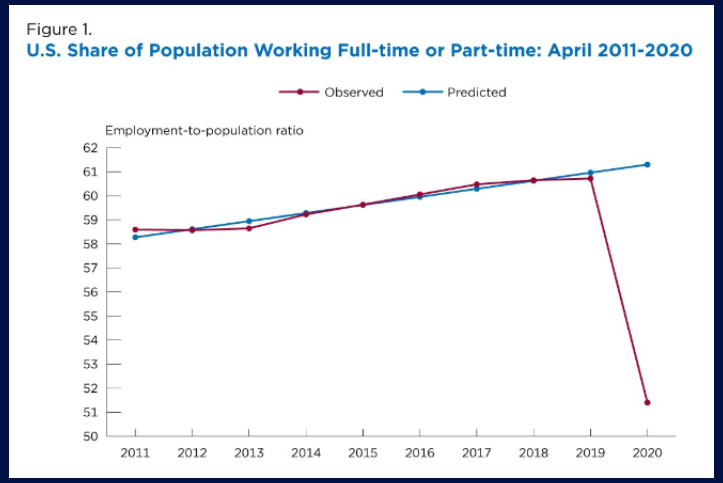
- At least half of households in the four largest U.S. cities—New York City (53%), Los Angeles (56%), Chicago (50%), and Houston (63%)—report serious financial problems including depleted savings, and trouble paying bills or affording medical care.
- Many of these experiences are concentrated among Black and Latino households; households with annual incomes below $100,000; and households experiencing job or wage losses since the start of the outbreak.
- At least four in ten Latino, Black, and Native American households report using up all or most of their household savings during this time.
- One in five households in the United States (20%) report household members unable to get medical care for serious problems. A majority unable to get care when needed (57%) report negative health consequences as a result.
- More than 1 in 3 households that include anyone with a disability report facing serious financial problems, many experiencing difficulty affording utilities and food.
- More than one in three (36%) households with children face serious problems keeping their children's education going, and among working households, nearly one in five (18%) report serious problems getting childcare when adults need to work.
- About one in three households with children (34%) either do not have a high-speed internet connection at home or report serious problems with their connection while doing schoolwork or their jobs during the pandemic.

https://www.rwjf.org/en/library/research/2020/09/the-impact-of-coronavirus-on-households-across-america.html

IMPACT OF COVID, WORLDWIDE AND US

https://www.brookings.edu/research/social-and-economic-impact-of-covid-19/





https://www.census.gov/library/stories/2021/03/initial-impact-covid-19-on-united-states-economy-more-widespread-than-on-mortality.html

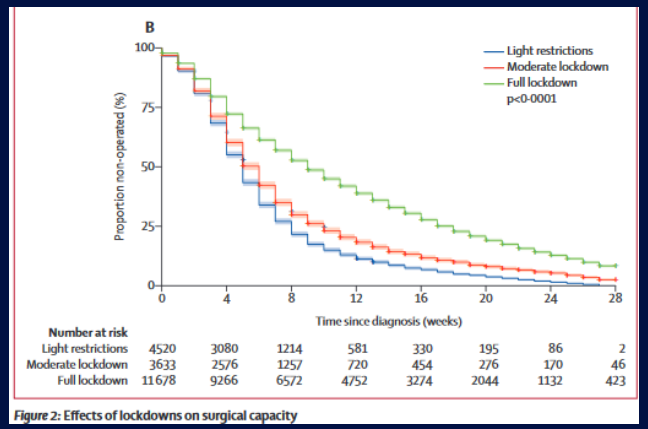
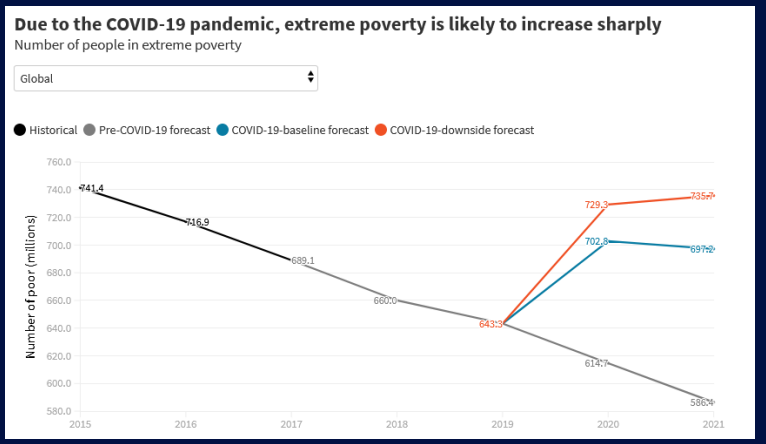


Figure 2: Effects of lockdowns on surgical capacity

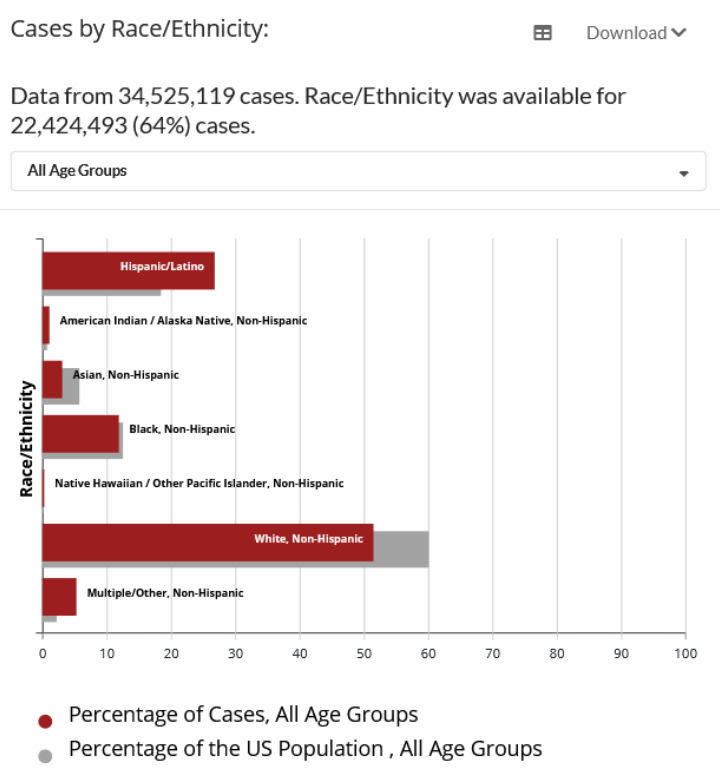
	All patients
COVID-19 related	
Multidisciplinary team decision to delay surgery due to patient risk during COVID-19	1456 (72·8%)
Change to alternative treatment modality because of COVID-19	533 (26·6%)
Patient choice to avoid surgery during COVID-19 pandemic	460 (23·0%)
Ongoing neoadjuvant therapy (COVID decision)	378 (18·9%)
No bed, critical care bed, or operating room space available due to COVID-19	299 (14·9%)
Change of recommendations in society guidelines related to COVID-19	220 (11·0%)
Patient unable to travel to hospital related to COVID-19	140 (7·0%)
Collateral impact on supporting services causing delay	24 (1·2%)
Patient delayed due to SARS-CoV-2 infection	23 (1·1%)
Died of COVID-19 while waiting for surgery	14 (0·6%)
Total	2001 (100·0%)

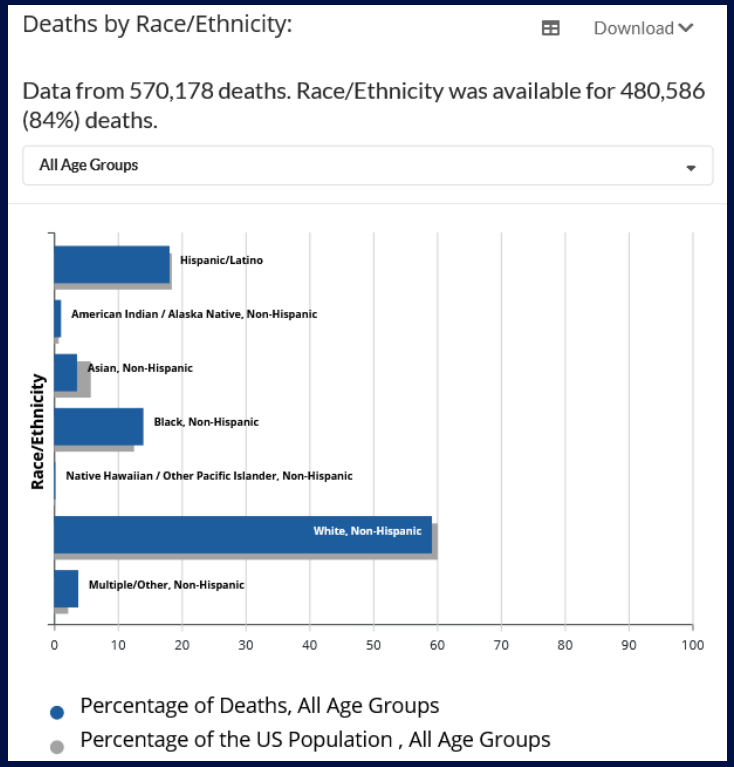


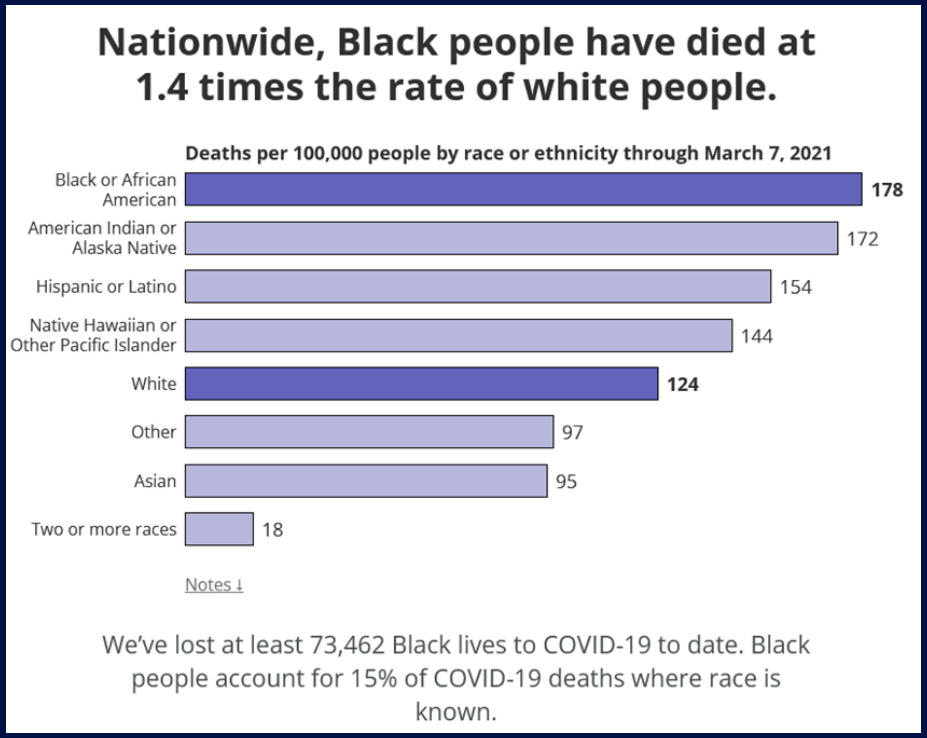
Effect of COVID-19 pandemic lockdowns on planned cancer surgery for 15 tumour types in 61 countries: an international, prospective, cohort study, Lancet Oncology 2021

https://blogs.worldbank.org/voices/2020-year-review-impact-covid-19-12-charts

COVID-19 CASES/DEATHS, DISPARITIES, US



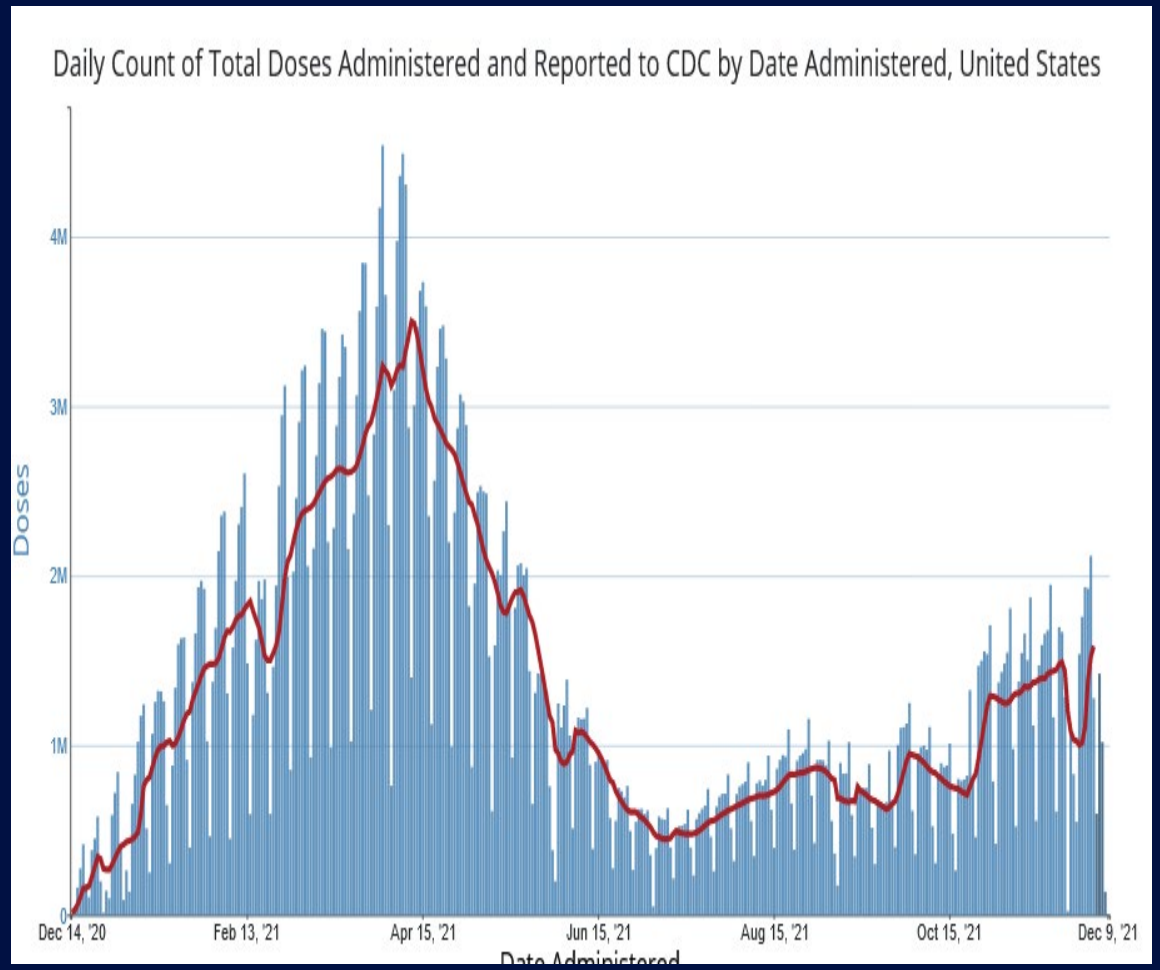




https://covid.cdc.gov/covid-data-tracker/#demographics

https://covidtracking.com/race

COVID-19 VACCINATION, US



At Least One Dose	Fully Vaccinated	Booster Doses***
Vaccinated People	Count	Percent of US Population
Total	237,468,725	71.5%
Population ≥ 5 Years of Age	237,430,134	76%
Population ≥ 12 Years of Age	232,294,603	81.9%
Population ≥ 18 Years of Age	216,653,622	83.9%
Population ≥ 65 Years of Age	55,699,115	95%

	Pct. of population			Doses administered		
	▾ Vaccinated	Fully vaccinated	Additional dose	Per 100 people	Total	Additional doses
World	57%	46%	4.2%	109	8,342,754,217	325,218,097
U.A.E.	>99%*	90%*	30%	221*	21,548,528*	2,914,743*
Brunei	93%	85%	–	178	771,983	–
Cuba	90%	82%	–	254	28,741,454	–
Chile	89%	86%	47%	219	41,539,321	8,986,384
Portugal	88%	88%	17%	176	18,065,162	1,722,665
Mainland China	88%*	80%	6.9%	184	2,574,931,000	96,312,000
Malta	87%	86%	29%	195	981,712	143,935
Cambodia	86%	82%	16%	178	29,284,160	2,626,019
Qatar	83%*	78%*	–	178	5,043,480	–
Singapore	83%	83%	11%	166	9,489,264	622,452*
South Korea	83%	80%	10%	171	88,227,374	5,289,734
Canada	83%	78%	6.6%	167	62,771,921	2,496,915
Argentina	83%	68%	6.1%	157	70,657,836	2,719,935
Spain	82%	80%	13%	165	77,653,701	5,898,138

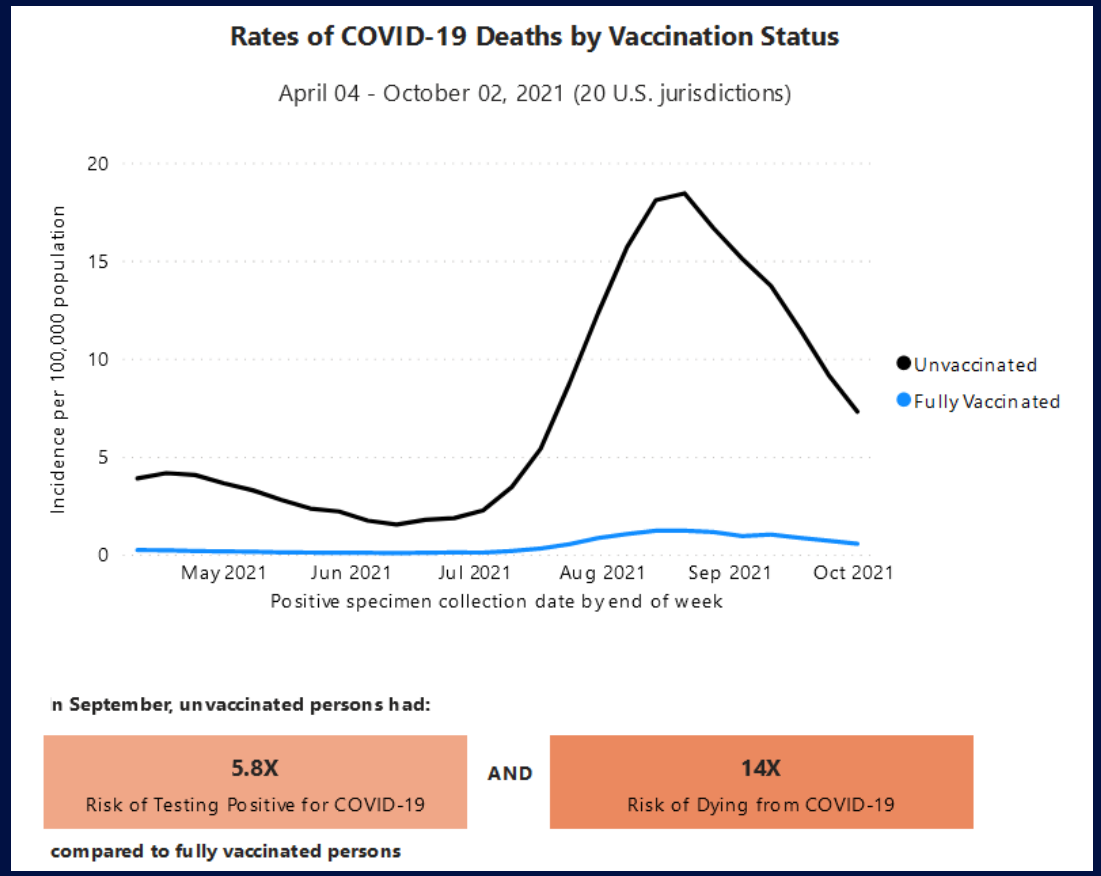
Number 50

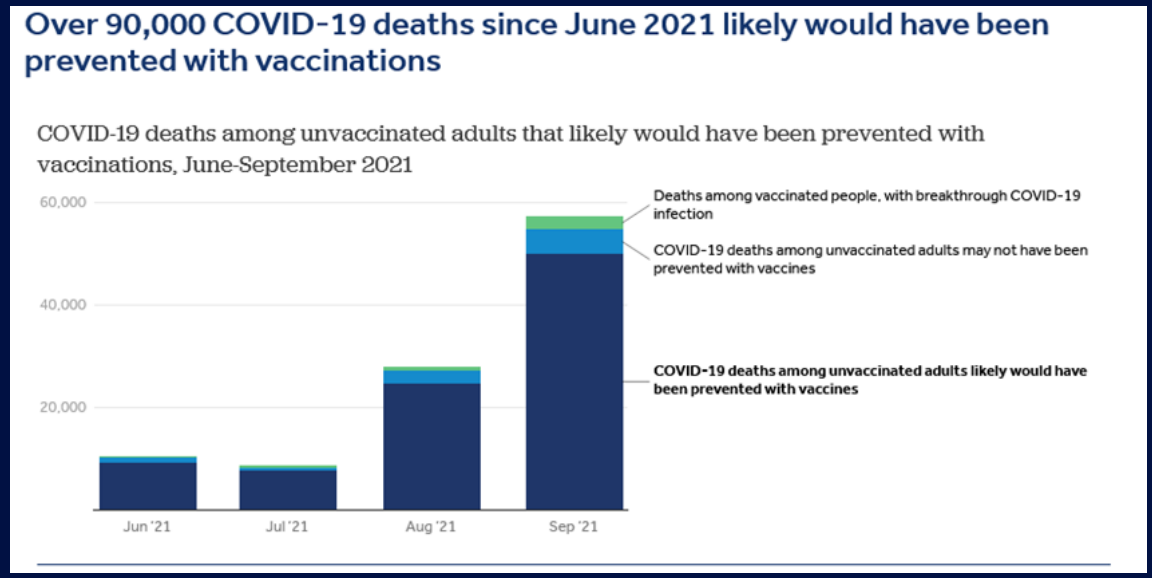
United States	71%	60%	15%	143	475,728,399	48,896,346

https://covid.cdc.gov/covid-data-tracker/#vaccination-trends

https://covid.cdc.gov/covid-data-tracker/#vaccinations_vacc-total-admin-rate-total
https://www.nytimes.com/interactive/2021/world/covid-vaccinations-tracker.html

IMPACT OF COVID-19 VACCINES ON DEATHS, US





https://covid.cdc.gov/covid-data-tracker/#rates-by-vaccine-status

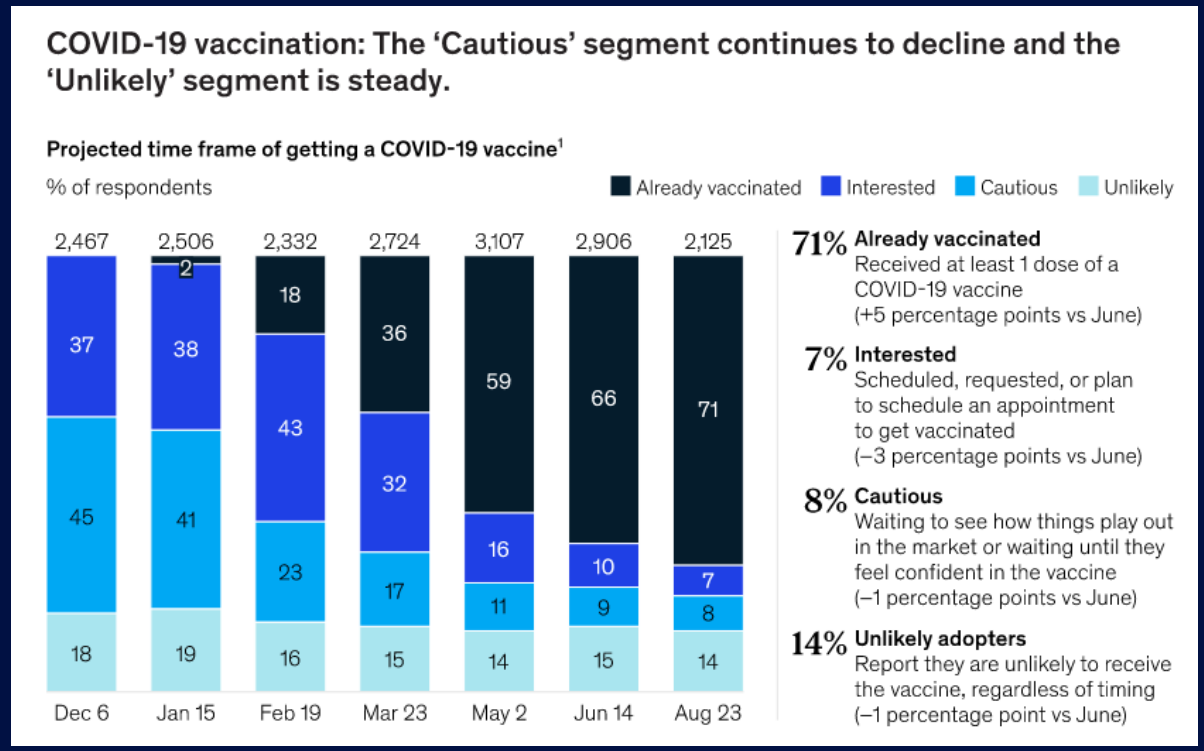
https://www.healthsystemtracker.org/brief/covid19-and-other-leading-causes-of-death-in-the-us/

DISPARTITIES IN VACCINE ACCEPTANCE

As you may know, an FDA-authorized vaccine for COVID-19 is now available for free to all adults in the U.S. Do you think you will...?

	Unvaccinated adults	Wait and see	Definitely not get the vaccine
Age			
18-29	28%	24%	30%
30-49	44%	52%	43%
50-64	20%	17%	17%
65+	8%	7%	10%
Race/Ethnicity			
Black	13%	14%	13%
Hispanic	20%	27%	13%
White	57%	50%	65%
Party identification			
Democrat	23%	27%	15%
Republican	51%	46%	58%
Education			
High school or less	46%	53%	37%
Some college	36%	32%	43%
College degree or more	17%	14%	19%
Income			
Less than $40K	44%	45%	44%
$40K-$89.9K	29%	35%	26%
$90K+	19%	17%	23%
Insurance status			
Insured, under 65 years old	78%	82%	77%
Uninsured, under 65 years old	22%	18%	23%
Community type			
Urban	28%	30%	28%
Suburban	52%	52%	50%
Rural	20%	17%	22%

KFF COVID-19 Vaccine Monitor
https://www.kff.org/coronavirus-covid-19/dashboard/kff-covid-19-vaccine-monitor-dashboard/



https://www.mckinsey.com/business-functions/risk-and-resilience/our-insights/covid-19-implications-for-business

LONG-COVID-19 SYNDROME

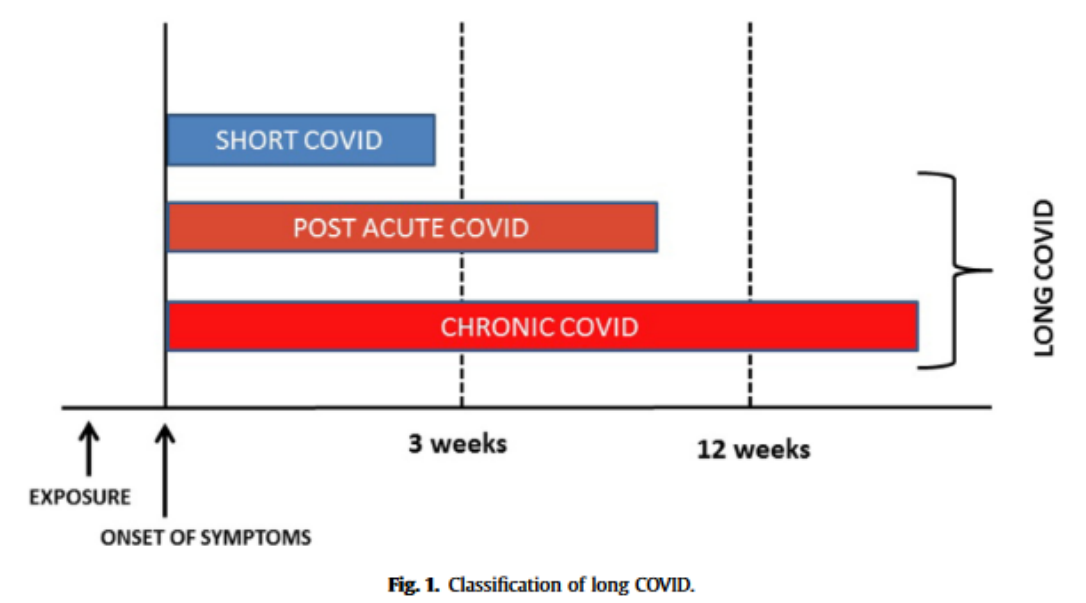


Fig. 1. Classification of long COVID.

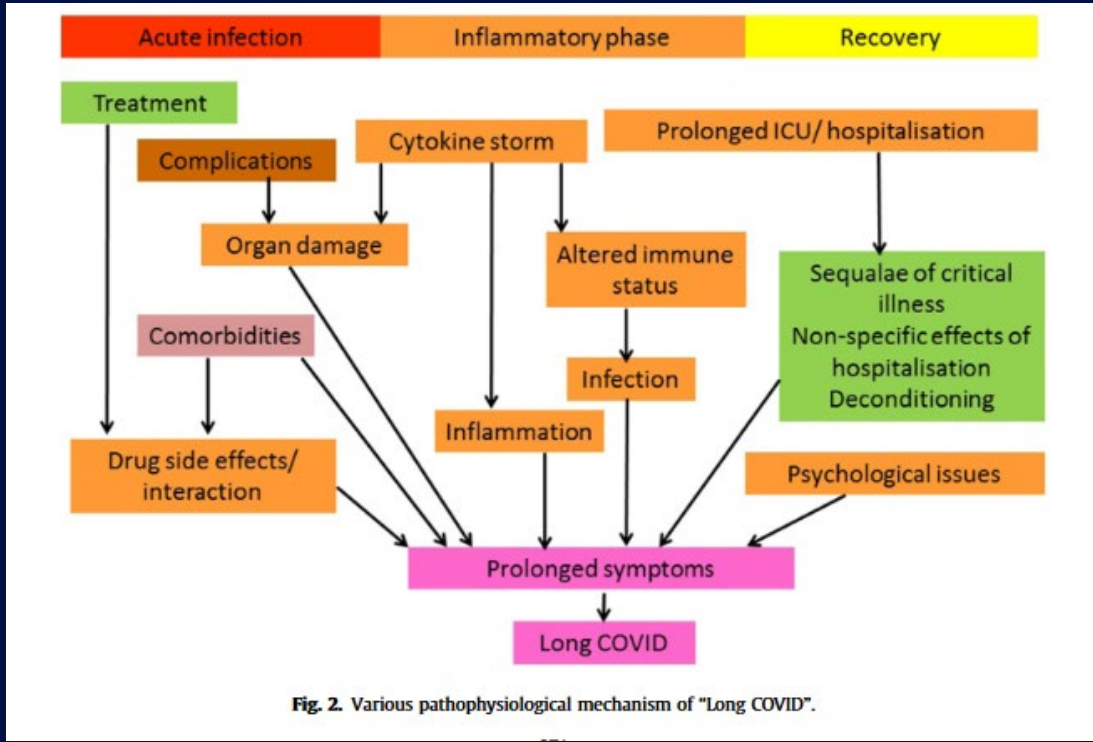


Fig. 2. Various pathophysiological mechanism of "Long COVID".

Raveendran AV, et al. Diabetes & Metabolic Synrome: Clinical Research and Reviews 2021;15:869-875

FREQUENCY AND SYMPTOMS OF LONG-COVID-19

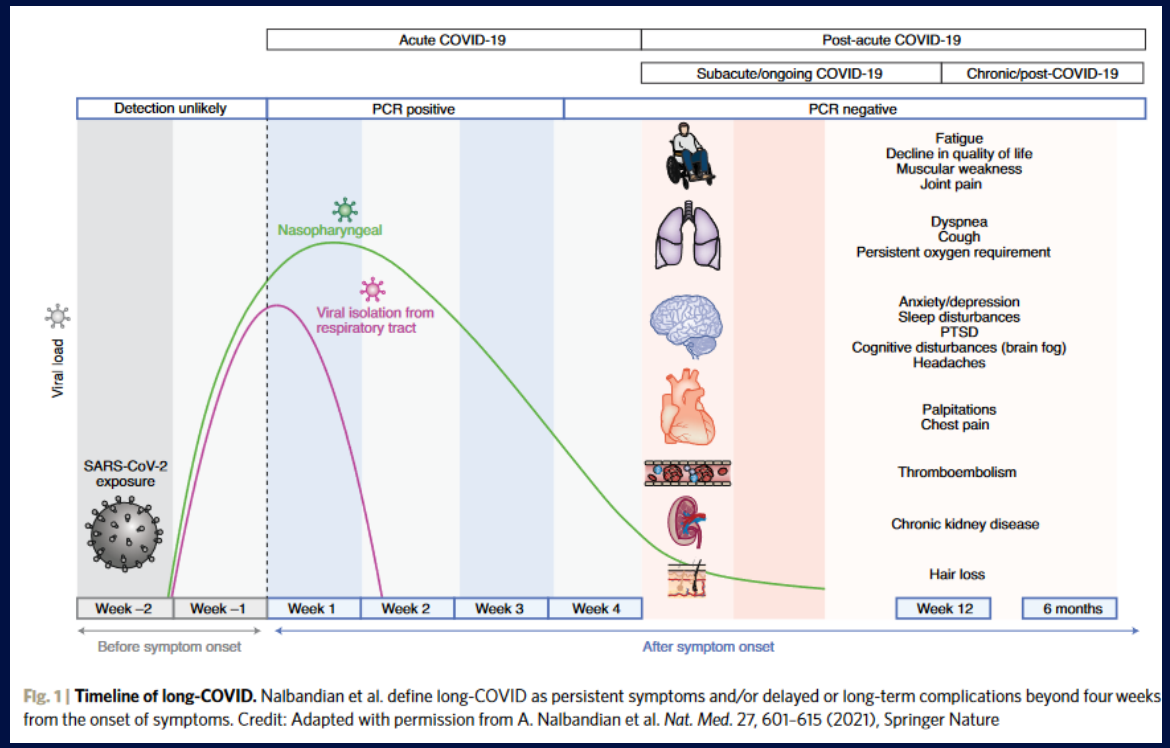
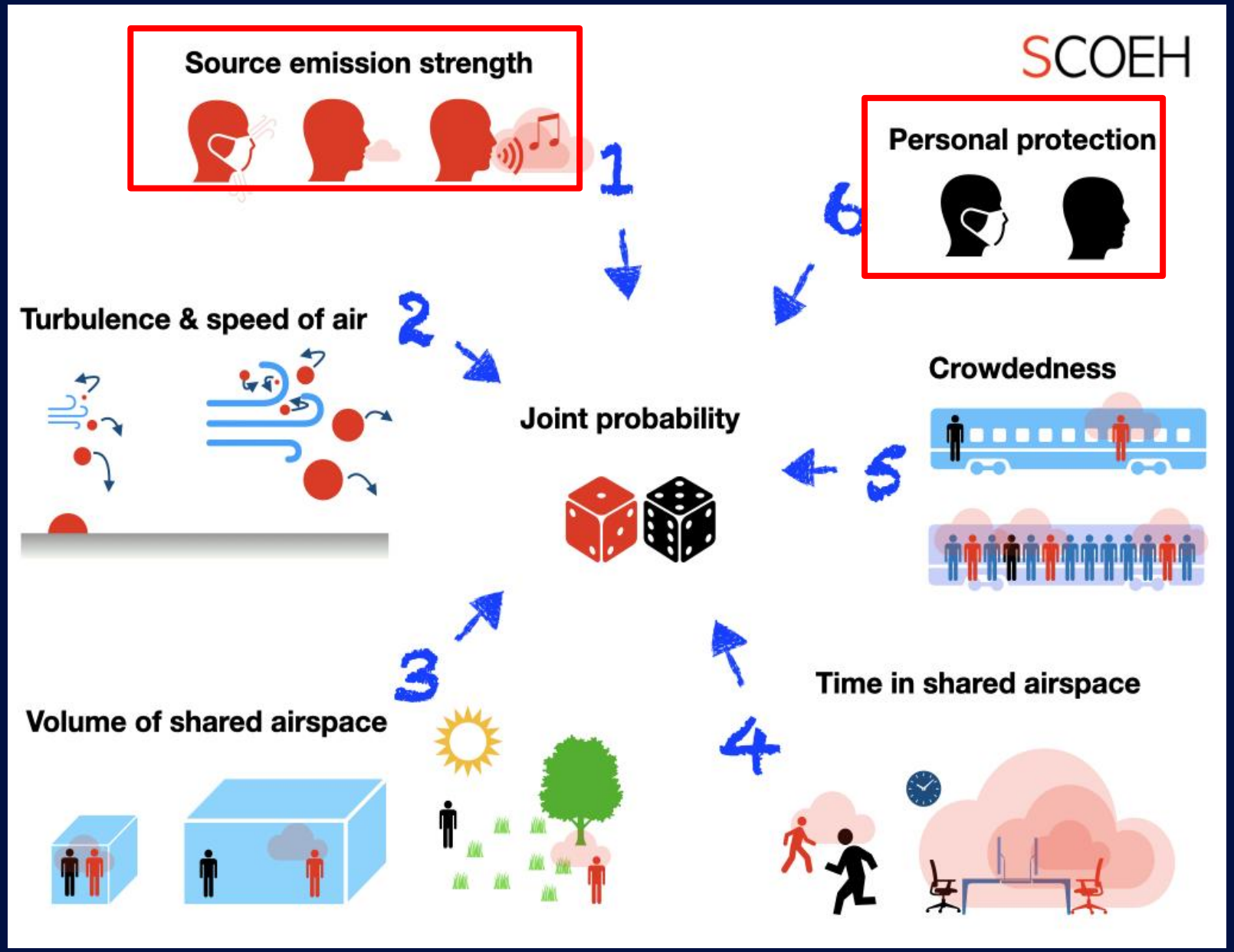


Fig. 1 | **Timeline of long-COVID.** Nalbandian et al. define long-COVID as persistent symptoms and/or delayed or long-term complications beyond four weeks from the onset of symptoms. Credit: Adapted with permission from A. Nalbandian et al. *Nat. Med.* 27, 601–615 (2021), Springer Nature

Schmidt C. Nature Biotechnology 2021;39:908-913

- Goal: Assess long-COVID-19 in large EMR database
- Methods: Retrospective cohort study using EMR data from 81 million patients, 273,618 COVID-19 survivors; incidence within 6 months and 3-6 months after diagnosis
- Results: Among COVID-19 survivors (mean [SD] age: 46.3 [19.8], 55.6% female), 57.00% had one or more long-COVID feature recorded during the whole 6-month period (i.e., including the acute phase), and 36.55% between 3 and 6 months.
  - 1 in 3 patients had one or more features of long-COVID recorded between 3 and 6 months after a diagnosis of COVID-19. This was significantly higher than after influenza.
  - 2 in 5 of the patients who had long-COVID features in the 3- to 6-month period, had no record of any such feature in the previous 3 months.
  - The risk of long-COVID features was higher in patients who had more severe COVID-19 illness, and slightly higher among females and young adults. White and non-white patients were equally affected.

Taquet M, et al. PLOS Medicine 2021;28 September



Factors affecting acquisition of a viral respiratory infection

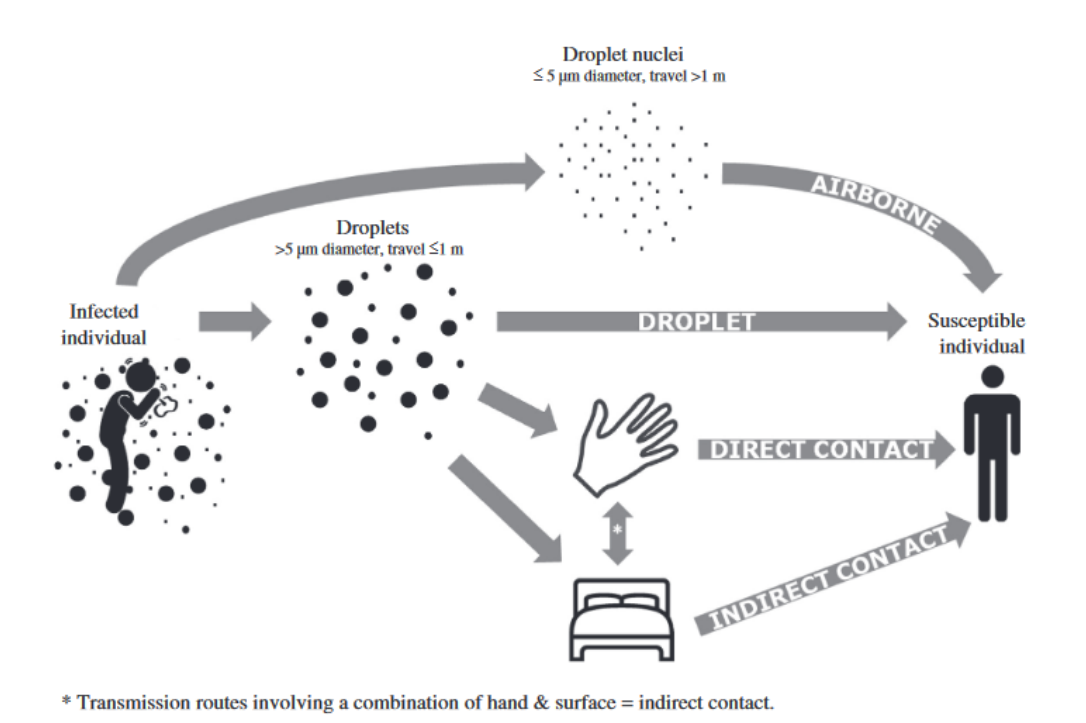
1. Virus must survive drying and UV
2. To cause infection, virus must be delivered in infectious dose (i.e., survive dispersal/dilution)

Risk reduced by:

1. Vaccine receipt
2. Infected persons wearing a mask
3. Non-infected persons wearing a mask
4. Physical distancing
5. Hand hygiene
6. Surface disinfection

https://scoeh.ch/de/kontakt/

TRANSMISSION OF SARS CoV-2

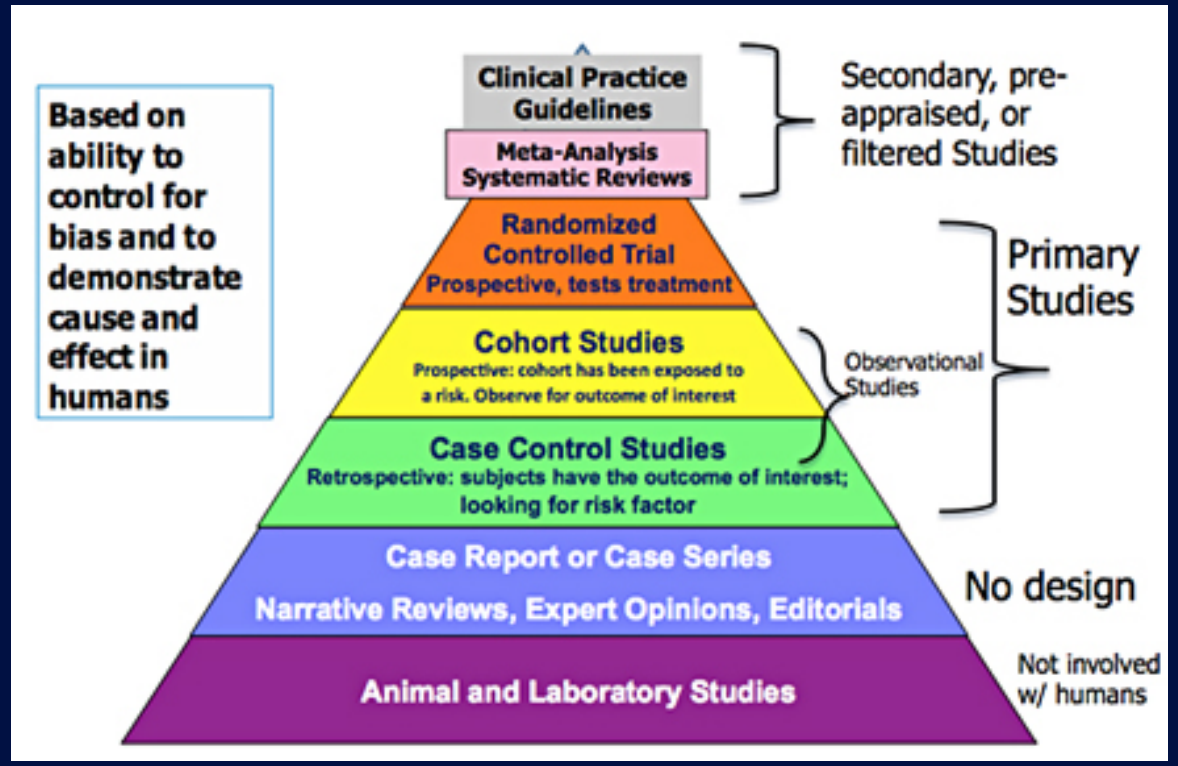


- Aerosol/Droplet (≤6 feet) most important mode of transmission
- Aerosol (≥6 feet) demonstrated indoor with directional airflow and poor ventilation (less important that short distance transmission)
- Other modes: Direct contact and indirect (via the contaminated environment)
- Pre-symptomatic (i.e., up to 48 hours before person develops symptoms) and asymptomatic transmission well documented – important in maintaining pandemic
- Transmission via blood not demonstrated; via stool (very rare; single outbreak linked to plumbing)
- Delta has identical transmission mechanisms
- **Prevention - In hospital, adhere to Universal Pandemic Precautions**

Otter JA, et al. J Hosp Infect 2016;92:235-50

Otter JA,…Weber DJ. J Hosp Infect 2016;92:235-50

HIERARCHY OF RESEARCH DESIGNS & LEVELS OF SCIENTIFIC EVIDENCE



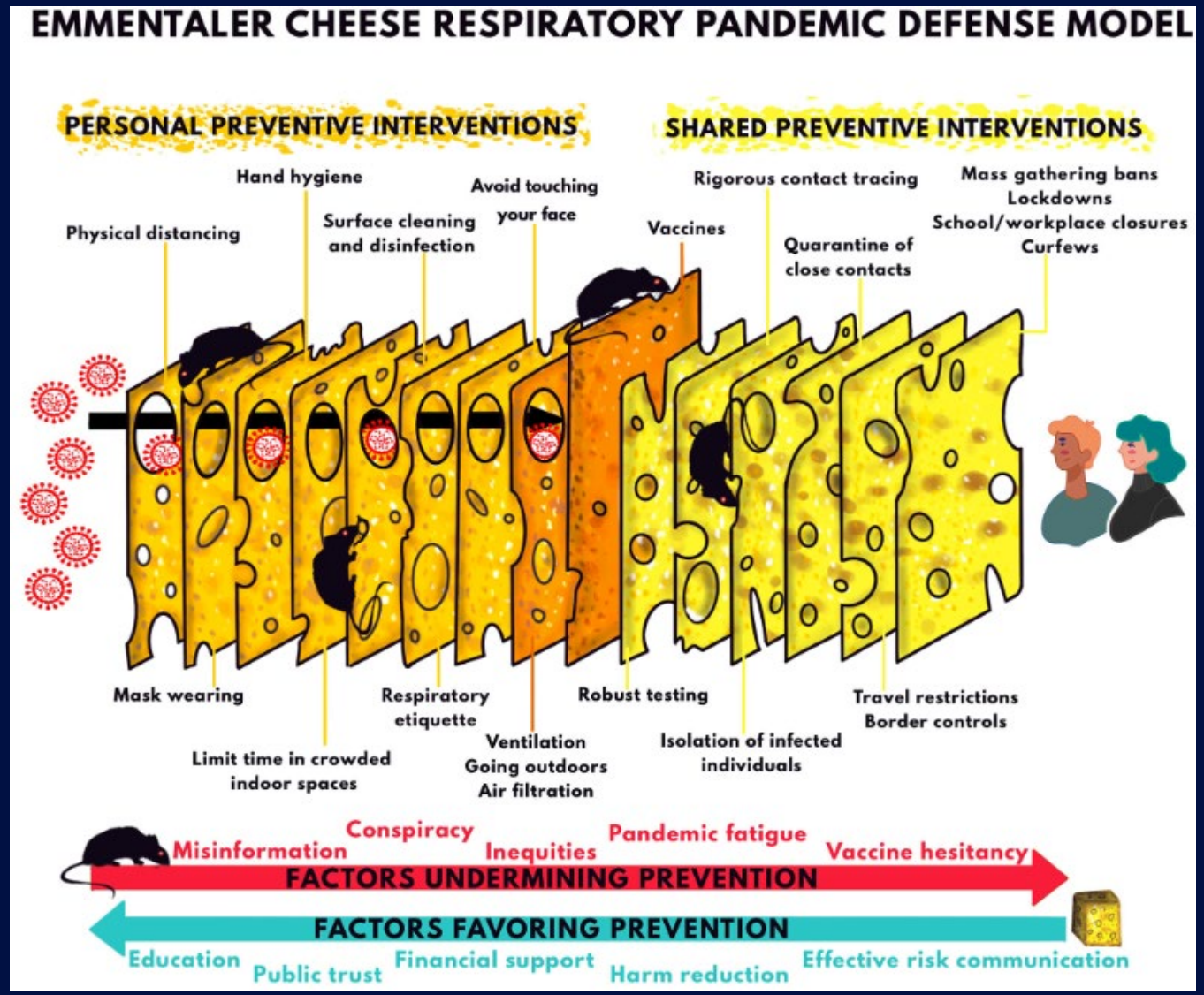
https://sites.google.com/site/evidencebasedd/types-of-pyramid

COVID-19 Mitigation Strategies

- Mitigation strategies developed specifically for COVID-19 prevention: Supported by high-quality scientific studies
  - COVID-19 vaccines: Supported by efficacy and safety RCTs, and effectiveness trials (cohort, case-control)*^
  - Universal pandemic precautions: Supported by laboratory studies, and cohort and case-control studies (plus meta-analyses)*
    - Masking while in the facility
    - N95 respiratory when providing care for known or suspected COVID-19 patients or for aerosol generating procedures
    - Eye protection with direct patient contact (and for AGPs)
  - Physical distancing (ideally, >6 feet; minimally, >3 feet) – especially important when not masked*^
  - PPE monitors or buddies to aid in appropriate donning and doffing of PPE*
  - Monoclonal antibodies for pre- and post-exposure prophylaxis (PEP)*^
- Mitigation strategies standard in healthcare facilities; especially important for communicable diseases*^
  - Hand hygiene and surface disinfection: Supported by experience with viral respiratory pathogens, survival of SARS-CoV-2 on hands and environmental surfaces, and antiseptic/disinfectant susceptibility
  - Contact tracing with isolation and quarantine as indicated
  - Wellness self-checks (prior to coming to work) with evaluation by occupational health if positive

*Healthcare facility prevention strategies, ^Community prevention strategies

RATIONALE BEHIND COVID-19 MITIGATION



Escandon K, et al. BMC Infect Dis 2021;21:710

Employee COVID Trends and Mitigation, UNC, US

- From April 1, 2020, through February 15, 2021, UNC-MC admitted 1,427 COVID-19 positive patients within the high-risk containment zones; within these units there were only 2 possible healthcare-associated COVID-19 transmissions
- In the last month (July 11-Aug 12), **83 new positive** employees**; 49 among fully vaccinated; only 2 cases possibly healthcare-associated** (UNC Medical Center, facility-wide)
  - Five times increased number of cases from previous month
  - Transmission primarily occurring in community; **workplace strategies are effective – masking, vaccination, physical distancing when eating/drinking, staying home when sick**
- **Vaccination and Universal Pandemic Precautions** important prevention strategies for our healthcare providers and patients (remember to wear eye protection when in patient rooms)
  - For aerosol generating procedures, PPE includes an N95 respirator (or PAPR) plus eye protection

Summerlin-Long S, et al. Am J Infect Control 2021;17 Aug

VALUE OF MASK WEARING, PHYSICAL DISTANCING, AND HAND HYGIENE

- Goal: To assess effectiveness of PPE to prevent acquisition of SARS-CoV-2 infection
- Methods: Case control study, 211 cases and 839 controls, Thailand
- Results:
  - Wearing a mask at all times during contact was independently associated with lower risk for SARS-CoV-2
  - Gender, age group (≤15, 16-40, 41-65, >65), contact place (night club, boxing stadium, workplace, household, others), sharing dishes or cups – NOT significant
  - Shortest distance of contact (physical contact, ≤1m, >1 m), duration of contact within 1m (>60min,16-60min, ≤15min), sharing cigarettes (N, Y), handwashing (none, sometimes, often), type of mask (none, nonmedical only, nonmedical and medical, medical only), and compliance with mask wearing (never, sometimes, always) – SIGNFICANT REDUCTION IN RISK OF ACQUIRING COVID-19
  - Maintaining >1m distance from a person with COVID-19, having close contact for <15 minutes, and frequent handwashing were independently associated with lower risk for infection.

Doung-ngern P, et al. EID 2020 Nov

Community SARS-CoV-2 Surge and Within-School Transmission

Kanecia O. Zimmerman, MD, MPH; M. Alan Brookhart, PhD; Ibukunoluwa C. Kalu, MD; Angelique E. Boutzoukas, MD; Kathleen A. McGann, MD; Michael J. Smith, MD, MSCE; Gabriela M. Maradiaga Panayotti, MD; Sarah C. Armstrong, MD; David J. Weber, MD, MPH; Ganga S. Moorthy, MD; Daniel K. Benjamin, Jr., MD, PhD; for The ABC Science Collaborative

- Results: More than 100,000 students and staff from 13 school districts attended school in-person; of these, 4,969 community-acquired SARS-CoV-2 infections were documented by molecular testing. Through contact tracing, NC local health department staff identified an additional 209 infections among >26,000 school close contacts (secondary attack rate <1%). Most within-school transmissions in high schools (75%) were linked to school-sponsored sports. School-acquired cases slightly increased during the surge; however, within-school transmission rates remained constant, from pre-surge to surge, with approximately 1 school-acquired case for every 20 primary cases.
- No district implemented large scale overhaul of their ventilation systems; none installed HEPA filters or UVGI; only 1 upgraded filters
- Summary: During the 2020–2021 winter surge of SARS-CoV-2 in North Carolina, K–12 within-school transmission remained extremely low among districts implementing basic mitigation strategies.

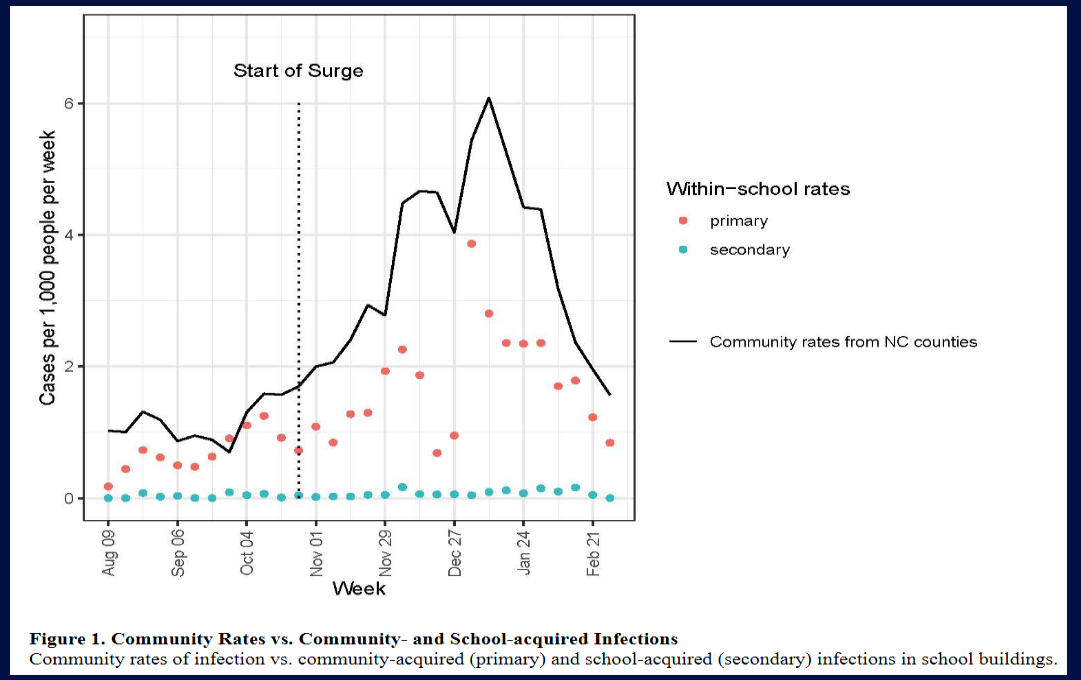


Figure 1. Community Rates vs. Community- and School-acquired Infections
Community rates of infection vs. community-acquired (primary) and school-acquired (secondary) infections in school buildings.

Rate of Expected Secondary Infections /100 Primary Cases (95% CI), by Grade Level

Grade Level	Pre-surge Secondary Infections/100 Primary Cases (95% CI)	Post-surge	Post-surge without Sports
Elementary	6.51 (3.70, 11.5)	4.43 (2.82, 6.96)	4.43 (2.91, 6.75)
Middle	4.48 (1.73, 11.6)	2.68 (1.25, 5.75)	2.68 (1.31, 5.47)
High	1.57 (0.49, 5.06)	3.92 (2.36, 6.51)	1.05 (0.42, 2.63)
CI, confidence interval			

Pediatr 2021; DOI: 10.1542/peds.2021-052686

SCHOOL SAFETY, MASKING AND THE DELTA VARIANT

- Goal: Assess K-12 school safety in the Delta era
- Methods: Study time, 14 June-13 August 2021, NC; mitigation (<3ft recommended, mask mandate, quarantine for contacts)
- Results: Participants = 20 school districts, 783 schools, 59,561 students, 11,854 staff. No schools closed as result of COVID-19. The community-acquired-to-within-school-acquired infection ratio was ~12.4 (808/64). The estimated secondary attack rate was 2.6% (64 secondary infections/2,431 quarantined close contacts).

Table 1. Primary Infections, Secondary Infections, and Quarantine Occurrences in Students and Staff

	Total Districts, n	Total Children, n	Total staff, n	COVID-19 Transmission				Quarantine	
				Student Primary, n	Student Secondary, n	Staff Primary, n	Staff Secondary, n	Student	Staff
Total districts	20	59561	11854	619	60	189	4	2032	399
District size									
Small	6	4071	484	26	1	9	0	84	7
Medium	7	9915	1599	47	14	21	1	248	31
Large	7	45,575	9771	546	45	159	3	1700	361

COVID-19, coronavirus 2019

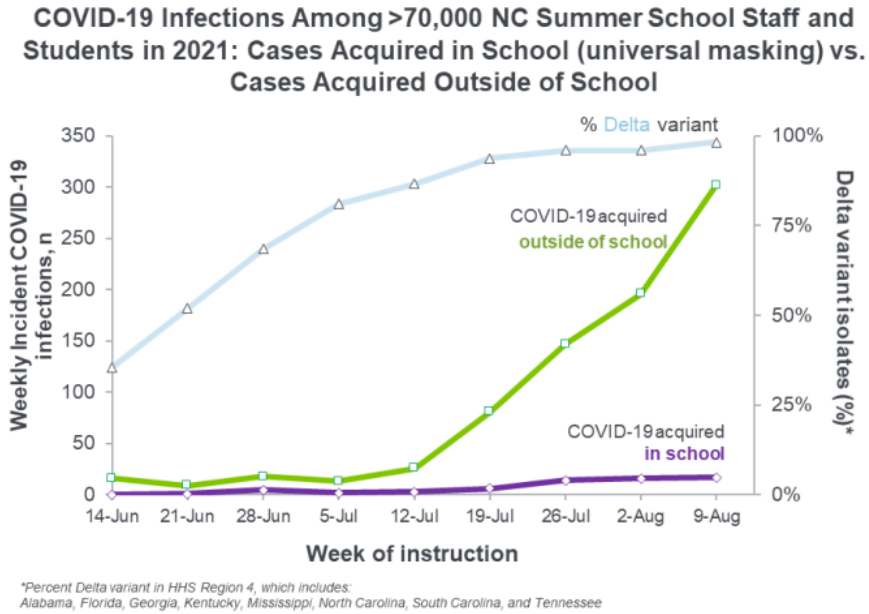


Figure 1. COVID-19 Infections among Summer School Staff and Students
COVID-19 infections among >70,000 North Carolina summer school staff and students, displayed according to weekly cases acquired in school vs. cases acquired outside of school, with an overlay of weekly proportion of SARS-CoV-2 isolates in the region consistent with the B.167.2 (Delta) variant.
COVID-19, coronavirus 2019; NC, North Carolina; SARS-CoV-2, severe acute respiratory syndrome coronavirus-2

Boutzoukas A, et al. Pediatrics 2021;8 Oct.

Recommended COVID-19 Mitigation Strategies That Lack Supportive Evidence

- Improved or enhanced ventilation: Installation of higher efficiency air filters, improved air exchanges, introduction of larger amounts of fresh air, in-room HEPA devices, and/or upper-room ultraviolet germicidal irradiation devices
- Routine COVID-19 testing of asymptomatic persons; might be useful in some community settings (e.g., sports teams, universities) – not a mitigation strategy but an early detection strategy for limiting transmission when coupled with contact tracing and isolation/quarantine – evidence does NOT suggest useful for HCP
- Plexiglass barriers
- Routine COVID-19 testing prior to aerosol generating procedures (excluding patients undergoing major surgery)

THE COVID-19 PANDEMIC: LOOKING BACK AND LOOKING FORWARD, US RESPONSE

Missteps and Misinformation in US Pandemic Response

- Lack of a centralized, coordinated Federal response
- Executive Branch consistently minimized and trivialized risk of COVID-19
- US Public Health infrastructure woefully inadequate
- Slow development and scale-up of rapid, accurate, and widely available testing
- Inaccurate initial assumptions about transmission: Failure to focus on aerosol transmission; failure to recognize the importance of asymptomatic and pre-symptomatic spread
- Inadequate stockpiles of PPE and failure to rapidly ramp up production
- Initial failure to recommend masking by the public as a mitigation strategy
- Failure to initially focus on transmission in nursing homes

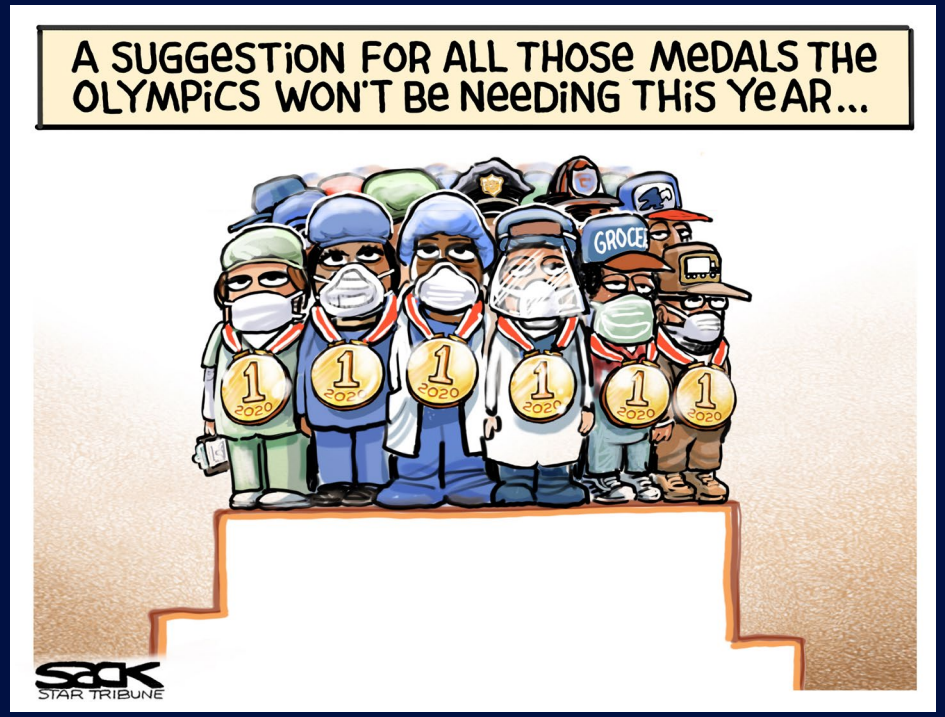
Major Remaining Pandemic Concerns

- Science denialism
- Politicization of pandemic response
- Vaccine hesitancy and resistance
- Vaccinations for children
- Evolution and spread of more highly transmissible and/or virulent variants
- Post-COVID-19 clinical issues
- Lack of public support for public health interventions (e.g., mask mandates) if /when another wave or new agent arrives
- Need for recurring boosters
- Unanticipated challenges
- Pandemic fatigue

Henderson D, Haessler S, Weber DJ. ICHE 2021;2 August

CONCLUSIONS

- SARS-CoV-2 is now endemic – major threats include emergence of new variants, resistance to mitigation strategies, especially vaccine resistance
- A coordinated political and public health response is required to manage COVID-19 and prepare for the next pandemic (it is not a question of whether we will have another pandemic but only a question of when)
- COVID-19 mitigation strategies of proven benefit in healthcare facilities include COVID-19 vaccines, universal pandemic precautions (e.g., masking, eye protection), and physical distancing
- All of the above mitigation strategies are of value in the community as well – all work despite emergence of new SARS-CoV-2 variants
- Strategies to prevent infectious disease transmission that are also recommended to reduce risk of SARS-CoV-2 transmission include hand hygiene, surface disinfection, and contract tracing (with as appropriate, isolation and quarantine)
- COVID-19 mitigation strategies that have been recommended, but for which scientific evidence of benefit is lacking, include improved ventilation, routine testing of asymptomatic HCP, Plexiglass barriers, and routine testing of asymptomatic patients prior to outpatient procedures
  - High quality research studies should be conducted to determine the benefits, if any, of these recommended pratices


A SUGGESTION FOR ALL THOSE MEDALS THE OLYMPICS WON'T BE NEEDING THIS YEAR...
GROCE
1
2020
SACK
STAR TRIBUNE


WELCOME TO THE CLUB.


To All The Wonderful Healthcare Workers
Thank You ! Thank you !
THANK YOU !


KEVIN SIERS
CHARLOTTE OBSERVER
©2020
THIS IS A JOB FOR REAL HEROES!