

# *The COVID-19 Pandemic – the Public Health Crisis of a Lifetime*

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Disclosures : None.

Presentation Includes: Discussion of unapproved off-label and/or investigational uses of one or more products.

# *SARS CoV-2 and COVID-19*

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- Historical Perspective
- Virology
- Epidemiology
- Transmission
- Mitigation Strategies
- Healthcare Epidemiology

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# **Novel Human Virus? Pneumonia Cases Linked to Seafood Market in China Stir Concern**

**By Dennis Normile**

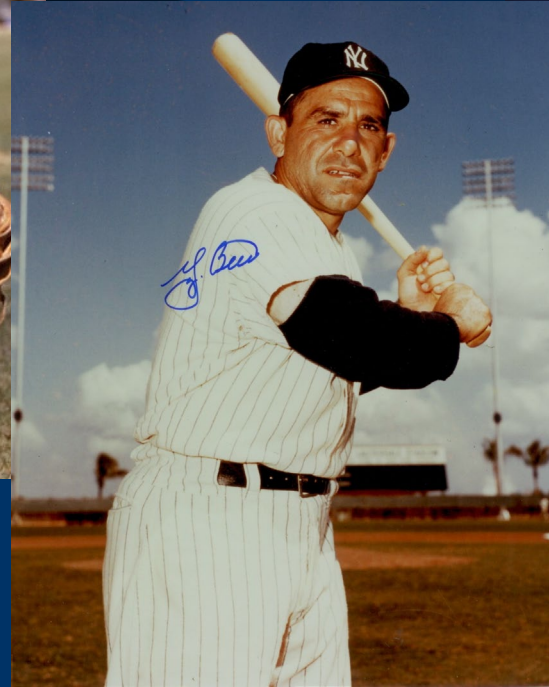
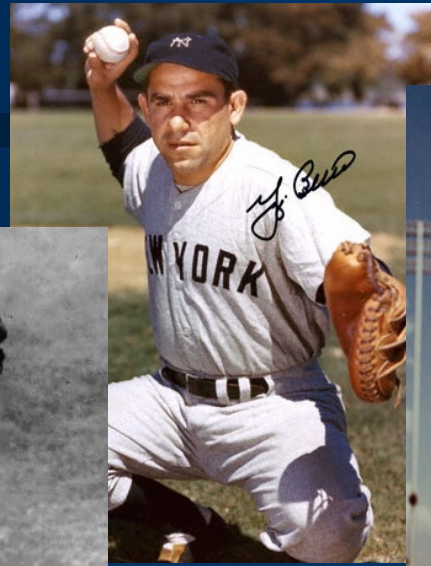
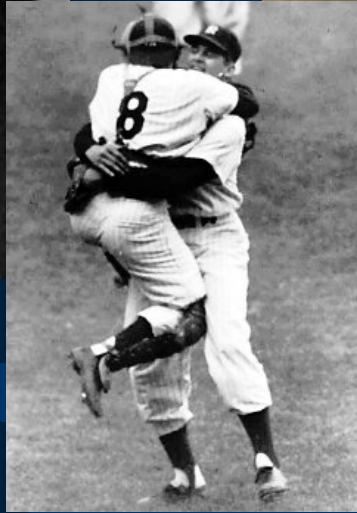
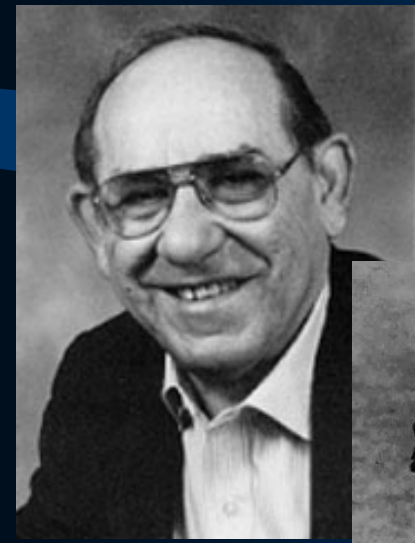


# **The Washington Post**

January 9, 2020

# **China Identifies New Strain of Coronavirus as Source of Pneumonia Outbreak**





*“This seems like deja vu all over again.”*

# *SARS-CoV-2 – Context*

- Emerging diseases are a burgeoning zoonotic problem
  - Animal (swine) influenza
  - Anthrax
  - Avian influenza
  - Brucellosis
  - Campylobacter infection
  - Cat scratch fever
  - Chikungunya
  - Crimean-Congo
  - Cryptosporidiosis
  - Cysticercosis
  - Dengue
  - Ebola virus disease
  - Erysipeloid
  - Giardiasis
  - Glanders
  - Hendra
  - Hepatitis E
  - Hydatid disease
  - Leptospirosis
  - Listeria infection
  - Louping ill
  - Lyme disease
  - Malaria
  - Marburg
  - MERS
  - Menangle
  - Nipah
  - Orf
  - Pasteurellosis
  - Plague
  - Psittacosis
  - Q fever
  - Rabies
  - Rat-bite fever
  - Rocky Mountain spotted fever
  - SARS CoV-1
  - SARS CoV-2
  - Tickborne encephalitis
  - Toxocariasis
  - Toxoplasmosis
  - Trichinellosis
  - Tularemia
  - West Nile virus
  - Zika

# SARS-CoV-2 – Context

- Emerging diseases that have bats as an intermediate host are particularly problematic

Nipah  
Hendra  
Menangle } → Paramyxoviruses

Ebola  
Marburg } → Filoviruses

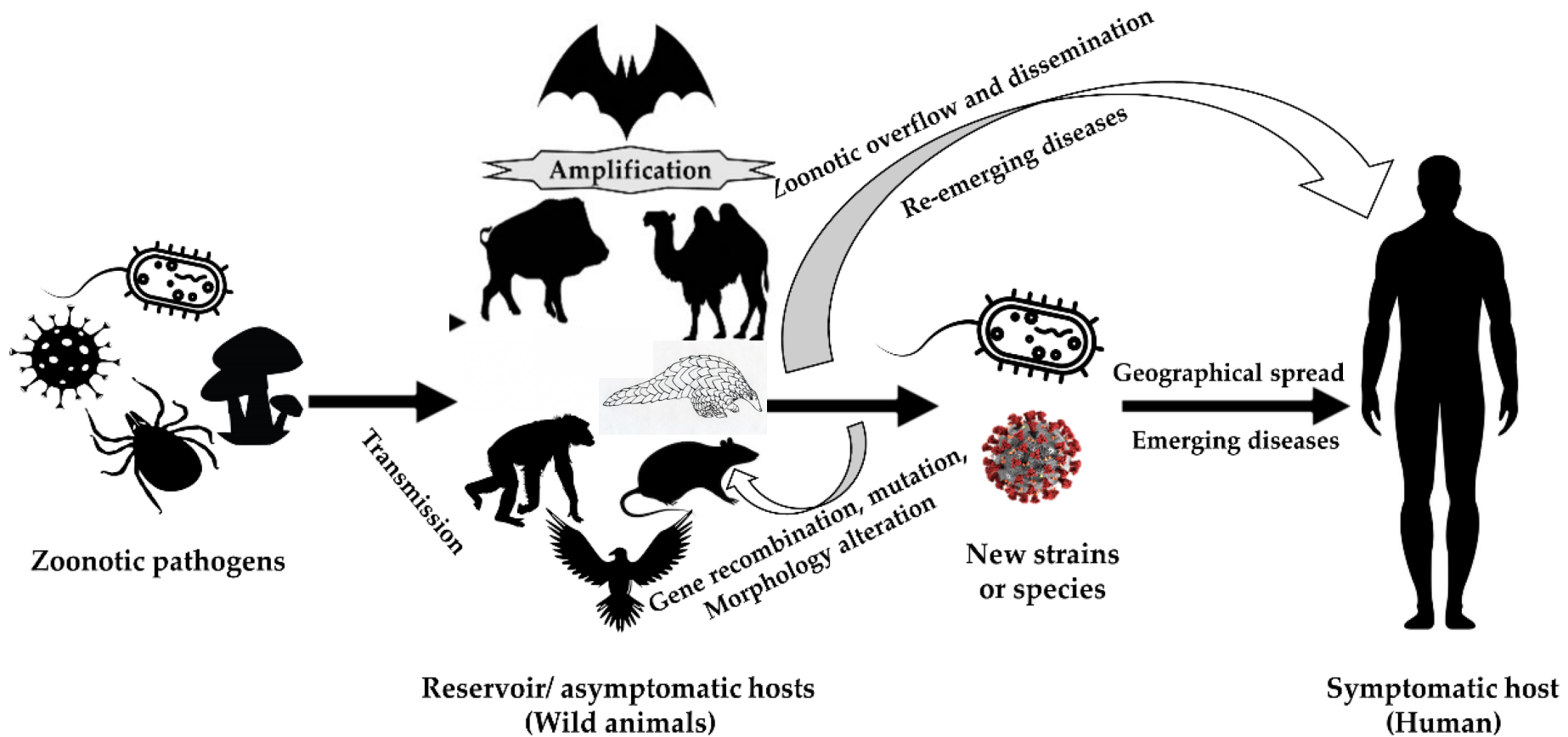
SARS CoV-1  
MERS  
SARS CoV-2 } → Coronaviruses

Rabies  
Rabies-related } → Rhabdoviruses

West Nile  
Chikungunya  
Crimean-Congo } → Flaviviruses  
Togaviruses  
Bunyaviruses



# SARS-CoV-2 – Context



# *SARS-CoV-2 – History*

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- Outbreak of pneumonia Wuhan, Hubei Province
- First case identified 12/1/2019
- 41 cases reported by 2/15/2020
- Two-thirds directly associated with Huanan seafood “wet” market
- Disease spread quickly to Thailand, Japan, South Korea, Germany, and US

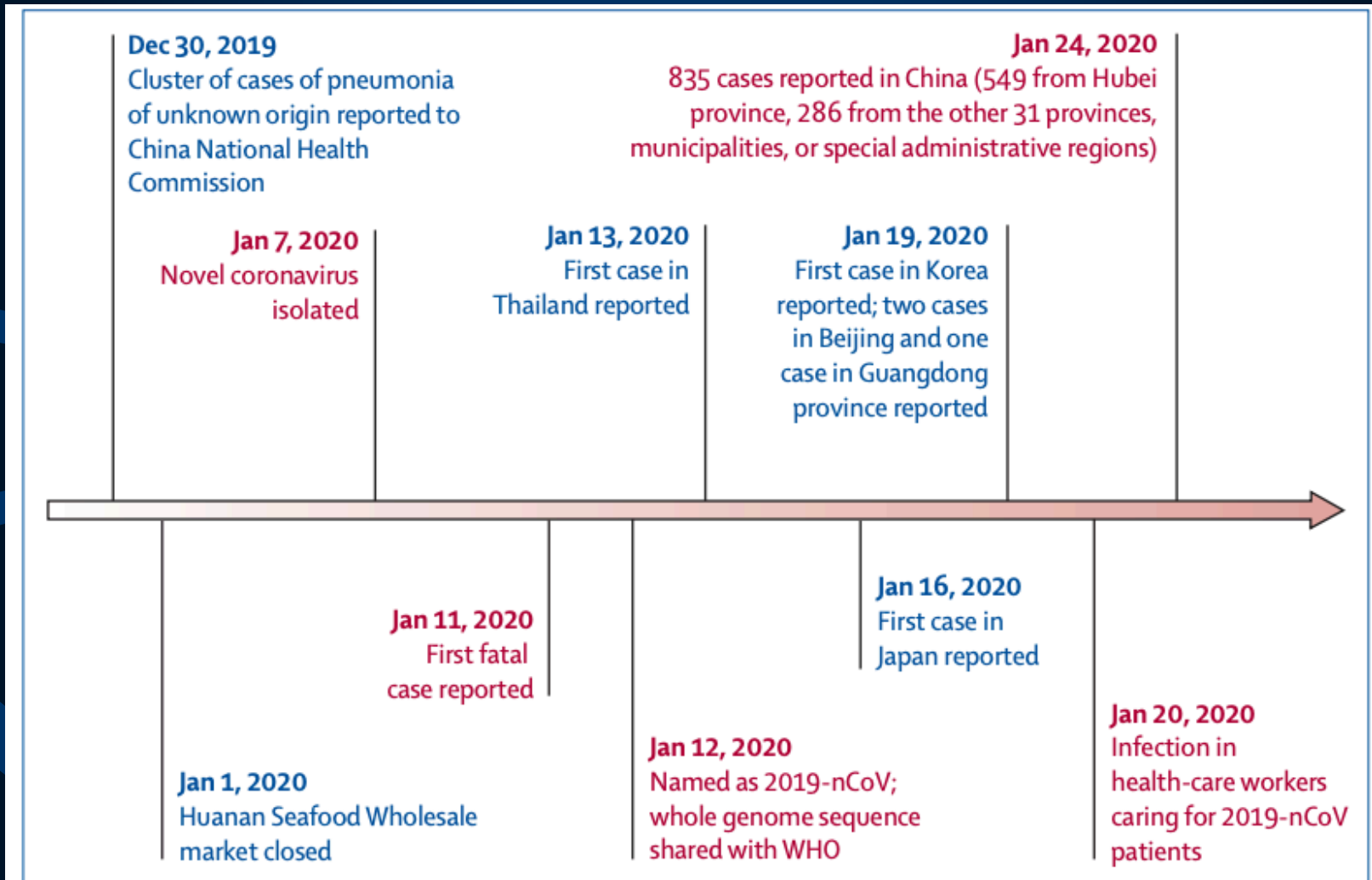
*Huang, C, et al., Lancet 2020; 395: 497–506*







# SARS-CoV-2 – Early Timeline





# SARS-CoV-2 – Early US

## Timeline

1/3 CDC Director notified a "mysterious respiratory illness" was spreading in Wuhan"	1/8 CDC issued first public alert about the coronavirus	1/20 First US case reported – an American citizen traveling from Wuhan to Washington state	1/31 DHHS declares a public health emergency	2/6 CDC test kits found defective;	2/20 first US COVID-19 death reported	2/20 Community transmission confirmed in CA	3/3. CDC lifts restriction on testing	3/12. Colleges and public schools begin to close	3/31. 3,170 deaths, 164,620 confirmed cases, and 1.07 million tests completed in the U.S
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<b>January</b>								<b>April</b>	
1/6 CDC Director offers to send a team of CDC scientists to assist China	1/17 CDC begins airport screening in NYC, LA, and SF.	1/23 CDC sought an FDA EUA for states to use its test	2/4 FDA issues EUA for CDC PCR test	2/15 338 US nationals stranded on the Diamond Princess evacuated	2/28 CDC test kit revised	3/11. WHO declares pandemic	3/16 DHHS and CDC Issue guidelines		

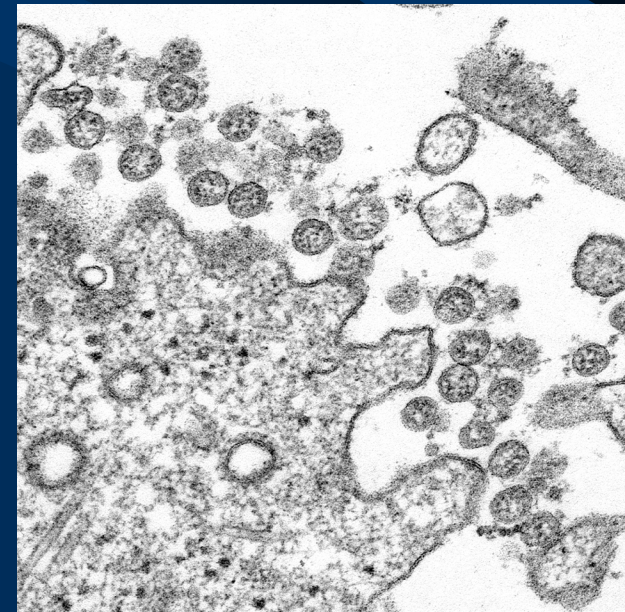
# *SARS CoV-2 and COVID-19*

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- **Virology**
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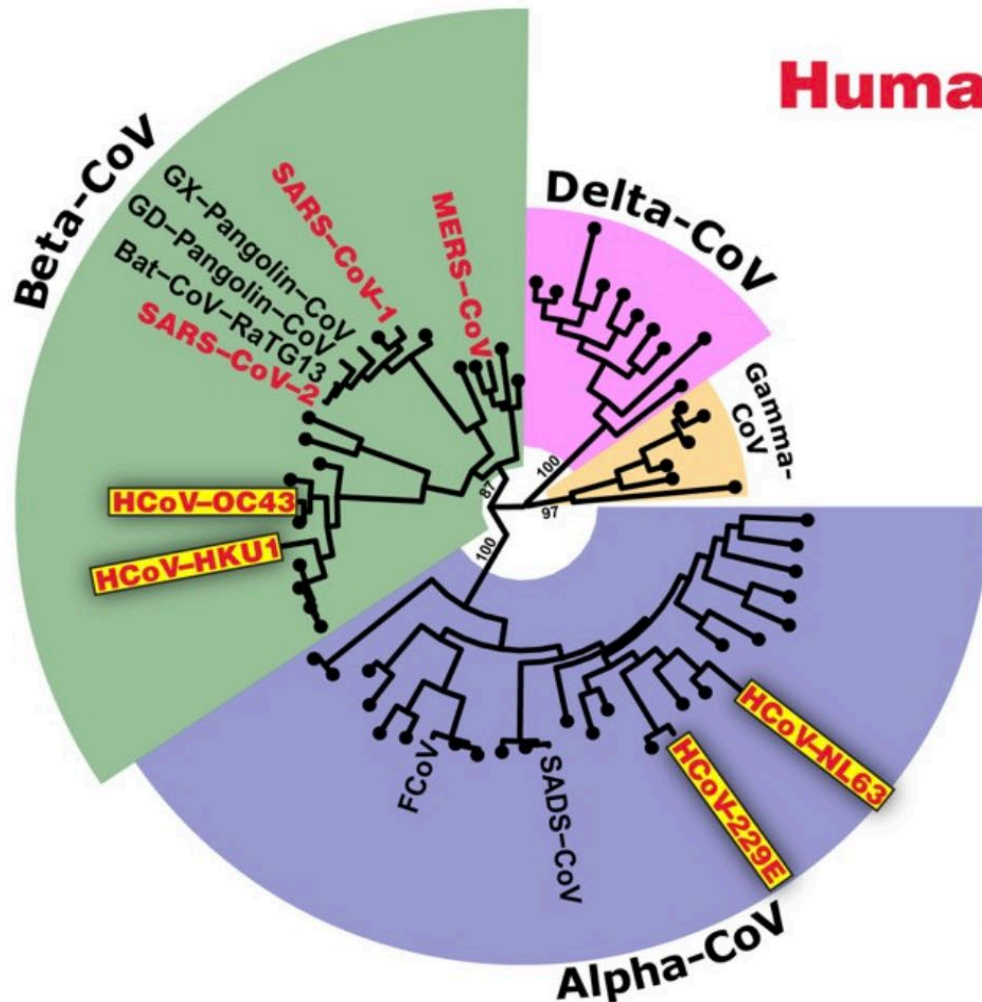
# Coronaviruses

- Size and shape: 120-160 nm, pleomorphic
- Genome: Single-stranded, linear, positive-sense RNA
- Lipid enveloped
- Reservoirs: Humans, multiple animal species
- Infection Syndromes
  - Common colds: Account for up to 50% of upper respiratory tract infections
  - Gastroenteritis
  - SARS, MERS, COVID-19



# SARS-CoV-2 – Virology

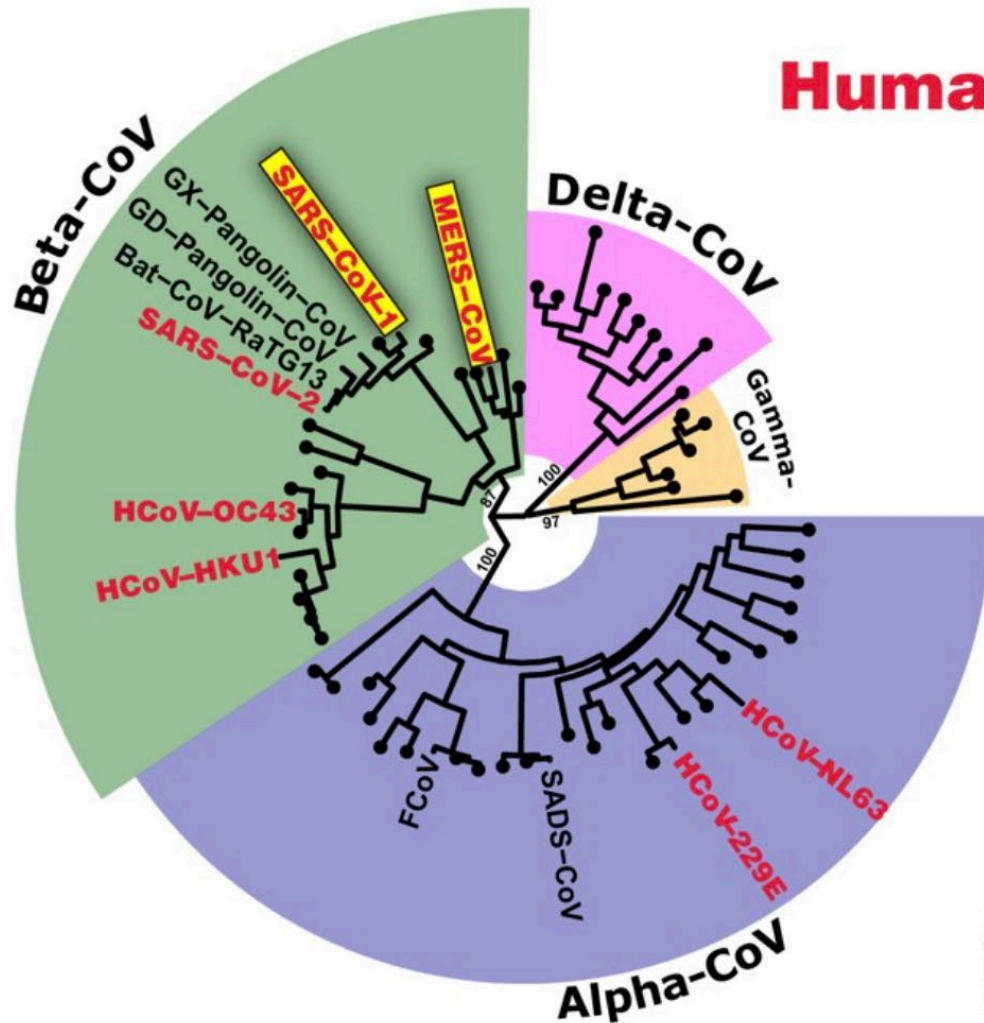
## Human coronaviruses



Source: SM Gygli, PhD, NIAID. Based on 440 bp nucleotide sequences of RNA-dependent RNA polymerase.

# SARS-CoV-2 – Virology

## Human coronaviruses

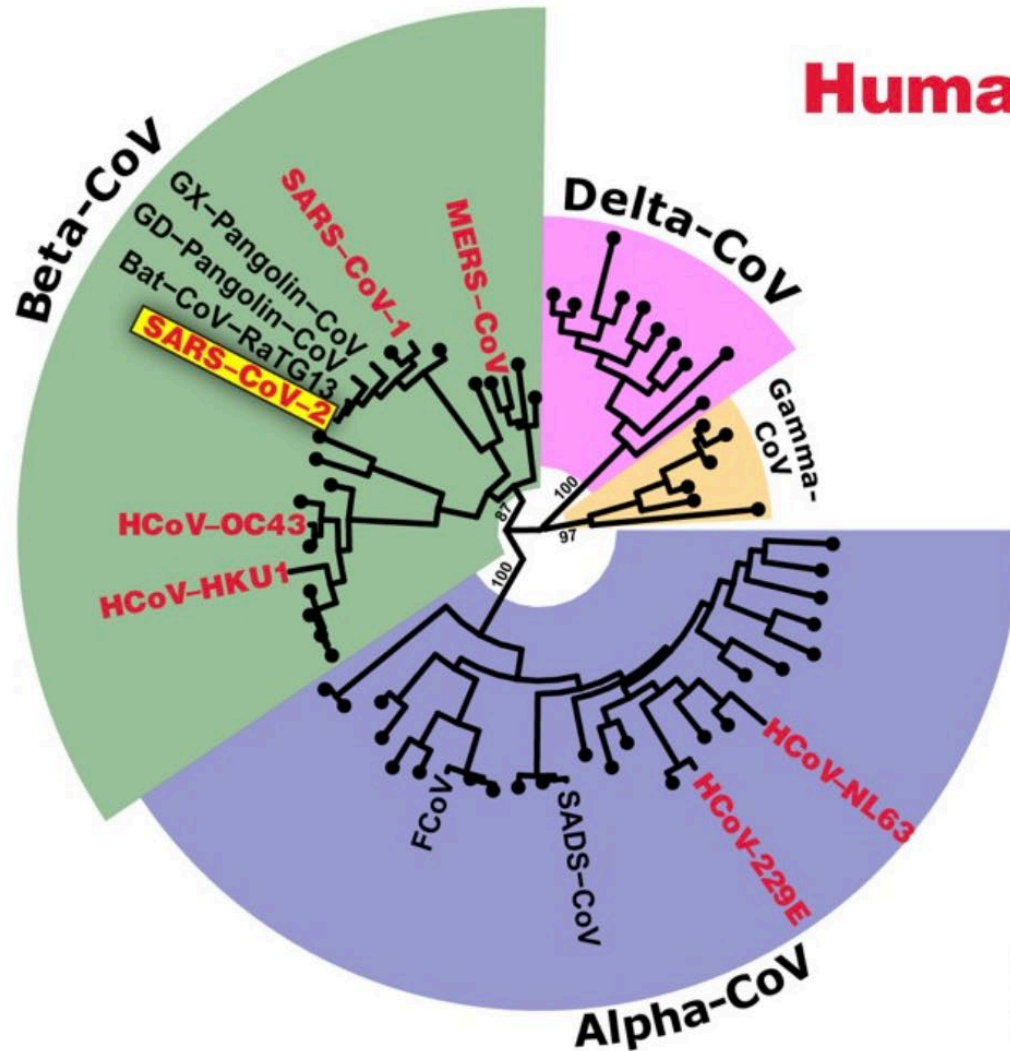


Source: SM Gygli, PhD, NIAID. Based on 440 bp nucleotide sequences of RNA-dependent RNA polymerase.



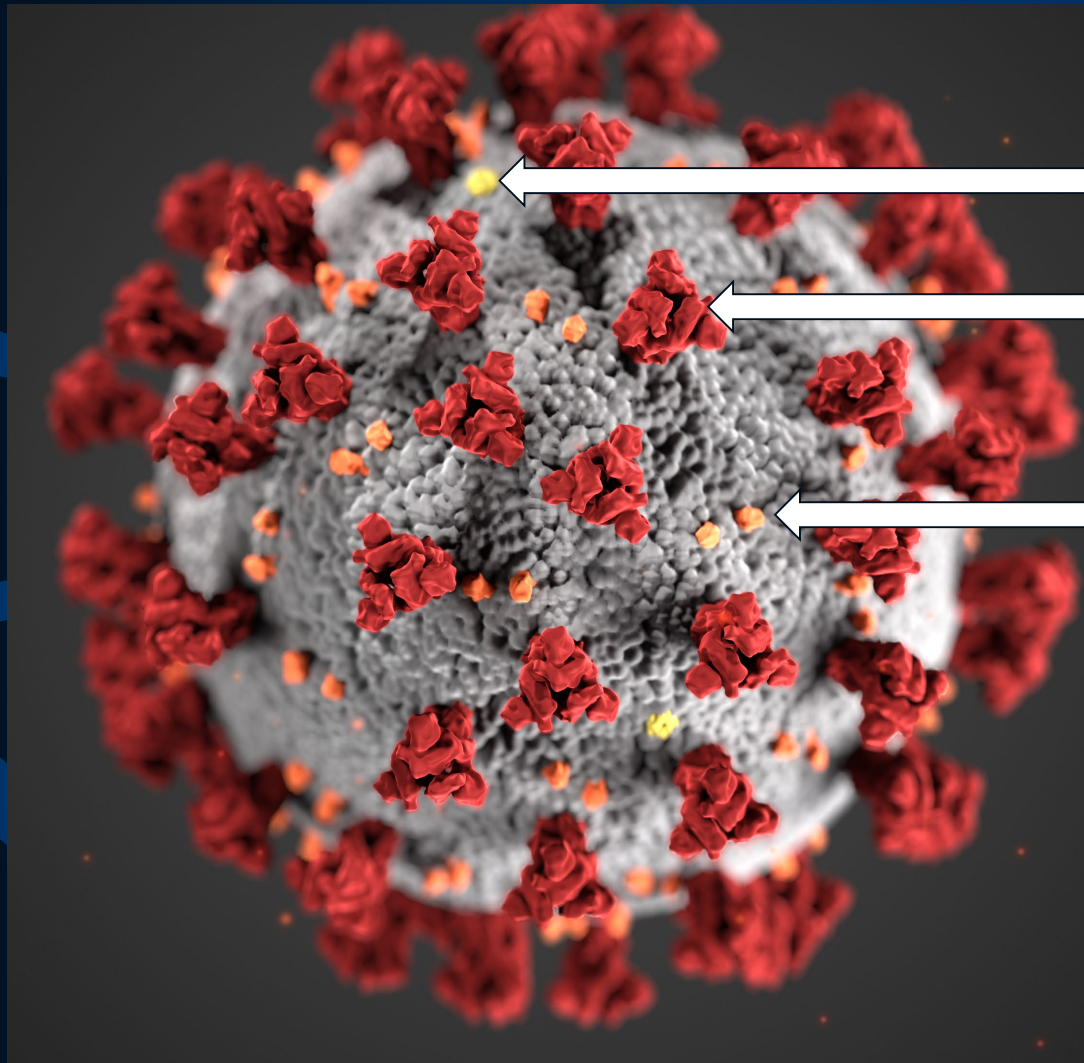
# SARS-CoV-2 – Virology

## Human coronaviruses



Source: SM Gygli, PhD, NIAID. Based on 440 bp nucleotide sequences of RNA-dependent RNA polymerase.

# SARS-CoV-2



*Envelope Protein*

*Spike Glycoprotein*

*Matrix Protein*

*High Resolution Photograph Courtesy of CDC*

# *SARS CoV-2 and COVID-19*

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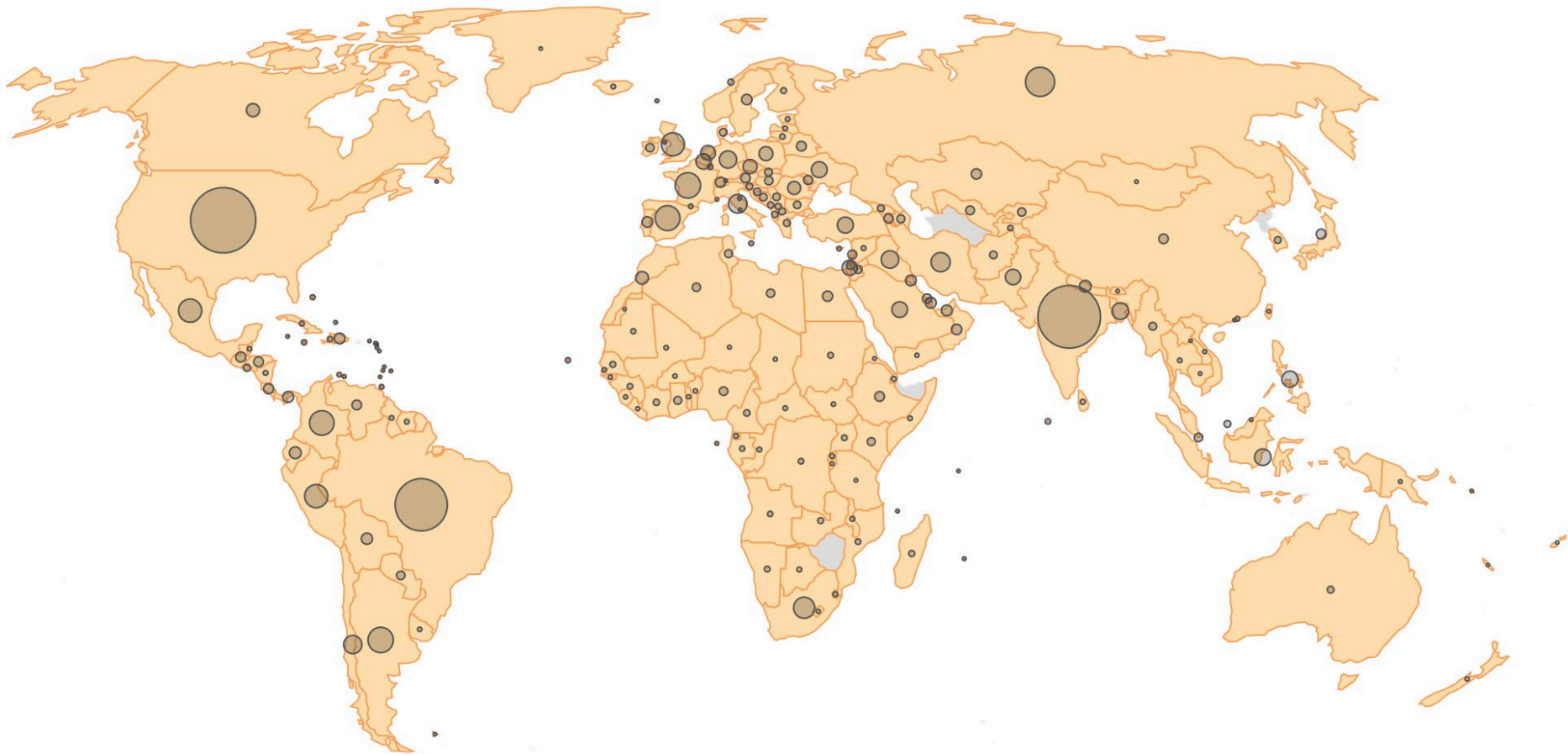
- Historical Perspective
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# COVID-19 – Global Epidemiology

Total Cases = 50,866,743

Total Deaths = 1,263,992



Source: [NPR.org](https://www.npr.org); [Worldometer.data](https://www.worldometer.com) as of 11-9-2020

# COVID-19 – Global Epidemiology

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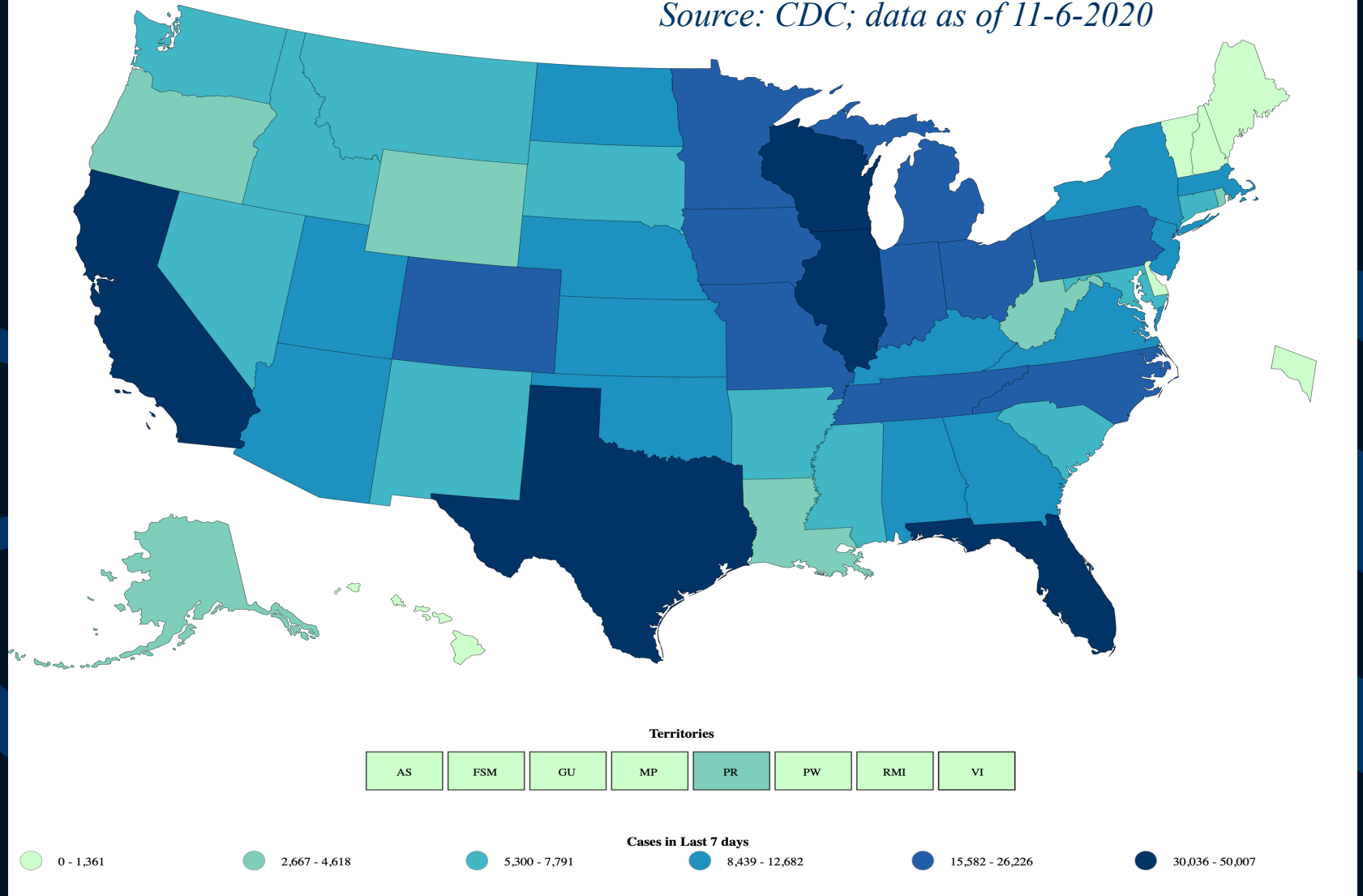
Country	Cases	Deaths
Viet Nam	401	0
Taiwan	455	7
Iceland	1839	10
New Zealand	1205	22
Singapore	48,434	27
Australia	27,633	905
Italy	244,752	35,073
Mexico	356,255	40,400
UK	295,817	45,312
Brazil	2,160,000	81,487
United States	3,900,000	240,000

of 11-3-2020

Source: Our World in Data; data as of November 7.

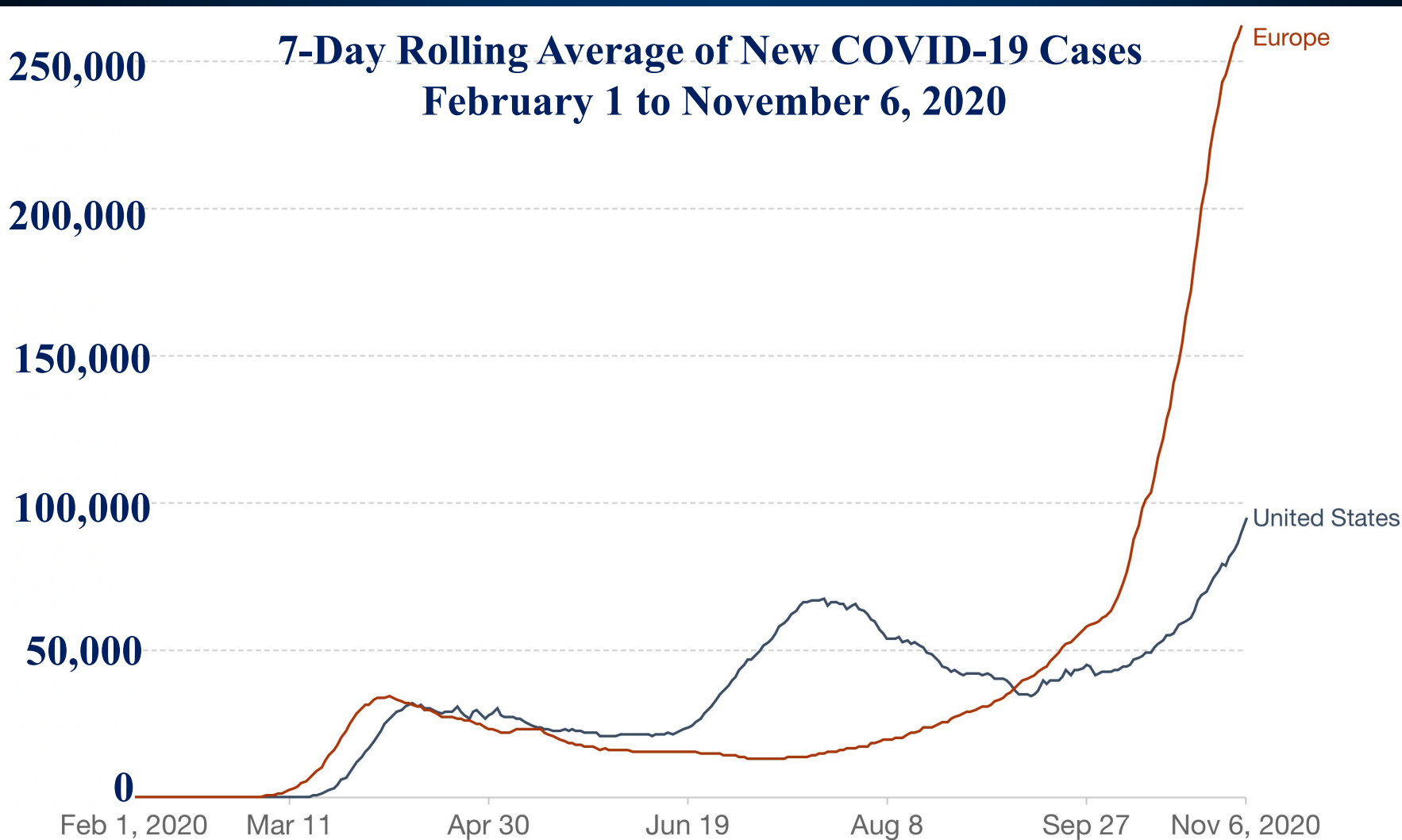
# COVID-19 – US Epidemiology

Source: CDC; data as of 11-6-2020



US COVID-19 Cases Reported to the CDC in the Last 7 Days, by State/Territory

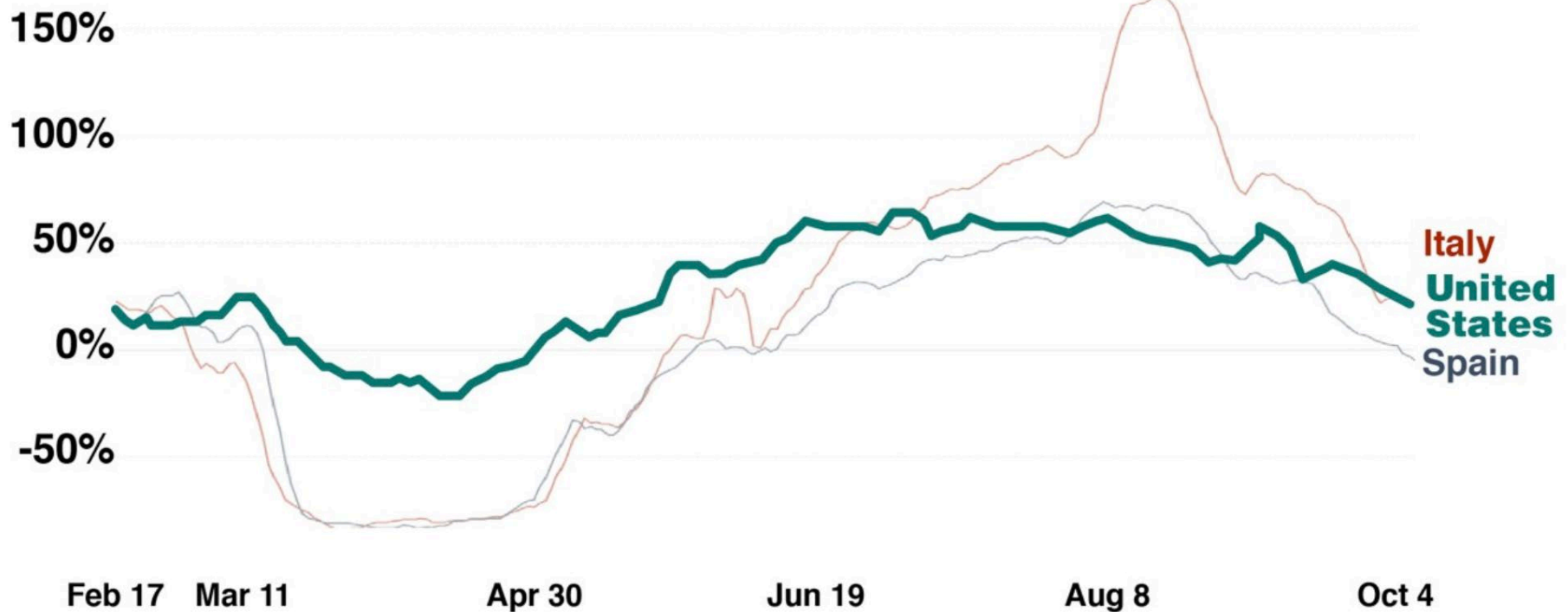
# COVID-19 – Epidemiology – US vs. Europe



*Source: Our World in Data; data as of November 6, 2020.*

# COVID-19 – Epidemiology – US vs. Europe

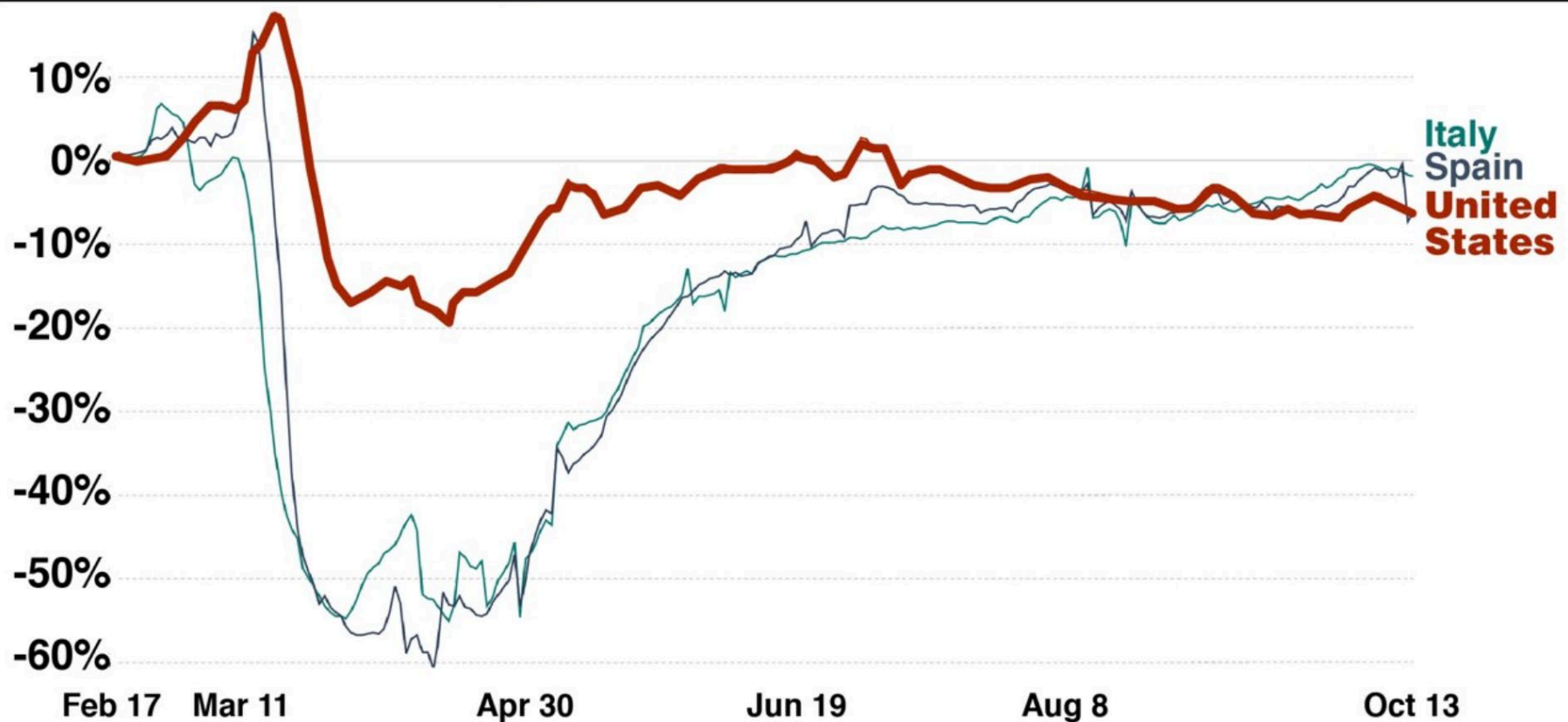
## Change in Mobility Over Time: Parks and Outdoor Spaces



Source: Our World in Data; data as of October 20.

# COVID-19 – Epidemiology – US vs. Europe

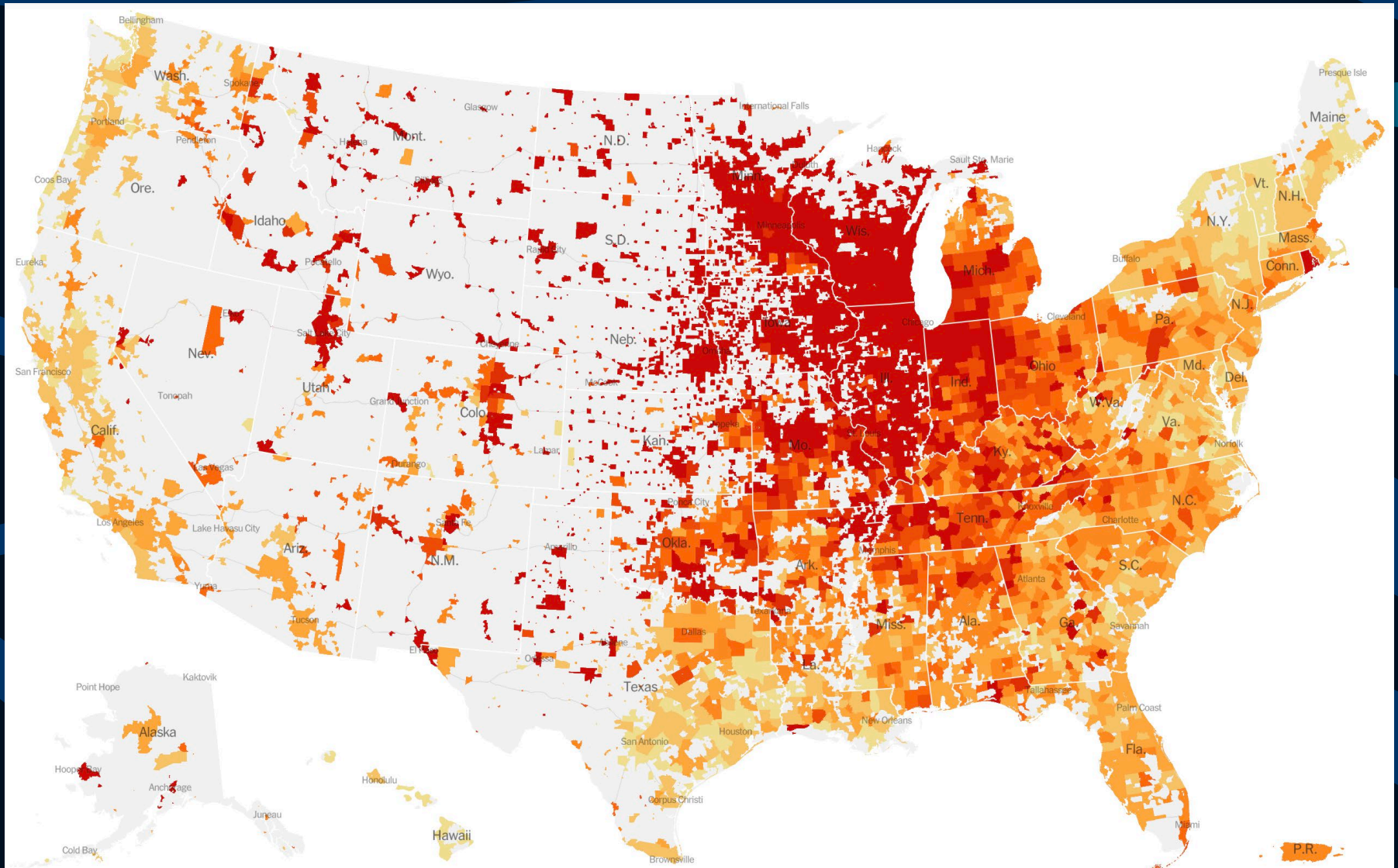
## Change in Mobility Over Time: Grocery and Pharmacy Stores



*Source: Our World in Data; data as of October 20.*

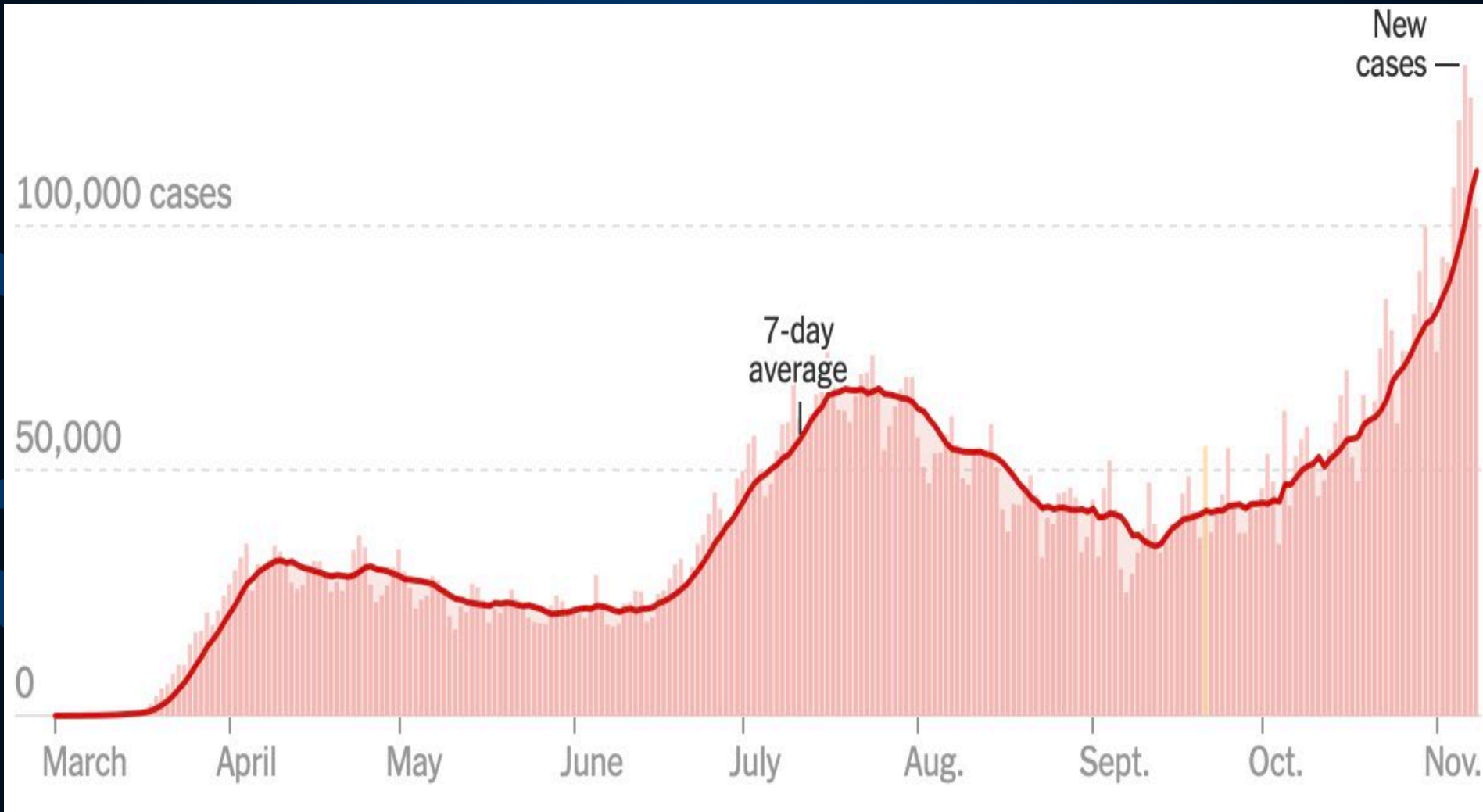


# COVID-19 – Epidemiology – US vs. Europe



*Source: New York Times; data as of November 7.*

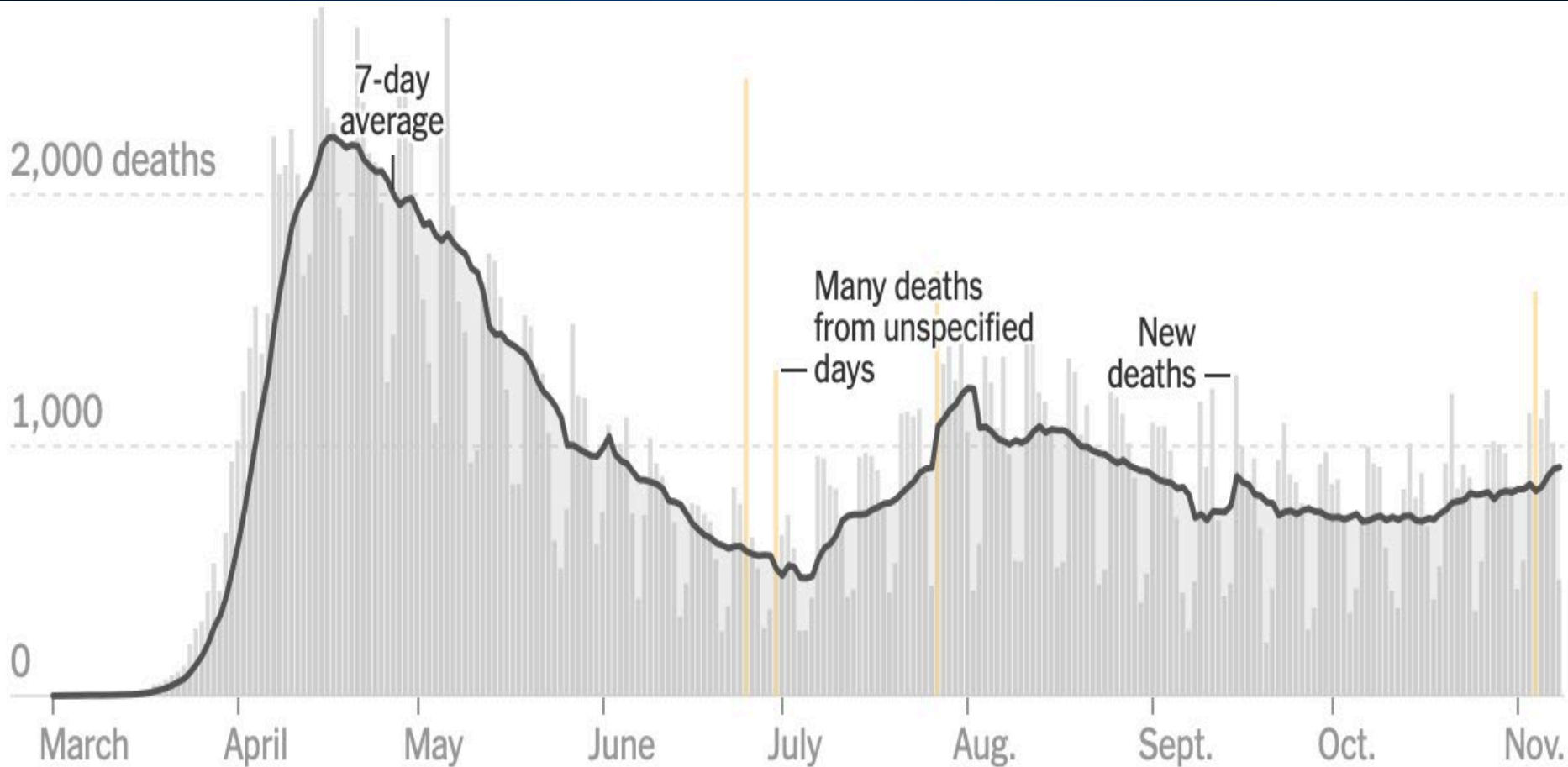
# COVID-19 – Epidemiology – US



*Source: New York Times; data as of November 9*



# COVID-19 – Epidemiology – US



*Source: New York Times; data as of November 9.*

# JAMA

The Journal of the American Medical Association

May 11, 2020

**Viewpoint**

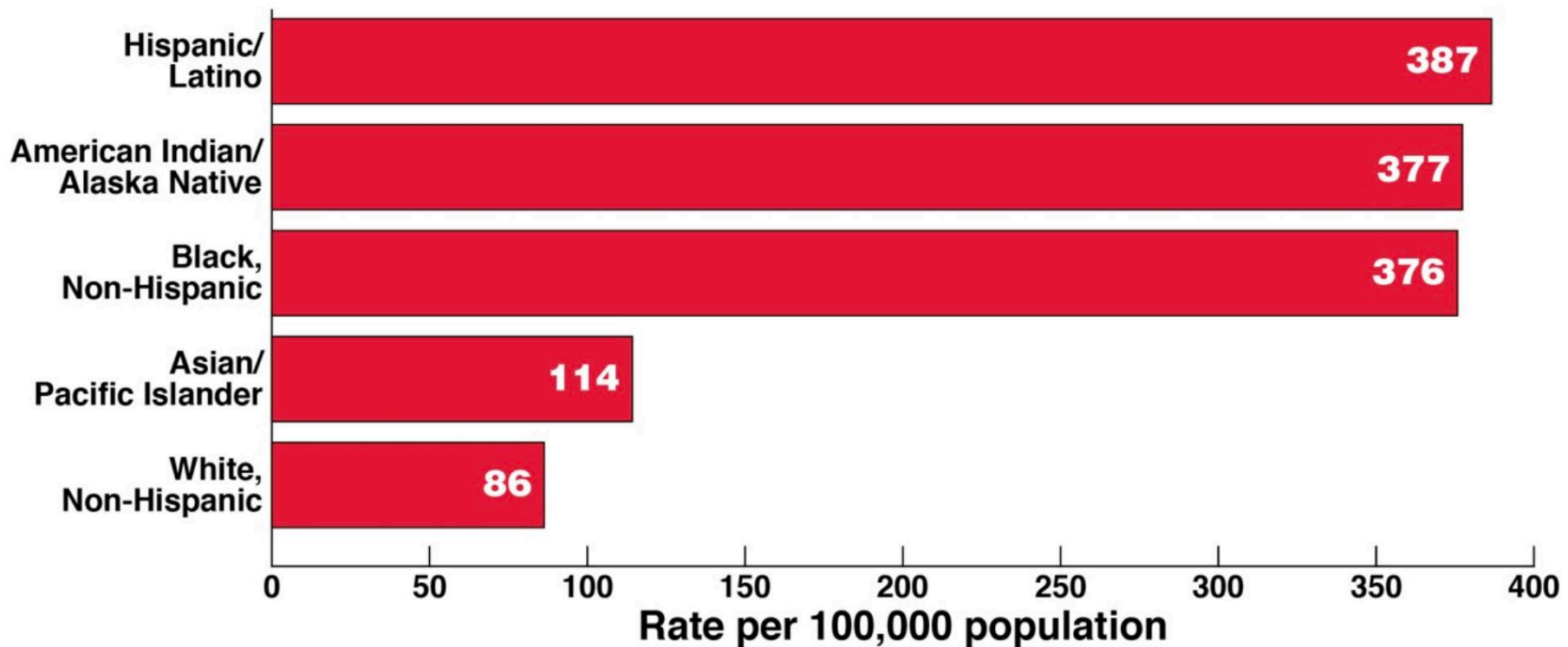
## **COVID-19 and Racial/Ethnic Disparities**

MW Hooper, AM Nápoles and EJ Pérez-Stable

***“The most pervasive disparities are observed among African American and Latino individuals, and where data exist, American Indian, Alaska Native, and Pacific Islander populations.”***

*Slide Source: A.S. Fauci, MD; ID Week 2020*

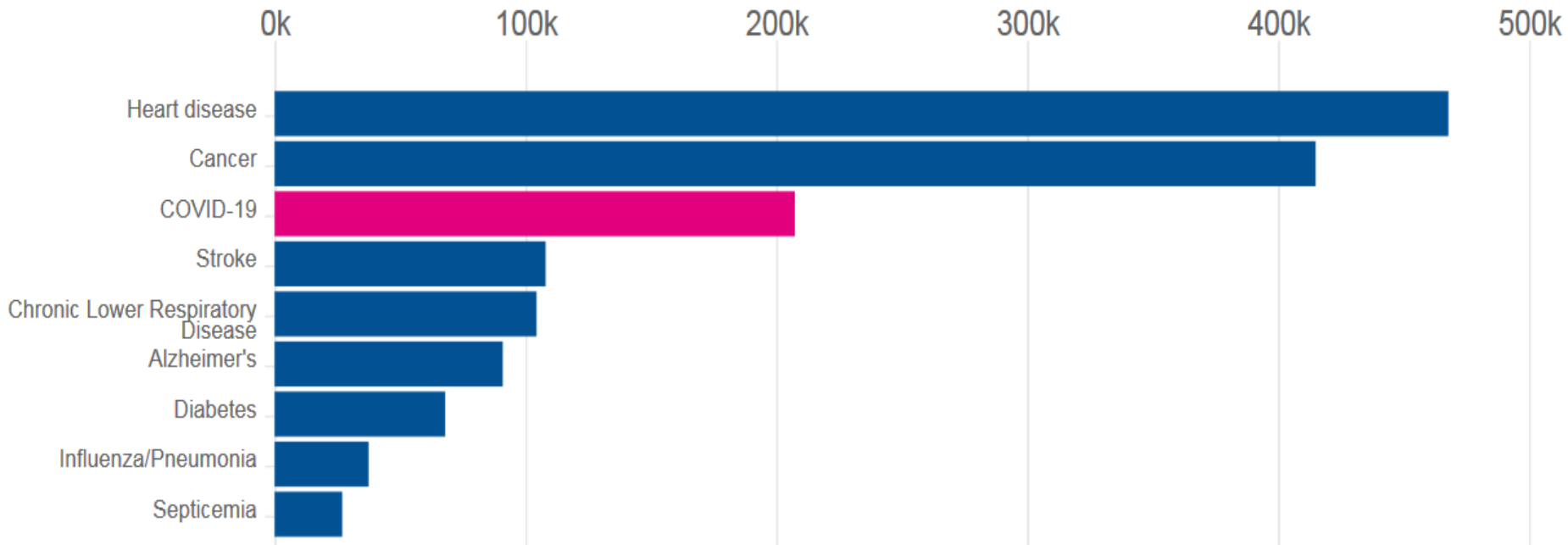
# Age-Adjusted COVID-19-Associated Hospitalization Rates by Race and Ethnicity, United States, March 1 – October 10, 2020



Source: CDC COVID-NET. Data from 14 states.

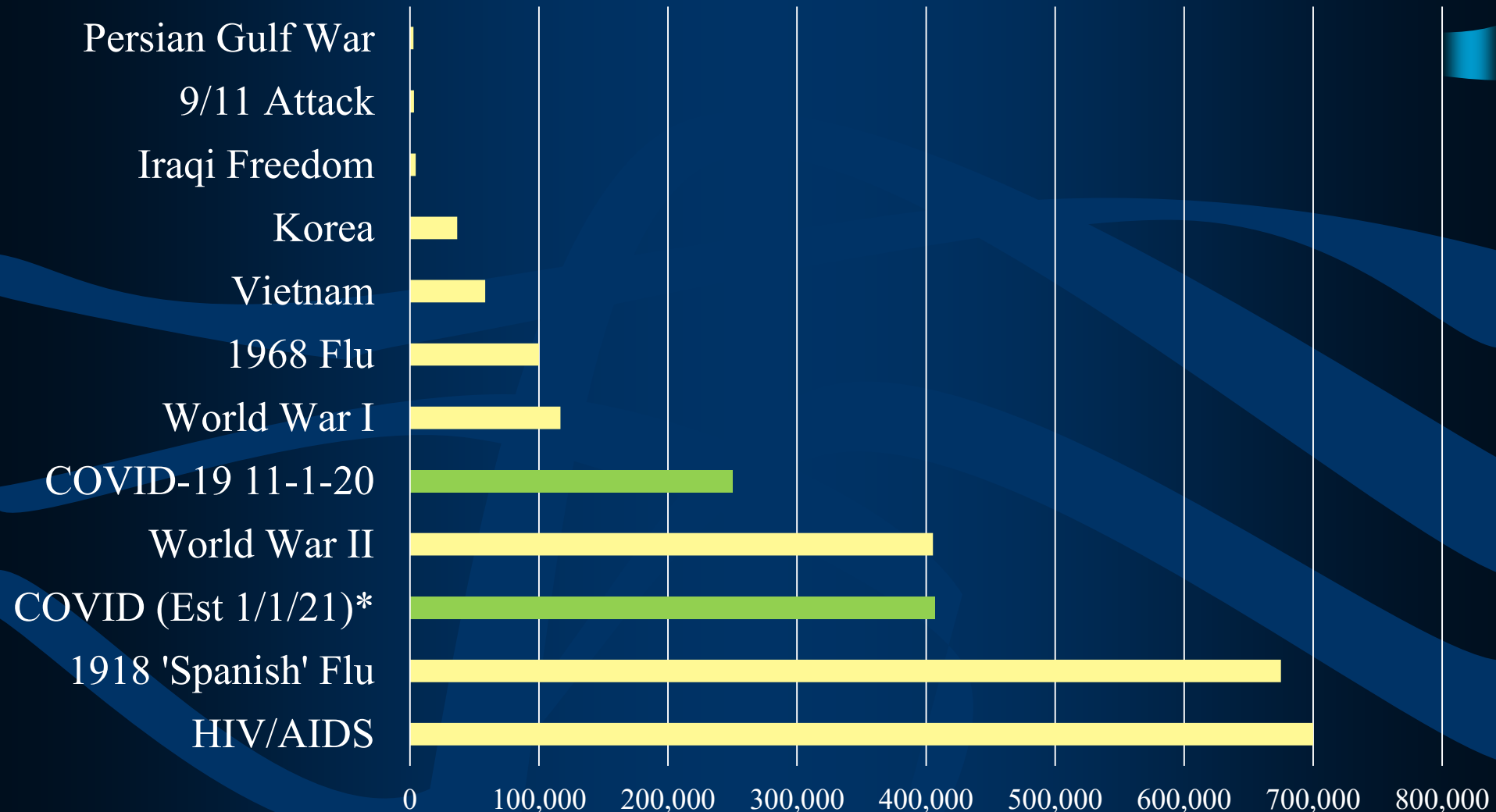
# Impact of COVID-19 on Causes of Mortality, US

Number of deaths in the United States between February 1 and October 10



<https://usafacts.org/articles/top-causes-death-united-states-heart-disease-cancer-and-covid-19/#:~:text=Coronavirus%20is%20one%20of%20the,after%20heart%20disease%20and%20cancer.>

# COVID-19 Deaths



\* *University of Washington Institute for Health Metrics and Evaluation*

# *SARS CoV-2 Epidemiology*

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## *Summary*

- Easily transmitted
- Worldwide, pandemic distribution
- Has proven difficult to control in most settings
- Morbidity and mortality associated with older age and comorbidities.
- Attack rates and disease severity increased for minorities and underserved populations in the US.
- The major challenge to containment is asymptomatic transmission.

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# *SARS-CoV-2 Transmission Dynamics*

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- Infectivity defined as detection of viable, cultivable virus in respiratory secretions.
- Transmission defined as epidemiological evidence of person-to-person spread.
- Based on observations to date, transmission occurs primarily when a person has cultivable virus (may be asymptomatic, presymptomatic or symptomatic).



# *COVID-19 – Epidemiology – US*

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## *Clinical Illness*

- An undetermined percentage of infections are asymptomatic (Estimates range from 25 to 80%).
- For symptomatic infections, 81% of patients had mild to moderate illness; 14% had severe illness and 5% became critically ill.

*Wu Z, McGoogan JM.. JAMA. 2020;323(13):1239-42.*

# *SARS-CoV-2 Transmission Dynamics*

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- Patients are infectious up to 48 hours prior to symptom development.
- Viral RNA is detectable by PCR for weeks, sometimes months; however, cultivable virus does not track with PCR.

*Wolfel R. et al. Nature. 2020;581(7809):465-9.*

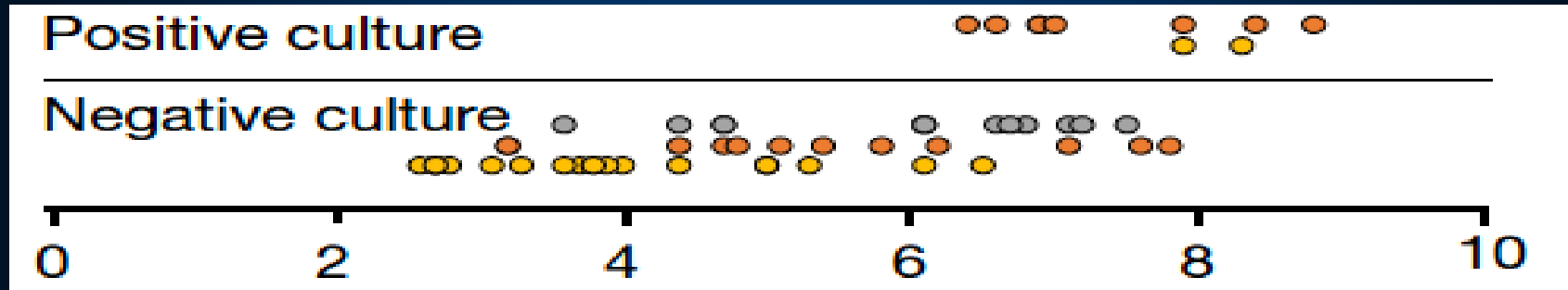
- For symptomatic patients, virus is cultivable for 7-10 days; immunosuppressed/critically-ill patients shed virus for up to 20 days.
- Rare exceptions documented.

*Avanzato VA, et al. Cell (2020), doi:*

*<https://doi.org/10.1016/j.cell.2020.10.049>*

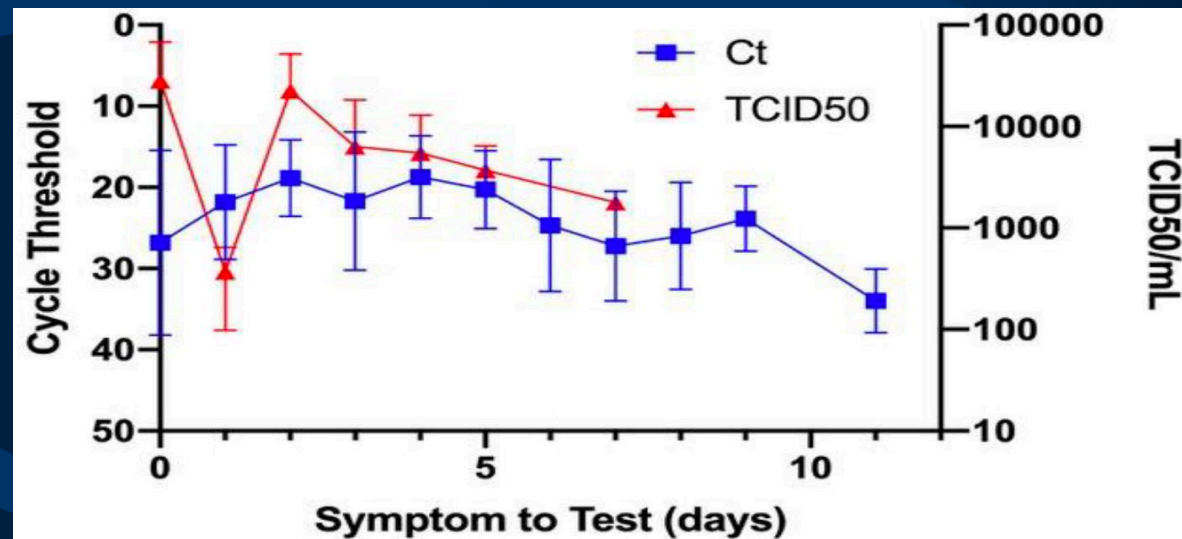
# SARS-CoV-2 Transmission Dynamics

- In a German study virus was not cultured after day 9.



*Wolfel R. et al. Nature. 2020;581(7809):465-9.*

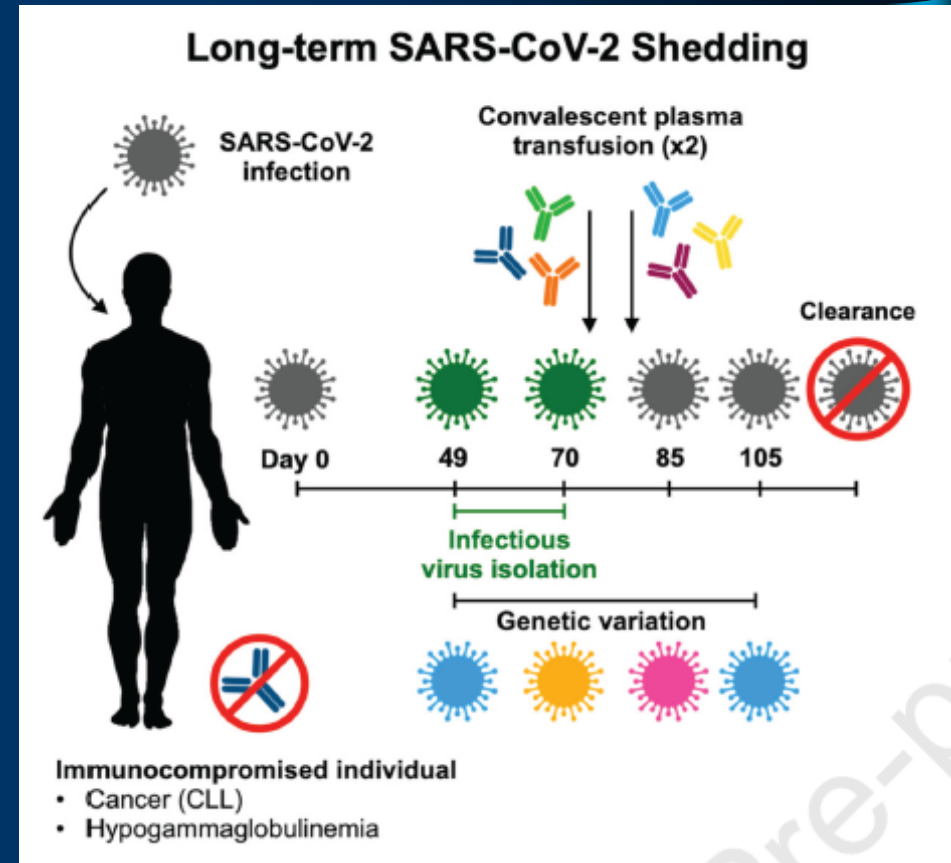
- In a Canadian study virus was not cultured after day 7.



*Bullard R. et al. Clin Infect Dis. <https://www.ncbi.nlm.nih.gov/pubmed/32442256>.*

# SARS-CoV-2 Transmission Dynamics

- Case report of woman who has with chronic lymphocytic leukemia and acquired hypogammaglobulinemia.
- Shedding of infectious SARS-CoV-2 observed up to 70 days, and genomic and subgenomic RNA up to 105 days post initial diagnosis.
- Infection not cleared after first treatment with convalescent plasma. Several weeks after a 2<sup>nd</sup> convalescent plasma transfusion, SARS-CoV-2 RNA was no longer detected
- Detection of subgenomic RNA is recommended in persistently SARS-CoV-2 positive individuals as a proxy for shedding of infectious virus



*Avanzato VA, et al. Cell (2020), doi:  
<https://doi.org/10.1016/j.cell.2020.10.049>*