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

- Historical Perspective
- Virology
- Epidemiology
- Transmission
- Mitigation Strategies
- Healthcare Epidemiology
SARS CoV-2 and COVID-19

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

By Dennis Normile

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

\[ \text{Paramyxoviruses} \]

- Ebola
- Marburg

\[ \text{Filoviruses} \]

- SARS CoV-1
- MERS
- SARS CoV-2

\[ \text{Coronaviruses} \]

- Rabies
- Rabies-related

\[ \text{Rhabdoviruses} \]

- West Nile
- Chikungunya
- Crimean-Congo

\[ \text{Flaviviruses} \]
\[ \text{Togaviruses} \]
\[ \text{Bunyaviruses} \]
SARS-CoV-2 – Context

Modified from Rahman, T., et al. Microorganisms 2020, 8(9), 1405; https://doi.org/10.3390/microorganisms8091405
SARS-CoV-2 – History

• 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

SARS-CoV-2 – Early Timeline

Dec 30, 2019
Cluster of cases of pneumonia of unknown origin reported to China National Health Commission

Jan 7, 2020
Novel coronavirus isolated

Jan 11, 2020
First fatal case reported

Jan 1, 2020
Huanan Seafood Wholesale market closed

Jan 3, 2020
First case in Wuhan reported

Jan 13, 2020
First case in Thailand reported

Jan 19, 2020
First case in Korea reported; two cases in Beijing and one case in Guangdong province reported

Jan 16, 2020
First case in Japan reported

Jan 24, 2020
835 cases reported in China (549 from Hubei province, 286 from the other 31 provinces, municipalities, or special administrative regions)

Jan 20, 2020
Infection in health-care workers caring for 2019-nCoV patients

# SARS-CoV-2 – Early US Timeline

<table>
<thead>
<tr>
<th>January</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/6 CDC Director offers to send a team of CDC scientists to assist China</td>
<td>3/31, 3,170 deaths, 164,620 confirmed cases, and 1.07 million tests completed in the U.S.</td>
</tr>
<tr>
<td>1/7 CDC begins airport screening in NYC, LA, and SF.</td>
<td>3/12, Colleges and public schools begin to close</td>
</tr>
<tr>
<td>1/17 CDC sought an FDA EUA for states to use its test</td>
<td>3/13, 3,170 deaths, 164,620 confirmed cases, and 1.07 million tests completed in the U.S.</td>
</tr>
<tr>
<td>1/23 CDC sought an FDA EUA for CDC PCR test</td>
<td>3/14, CDC lift restriction on testing</td>
</tr>
<tr>
<td>1/20 First US case reported – an American citizen traveling from Wuhan to Washington state</td>
<td>3/15, 338 US nationals stranded on the Diamond Princess evacuated</td>
</tr>
<tr>
<td>1/31 DHHS declares a public health emergency</td>
<td>2/28, CDC test kit revised</td>
</tr>
<tr>
<td>1/3 CDC Director notified a &quot;mysterious respiratory illness&quot; was spreading in Wuhan</td>
<td>3/16, WHO declares pandemic</td>
</tr>
<tr>
<td>1/8 CDC issued first public alert about the coronavirus</td>
<td>3/17, CDC and DHHS issue guidelines</td>
</tr>
</tbody>
</table>
SARS CoV-2 and COVID-19

- Historical Perspective
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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 Gugli, PhD, NIAID. Based on 440 bp nucleotide sequences of RNA-dependent RNA polymerase.

Slide Source: A.S. Fauci, MD; ID Week 2020
SARS-CoV-2 – Virology

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SARS-CoV-2 – Virology

Human coronaviruses

Beta-CoV
- GX-Pangolin-CoV
- GD-Pangolin-CoV
- Bat-CoV-RaTG13
- SARS-CoV-2

Gamma-CoV
- HCoV-OC43
- HCoV-HKU1

Delta-CoV
- MERS-CoV
- HCoV-NL63
- HCoV-229E

Alpha-CoV
- FCoV
- SADS-CoV

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

Slide Source: A.S. Fauci, MD; ID Week 2020
SARS-CoV-2

- Spike Glycoprotein
- Envelope Protein
- Matrix Protein

High Resolution Photograph Courtesy of CDC
SARS CoV-2 and COVID-19

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COVID-19 – Global Epidemiology

Total Cases = 50,866,743  Total Deaths = 1,263,992

Source: NPR.org; Worldometer.data as of 11-9-2020
## COVID-19 – Global Epidemiology

Total Cases = 50,866,743  
Total Deaths = 1,263,992

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

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

Source: NPR.org; Worldometer.data as of 11-3-2020
US COVID-19 Cases Reported to the CDC in the Last 7 Days, by State/Territory

Source: CDC; data as of 11-6-2020
COVID-19 – Epidemiology – US vs. Europe

7-Day Rolling Average of New COVID-19 Cases
February 1 to November 6, 2020

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

COVID-19 – Epidemiology – US

Source: New York Times; data as of November 9
COVID-19 – Epidemiology – US

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

- Hispanic/Latino: 387
- American Indian/Alaska Native: 377
- Black, Non-Hispanic: 376
- Asian/Pacific Islander: 114
- White, Non-Hispanic: 86

Source: CDC COVID-NET. Data from 14 states.
Impact of COVID-19 on Causes of Mortality, US

COVID-19 Deaths

Persian Gulf War
9/11 Attack
Iraqi Freedom
Korea
Vietnam
1968 Flu
World War I
COVID-19 11-1-20
World War II
COVID (Est 1/1/21)*
1918 'Spanish' Flu
HIV/AIDS

* University of Washington Institute for Health Metrics and Evaluation
**SARS CoV-2 Epidemiology**

**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

- 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).
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.

SARS-CoV-2 Transmission Dynamics

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


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

**SARS-CoV-2 Transmission Dynamics**

- Case report of woman who has 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 2nd 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.