novel coronavirus 2019
What is it?

» Coronavirus
  • based on crown-like Spike proteins
  • related to SARS, MERS, and HCoV strains

» Group infects a wide range of mammals
  • bats
  • palm civets (SARS)
  • camels (MERS)
  • humans (HCoV)

» Naming conventions
  • virus - SARS-CoV-2
  • disease - COVID-19
COVID-19

Cumulative versus daily case reports by case designation

Data source: https://github.com/CSSEGISandData/COVID-19 last downloaded Wed May 13 07:11:17 2020 PST
COVID-19

Case reports by case designation

Washington  California  Georgia  New York  Puerto Rico

Cases +1 (log10 scale)

Date (2020)

Case designation

confirmed  deceased

Incubation period: time between exposure and onset of sign or symptoms
Symptoms: fever (88%), dry cough (68%), fatigue (38%), sputum production (33%), shortness of breath (18%)...
Resolved: patient either recovers or passes; transmission ceases
Modes of transmission

» Droplet
  • large respiratory droplets from coughs or sneezes

» Airborne
  • smaller droplets hanging in airspace

» Contact or fomites
  • virus-contaminated surfaces

» Direct
  • sharing mucous

» Fecal/oral
  • shed in feces

Estimating parameters:
Reproductive Number

<table>
<thead>
<tr>
<th>Disease</th>
<th>Transmission</th>
<th>$R_0$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SARS-CoV-2</td>
<td>Airborne droplet</td>
<td>2 - 4</td>
</tr>
<tr>
<td>Measles</td>
<td>Airborne</td>
<td>12 - 18</td>
</tr>
<tr>
<td>HIV/AIDS</td>
<td>Sexual contact</td>
<td>2 - 5</td>
</tr>
<tr>
<td>H1N1 Swine flu</td>
<td>Airborne droplet</td>
<td>1.2 - 1.5</td>
</tr>
<tr>
<td>Rotavirus</td>
<td>Fecal-oral</td>
<td>16 - 25</td>
</tr>
<tr>
<td>SARS-CoV</td>
<td>Airborne droplet</td>
<td>2 - 5</td>
</tr>
<tr>
<td>MERS</td>
<td>Airborne droplet</td>
<td>0.7</td>
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<tr>
<td>Influenza (Seasonal)</td>
<td>Airborne droplet</td>
<td>0.9 - 1.8</td>
</tr>
<tr>
<td>Influenza (Spanish Flu 1918)</td>
<td>Airborne droplet</td>
<td>2 - 3</td>
</tr>
<tr>
<td>Ebola (2014 outbreak)</td>
<td>Bodily fluids</td>
<td>1.5 - 2.5</td>
</tr>
<tr>
<td>Zika</td>
<td>Mosquito-borne</td>
<td>3 - 6.6</td>
</tr>
</tbody>
</table>
Estimating parameters

Fatality rate (log scale)

100%

Average number of people infected by each sick person

New coronavirus
Most estimates put the fatality rate below 3%, and the number of transmissions between 2 and 4.

More deadly

Spreads faster

New York Times summary 2020
Crowd-sourcing the data and dashboards

- Johns Hopkins CSSE
- World-o-meter
- New York Times Tracker
- OurWorldinData
- ESRI Coronavirus storymap
- Common Operations dashboard
- Nextstrain
- GISAID
Evolution

+ssRNA virus:

- genome 29,903bp
- 10 genes
- 1-3 changes per month

SARS CoV-2 precursor, bat RaTG13 96%
pangolin, Guangdong 90%

SARS CoV 80%
MERS CoV

seasonal HCoV
Evolution: Spike protein receptor binding site & furin cleavage site differences

Cyan - ACE2 human receptor
Gray - CoV spike glycoprotein
Red - mutation differences

SARS vs hCoV-19
RaTG13 vs hCoV-19
Vaccines - safety, efficacy, scalability

- traditional recombinant protein (e.g. flu vaccine)
- replicating & non-replicating viral vectors
- nucleic acid DNA and mRNA
- passive transfer of neutralizing antibodies
Therapeutics

- Hydroxy-, Chloroquine, and phosphate anti-malaria drug also used to treat some autoimmune disorders (e.g., lupus)
- Remdesivir - antiviral drug developed for Ebola
- Kaletra - Lopinavir and ritonavir drug combination approved to treat HIV, two alone or in combination with the flu drug oseltamivir (Tamiflu)
- Favipiravir - antiviral drug for the treatment of influenza
- Arbidol - antiviral
- Monoclonal antibodies
- Immunosuppressants
Updated Recommendations (CDC, WHO)

- Stay home if you are sick; stay home if you aren’t sick (aka shelter-in-place)
- Wash hands often & thoroughly (20 s) with soap & water or alcohol-based (>60%) hand sanitizer
- Avoid touching face with unwashed hands
- Practice social distancing
- Where a cloth face covering where it is difficult to maintain social distance

Coronaviruses can travel only about six feet from the infected person. It’s unknown how long they live on surfaces.

Some other viruses, like measles, can travel up to 100 feet and stay alive on surfaces for hours.
Evolution: G lineage Spike protein mutation D614G

Spike mutation pipeline reveals the emergence of a more transmissible form of SARS-CoV-2

B Korber, WM Fischer, S Gnanakaran, H Yoon, J Theiler, W Abfalterer, B Foley, EE Giorgi, T Bhattacharya, MD Parker, DG Partridge, CM Evans, TM Freeman, TI de Silva, on behalf of the Sheffield COVID-19 Genomics Group, CC LaBranche, DC Montefiori

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