The Coronavirus (COVID-19) Epidemic
What do we know and what can public health scientists and advocates do?
Submit a question at:
go.umd.edu/covid19question

University of Maryland Coronavirus Information
umd.edu/virusinfo
THE NOVEL CORONAVIRUS: What We Know About How They Infect and Spread Among Us

Donald Milton, MD, DrPH / Professor / Institute for Applied Environmental Health
Coronaviruses

• Large family of RNA viruses
  – Infect many species from rats and bats to Beluga whales
  – Mutate slowly compared with influenza viruses (another RNA virus)

• Seven coronaviruses infect humans:
  – Four common cold viruses: OC43, HKU1, 229E, NL63
    • Have been infecting humans for hundreds to thousands of years
  – Three new ‘emerging’ viruses cause severe disease:
    • COVID-19 is the disease, SARS-CoV-2 is the virus.

• Currently no vaccines and no antiviral medications available
Common Coronavirus & Influenza Infections in the C.A.T.C.H. the virus Study at UMD 2017-2019

<table>
<thead>
<tr>
<th>Virus</th>
<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Participants</td>
<td>68</td>
<td>164</td>
<td>398</td>
<td>630</td>
</tr>
<tr>
<td>CoV229E</td>
<td>5</td>
<td>6</td>
<td>20</td>
<td>31</td>
</tr>
<tr>
<td>CoVHKU1</td>
<td>4</td>
<td>15</td>
<td>2</td>
<td>21</td>
</tr>
<tr>
<td>CoVNL63</td>
<td>3</td>
<td>-</td>
<td>15</td>
<td>18</td>
</tr>
<tr>
<td>CoVOC43</td>
<td>13</td>
<td>3</td>
<td>19</td>
<td>35</td>
</tr>
<tr>
<td>All HCoV</td>
<td>25</td>
<td>24</td>
<td>56</td>
<td>105</td>
</tr>
<tr>
<td>Percent infected</td>
<td>37%</td>
<td>15%</td>
<td>14%</td>
<td>17%</td>
</tr>
<tr>
<td>Influenza A</td>
<td>12</td>
<td>6</td>
<td>32</td>
<td>50</td>
</tr>
<tr>
<td>Influenza B</td>
<td>1</td>
<td>9</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>All Influenza</td>
<td>13</td>
<td>15</td>
<td>32</td>
<td>60</td>
</tr>
<tr>
<td>Percent infected</td>
<td>19%</td>
<td>9%</td>
<td>8%</td>
<td>10%</td>
</tr>
</tbody>
</table>
The Common Killer and the Novel Virus

Influenza

294,000 - 518,000: global deaths/year¹
Case fatality rate 0.13 to 0.16%
75% of infected are asymptomatic³

COVID-19

2,128: global deaths (2/19/2020)
75,725: global confirmed cases
Unknown #: undiagnosed symptomatic cases
Unknown #: asymptomatic cases
Case fatality rate
~2.5% of confirmed cases
Rate among all cases unknown – probably lower

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Annual Influenza Infections in the USA²

<table>
<thead>
<tr>
<th></th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deaths</td>
<td>12,000</td>
<td>56,000</td>
</tr>
<tr>
<td>Hospitalizations</td>
<td>139,000</td>
<td>708,000</td>
</tr>
<tr>
<td>Outpatient Visits</td>
<td>4,200,000</td>
<td>16,700,000</td>
</tr>
<tr>
<td>Symptomatic</td>
<td>9,200,000</td>
<td>35,600,000</td>
</tr>
<tr>
<td>Asymptomatic³</td>
<td>36,800,000</td>
<td>142,400,000</td>
</tr>
</tbody>
</table>

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We are having a pretty bad influenza season

Medical Visits for Influenza-like Illness

Influenza-Associated Pediatric Deaths

<table>
<thead>
<tr>
<th>Seasons</th>
<th>Total Deaths</th>
<th>Deaths reported During the Week Ending 08 Feb 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010-71</td>
<td>113</td>
<td>0</td>
</tr>
<tr>
<td>2011-12</td>
<td>184</td>
<td>0</td>
</tr>
<tr>
<td>2012-13</td>
<td>146</td>
<td>0</td>
</tr>
<tr>
<td>2013-14</td>
<td>144</td>
<td>0</td>
</tr>
<tr>
<td>2014-15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2015-16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2016-17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2017-18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2018-19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2019-20</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Staying Safe During Flu Season

Get the flu shot and…
• Wash hands
• Cover coughs & dispose of used tissues
• Avoid crowds
• Stay home/isolate when sick

But also…
• Avoid close proximity to someone ill, coughing
• Avoid sharing poorly-ventilated spaces
Symptoms of COVID-19

• Respiratory / Systemic
  – Fever (43% at diagnosis, 88-98% in hospital), fatigue (38-70%),
  – Muscle and or joint aches (15-35%)
  – Dry cough (59-68%), short of breath (18-31%), sputum (33%),
    sore throat (14-17%)
• Gastrointestinal
  – Diarrhea (4-10%), abdominal pain (2%), nausea or vomiting (5%)

W. Guan et al., medRxiv, in press, doi:10.1101/2020.02.06.20020974.
Chest X-ray and CT

- Abnormal Chest X-ray
  - 15%
- Abnormal Chest CT
  - 76% to 100%
  - Cases reported with minimal symptoms and abnormal CT
- Indicates infection in small airways deep in the lung.


Human CoVs cause between 10-40% of colds
The new virus is a SARS-like betacoronavirus

- Natural reservoir in bats
- Pangolins are a possible bridging species

Trevor Bedford @trvrb Bedford.io/talks,
https://nextstrain.org/groups/blab/sars-like-cov?c=host&p=full

Luc Forsyth for The New York Times
Evolution in Time of SARS-CoV-2

Evidence that virus originated in Hubei in December 2019.

X-axis is time Dec 2019 – Feb 2020

Y-axis is number of mutations (0 to 7)

Color shows location of sample collection

https://nextstrain.org/ncov
Timeline of Exposure to Index Patient with 2019-CoV Infection in Germany, and Secondary Cases from Asymptomatic Patient 1

- Index Patient:
  - Visited Germany
  - Attended business meetings
  - Flight to China
  - Symptoms
  - Positive PCR

- Patient 1:
  - Attended business meetings
  - Symptoms
  - Positive PCR

- Patient 2:
  - Attended business meetings
  - Symptoms
  - Positive PCR

- Patient 3:
  - Contacted (C)
  - Symptoms
  - Positive PCR

- Patient 4:
  - Contacted (C)
  - Contacted (C)
  - Contacted (C)
  - Symptoms
  - Positive PCR
Modes of Transmission?
Modes of Transmission?

- Gesundheit-II exhaled breath sampler
- Fine aerosol = tiny particle suspended in air
- Influenza virus is present in exhaled breath – even without coughing.

Modes of Transmission?

Likely Modes of SARS-CoV-2 Transmission

- **Airborne transmission**
  - MERS-CoV and SARS-CoV can be
  - Short and long range possible
  - How often?
- **Large “respiratory” droplets**
  - Short range
  - Virus in nose and throat swabs
- **Fecal-oral**
  - Virus in feces
  - Likely in cases that start with diarrhea and abdominal pain

Infectious MERS-CoV in Hospital Corridor Air

Cleaning and Disinfection

- Coronaviruses are harder than influenza virus
- Coronaviruses can
  - Persist on metal, glass, and plastic for up to 9 days
  - Can be inactivated on surfaces within 1 minute by cleaning with
    - 62-71% ethanol
    - 0.5% hydrogen peroxide
    - 0.1% sodium hypochlorite (10% household chlorine bleach)
    - (benzalkonium chloride and chlorhexidine are not as effective)

Take Home Messages

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But also…
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THE FEATURES OF THE COVID-19 EPIDEMIC:
Why Has It Spread Fast in China, but Not in Other Countries?

Hongjie Liu, PhD, MS / Professor and Chair / Department of Epidemiology and Biostatistics
The Scope of the epidemic, February 16, 2020

- Globally: 51,857 confirmed cases
- China: 51,174 confirmed cases and 1,666 deaths
- Outside of China: 683 confirmed cases from 25 countries and 3 deaths
Epidemic Wave of COVID-19 in China (02/10)

- 89 cases reported by 12/31
- 759 Cases by 01/10
- 6165 Cases by 01/20
- 32655 Cases by 01/31
- 5003 cases by 02/11

01/23: Wuhan on Lockdown

44,672 Lab-confirmed cases

Date of symptom onset vs Date of report

SCHOOL OF PUBLIC HEALTH
Distribution of COVID-19 Patients Outside of China (02/06/20)

- The majority of patients had direct or indirect contacts to patients in Wuhan or other cities in China.

- Among 170 cases who had a travel history to China, only 11% (19) lead to onward transmission.

- The Diamond Princess cruise has the largest outbreak of COVID-19 outside China. By far, 17% (624/3,711) of passengers and crew have been infected.
Lab-Confirmed Cases and Fatality of COVID-19 in China

- Most of the cases were Hubei residents or had a recent travel history to Wuhan.
- The majority of the cases had mild and moderate symptoms.

<table>
<thead>
<tr>
<th>Cases (%)</th>
<th>Death</th>
<th>Fatality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>44672</td>
<td>1023</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age group</th>
<th>Cases (%)</th>
<th>Death</th>
<th>Fatality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-</td>
<td>416 (0.9)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10-</td>
<td>549 (1.2)</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>20-</td>
<td>3619 (8.1)</td>
<td>7</td>
<td>0.2</td>
</tr>
<tr>
<td>30-</td>
<td>7600 (17.0)</td>
<td>18</td>
<td>0.2</td>
</tr>
<tr>
<td>40-</td>
<td>8571 (19.2)</td>
<td>38</td>
<td>0.4</td>
</tr>
<tr>
<td>50-</td>
<td>10008 (22.4)</td>
<td>130</td>
<td>1.3</td>
</tr>
<tr>
<td>60-</td>
<td>8583 (19.2)</td>
<td>309</td>
<td>3.6</td>
</tr>
<tr>
<td>70-</td>
<td>3918 (8.8)</td>
<td>312</td>
<td>8.0</td>
</tr>
<tr>
<td>80-</td>
<td>1408 (3.2)</td>
<td>208</td>
<td>14.8</td>
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</table>

<table>
<thead>
<tr>
<th>Gender</th>
<th>Cases (%)</th>
<th>Death</th>
<th>Fatality (%)</th>
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</thead>
<tbody>
<tr>
<td>Male</td>
<td>22981 (51.4)</td>
<td>653</td>
<td>2.8</td>
</tr>
<tr>
<td>Female</td>
<td>21691 (48.6)</td>
<td>370</td>
<td>1.7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Province</th>
<th>Cases (%)</th>
<th>Death</th>
<th>Fatality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hubei</td>
<td>33367 (74.7)</td>
<td>979</td>
<td>2.9</td>
</tr>
<tr>
<td>Others</td>
<td>11305 (25.3)</td>
<td>44</td>
<td>0.4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Exposure to Wuhan</th>
<th>Cases (%)</th>
<th>Death</th>
<th>Fatality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>31974 (85.8)</td>
<td>853</td>
<td>2.7</td>
</tr>
<tr>
<td>No</td>
<td>5295 (14.2)</td>
<td>66</td>
<td>1.2</td>
</tr>
<tr>
<td>Unknown</td>
<td>7403</td>
<td>104</td>
<td>2.8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Severity of symptoms</th>
<th>Cases (%)</th>
<th>Death</th>
<th>Fatality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mild/Moderate</td>
<td>36160 (80.9)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Severe</td>
<td>6168 (13.8)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Extreme severe</td>
<td>2087 (4.7)</td>
<td>1023</td>
<td>49.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Having co-existing diseases (comorbidities)</th>
<th>Cases (%)</th>
<th>Death</th>
<th>Fatality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>5276</td>
<td>371</td>
<td>7.0</td>
</tr>
<tr>
<td>No</td>
<td>15536</td>
<td>133</td>
<td>0.9</td>
</tr>
</tbody>
</table>

- Fatality was higher among older cases, cases with extreme severe symptoms, cases with comorbidities.
Basic Reproductive Number ($R_0$) and Fatality

- $R_0$: the average number of individuals directly infected by an infectious case during his/her entire infectious period.

- An epidemic is expected to continue if $R_0$ has a value >1 and to end if $R_0$ is <1.

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Patients</td>
<td>Death</td>
<td>Illnesses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hospitalized</td>
</tr>
<tr>
<td>China</td>
<td>44,672</td>
<td>1,023</td>
<td>45,000,000</td>
</tr>
<tr>
<td>Hubei</td>
<td></td>
<td></td>
<td>6100</td>
</tr>
<tr>
<td>China w/o Hubei</td>
<td></td>
<td></td>
<td>6100</td>
</tr>
<tr>
<td>Outside of China</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fatality</td>
<td>2.3%</td>
<td>9.1%</td>
<td>0.13%</td>
</tr>
<tr>
<td>China</td>
<td>2.9%</td>
<td></td>
<td>7.5%</td>
</tr>
<tr>
<td>Outside of China</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Why Has the Epidemic Spread Fast in China, but Not in Other Countries?
420 Patients Identified in Wuhan Before the Declaration of Person-To-Person Transmission

01/23: Wuhan on Lockdown

Prevention opportunity missed

Person-to-person transmission Declared
Wuhan: Epicenter and Transportation Hub in China

Estimated from epidemic modeling, 75,815 individuals had been infected in Wuhan as of January 25.

Because of the Chinese Spring Festival season and concerns about the epidemic, about 5 million people had left Wuhan before Jan 26, 2019. Nine million residences remain in Wuhan.
Traditional Public Health Strategies Work

- Traditional 3E prevention strategies include:
  - **Early** identify infected individuals
  - **Early** treat patients and persons testing positive for COVID-19.
  - **Early** quarantine close contacts for 14 days

- The 3E prevention strategies have been effectively implemented in other counties (e.g., US).

- China missed the opportunity to uptake the 3E strategies on 01/01
EFFECTIVE RISK COMMUNICATION
As an Antidote to Fear, Uncertainty and Misinformation

Cynthia Baur, PhD, MA / Endowed Professor and Director / Herchel S. Horowitz Center for Health Literacy
Are you more likely to die today because of a distracted driver or coronavirus?

It depends.
Risk Perceptions Founded on Dread and Uncertainty

[Diagram showing a scatter plot with axes labeled 'Certainty', 'Low Dread', 'High Dread', and 'Uncertainty']
Q: What is a novel coronavirus?

A: A novel coronavirus is a new coronavirus that has not been previously identified. The virus causing coronavirus disease 2019 (COVID-19), is not the same as the coronaviruses that commonly circulate among humans and cause mild illness, like the common cold.

A diagnosis with coronavirus 229E, NL63, OC43, or HKU1 is not the same as a COVID-19 diagnosis. Patients with COVID-19 will be evaluated and cared for differently than patients with common coronavirus diagnosis.
FEMA PROPOSES MARTIAL LAW TO CONTAIN CORONAVIRUS

Breaking911
@Breaking911

Breaking: 23 confirmed cases of deadly coronavirus in New York, Chicago, and Los Angeles.

5:34 PM · Jan 25, 2020 · Twitter Web App

Parents Abandoned Sick Kids At Airport Outbreak

Coronavirus in China: 23 Million QUARANTINED, 2.8 Million Infected; 112,000 DEAD

The outbreak of an alleged new coronavirus in China is completely out of control, and is killing THOUSANDS every day. As of 6:00 PM eastern US...
Facebook, Google and Twitter scramble to stop misinformation about coronavirus
Consequences

More distrust
Fake or harmful remedies
Scapegoating
Prejudice
Fear
Racism
Bias
Stereotyping
Shortages
Anxiety
Personal To Do List

✓ Express empathy for those directly affected
✓ Expect new information will keep coming
✓ Follow basic precautions, such as handwashing
✓ Test assumptions of what's risky and credible
✓ Disrupt disinformation supply and distribution
✓ Take a break from constant news updates
LESSONS LEARNED FROM THE 2009 INFLUENZA PANDEMIC

Boris D. Lushniak, MD, MPH / Professor and Dean
10 Great Public Health Achievements–US 1900-1999

• Vaccination
• Motor-vehicle safety
• Safer workplaces
• Control of infectious diseases
• Decline in deaths from heart disease and stroke

• Safer and healthier foods
• Healthier mothers and babies
• Family planning
• Fluoridation of water
• Recognition of tobacco as a health hazard

MMWR 1999 Apr 2;48(12):241-3.
Seasonal Influenza

- Annual respiratory illness transmitted from person to person
- Impact
  - Globally 250,000-500,000 deaths each year
  - As high as 20% morbidity in the US
  - As many as 36,000 deaths and over 200,000 hospitalized in US
  - Total annual cost in US over $10-30 billion
Pandemic Influenza

• “An epidemic occurring worldwide…crossing international boundaries and usually affecting a large number of people.” (WHO)

• Three conditions
  • A new subtype of influenza virus and no immunity
  • Virus produces serious illness
  • Virus must be able to spread efficiently from person to person
### Previous Pandemics of Influenza

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td><strong>World Deaths</strong></td>
<td>40-50 million +</td>
<td>1-2 million</td>
<td>700,000</td>
<td>151,000 - 575,000</td>
</tr>
<tr>
<td><strong>US Deaths</strong></td>
<td>675,000 (young adults)</td>
<td>70,000+ (infants, elderly)</td>
<td>34,000+ (infants, elderly)</td>
<td>12,469 (children, working adults)</td>
</tr>
<tr>
<td><strong>Type</strong></td>
<td>Spanish flu H1N1 Infected 20-40% of world</td>
<td>Asian flu H2N2 To US in 4-5 mos; Global in 8 months</td>
<td>Hong Kong flu H3N2 To US in 2-3 mos</td>
<td>H1N1 In US 60.8 million cases 274,000 hospitalized</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
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</tbody>
</table>
21st Century Trends Affecting Pandemic Impact

• Global population larger and more urbanized

• Levels of international travel greater
  • Over 1 billion passengers annually in US (2018)
  • Increased population of elderly and those with chronic conditions
April 15 – first case confirmed in US (CA) in 10 yo old (clinical lab study)

April 17 -- second case confirmed in 8 yo (130 miles away)

April 21 – work on candidate vaccine virus

April 22 – CDC activated its Emergency Operations Center (EOC)

April 23 – 2 cases in Texas, Mexico and Canada cases confirmed

April 24 – FDA activated its EOC

April 25 – WHO declares a public health emergency of international concern
  • “an extraordinary event...constitutes a public health risk...thru international spread...to potentially require a coordinated international response.”
  • NYC cluster, case in Kansas and Ohio

April 26 – US Government declared a public health emergency and implemented the national pandemic response plan
  • Strategic National Stockpile moves antivirals and resp prot devices to States
Novel H1N1 Influenza 2009 Timeline

- **April 27** – WHO pandemic alert level to Phase 4 (human to human, community level outbreaks)
- **April 28** – diagnostic cleared by FDA under Emergency Use Authorization (EUA)
- **April 29** – WHO pandemic alert level to Phase 5 (human to human in 2 nations in one region, pandemic imminent)
- **June 11** – WHO pandemic alert level to Phase 6 (a pandemic--community level outbreaks in at least one nation in a different region)
  - Pandemic now affecting 70 nations
- **June 19** – All 50 States, DC, Puerto Rico, and US Virgin Islands report cases
- **July 6** – 122 countries reporting 94,512 cases with 429 fatal
  - US 33,902 with 170 fatal
- **July** – case counts stopped, > 1 million in US; reporting of hospitalizations and deaths
- **July 23** – start of clinical trials with new vaccine
Novel H1N1 Influenza 2009 Timeline

- **July 29** – initial target groups for vaccination established
  - Pregnant, caretakers of infants < 6 mos, health care workers, age 6 mos-24 yrs, age 25-64 at high risk
- **September 15** – FDA licenses 4 vaccines (a fifth added on Nov 16)
- **September 30** – States place order for vaccine
- **October 5** – first doses of vaccine administered
- **October** – peak of activity, launch of vaccination campaign
- **November/December** – easing of restrictions on vaccines
- **December** – preliminary safety results for vaccine
  - 3783 reports, 5 % serious, similar to seasonal
Novel H1N1 Influenza 2009

- Two waves (peak in June and Oct)
- Hospitalization rates highest in children age 0-4 and working adults
- Estimated 60.8 million cases in US
  - 274,304 hospitalizations and 12,469 deaths
  - 151,700 to 575,400 deaths worldwide
- Higher burden of disease in young
  - May be due to previous exposure of older persons to similar viruses
- Pandemic declared over on August 10, 2010

Shrestha et al, Clin Infect Dis 2011, 1; 52, Suppl 1:S75-82
National Framework for H1N1 Public Health Response

- Four major pillars
  - Surveillance
  - Community mitigation
    - Nonpharmaceutical interventions
      - Stay at home when sick
      - Cover coughs and sneezes
      - Frequent handwashing
      - Cleaning of touched surfaces and objects
      - Reduce social contacts
  - Vaccine delivery
  - Communication
Pandemic Influenza

“It is clear that pandemic influenza has the potential to pose disease control challenges unmatched by any other natural or intentional infectious disease event.” -- DHHS

SPANISH FLU 1918

FEDERAL MEDICAL SHELTER 2006
QUESTIONS?
Submit a question at:

go.umd.edu/covid19question
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But also…
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UPDATES ON THE CORONAVIRUS

umd.edu/virusinfo