COVID-19 Science

Dr. George Conway
Director – Deschutes County Health Services
'Virus' vs 'Bacteria'

The key differences between two common pathogens.

- **Viruses are not living organisms.**
  - Viruses only grow and reproduce inside of the host cells they infect. When found outside of these living cells, viruses are dormant. Their "life" therefore requires the hijacking of the biochemical activities of a living cell.
  - Viruses are submicroscopic.
  - A viral infection is systemic. Viruses infect a host cell and then multiply by the thousands, leaving the host cell and infecting other cells of the body.
  - Systemic diseases caused by viral infection include influenza, measles, polio, AIDS, and COVID-19.

- **Bacteria are living organisms.**
  - Bacteria are living organisms that consist of single cell that can generate energy, make its own food, move, and reproduce (typically by binary fission). This allows bacteria to live in many places—soil, water, plants, and the human body—and serve many purposes.
  - Bacteria are giant compared to viruses.
  - Bacterial infection is usually confined to a part of the body, described as a localized infection. Infections may be caused by the bacteria or by toxins (endotoxins) produced.
  - Bacterial diseases include pneumonia, tuberculosis, tetanus, and food poisoning.

Source: https://www.merriam-webster.com/words-at-play/virus-vs-bacteria-difference

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Hijack
How SARS-CoV-2 replicates itself in the cells of those infected

1 Spike protein on the virion binds to ACE2, a cell-surface protein. TMPRSS2, an enzyme, helps the virion enter. 2 The virion releases its RNA. 3 Some RNA is translated into proteins by the cell's machinery. 4 Some of these proteins form a replication complex to make more RNA. 5 Proteins and RNA are assembled into a new virion in the Golgi and 6 released.

Sources: Song et al., Viruses, 2019; Jiang et al., Emerging Microbes and Infections, 2012; The Economist
Know the symptoms of COVID-19, which can include the following:

- Cough, shortness of breath or difficulty breathing
- Fever or chills
- Muscle or body aches
- Vomiting or diarrhea
- New loss of taste or smell
Figure 1. Infection with SARS-CoV-2 (COVID-19) can be classified into three stages of increasing severity: early infection, pulmonary phase, and hyperinflammation phase (Adapted from Siddiqi, HK, and Mehra, MR. 2020).
COVID-19’s damaging effects on the body

Growing evidence suggests that the coronavirus, mostly known to cause respiratory illness, can also affect many of the body’s primary organs.

**Brain**
People with COVID-19 have had strokes and seizures. Some have reported confusion or delirium. Not directly involving the brain but a central nervous issue: Many patients have reported losing their sense of smell.

**Heart**
Doctors have reported inflammation to the heart and damage to the muscle. Some patients have died from severe heart attacks.

**Blood vessels**
Blood clotting in major arteries and veins has been reported. Clots can break off and damage multiple organs by stopping blood flow.

**Kidneys**
Many COVID-19 patients suffer serious kidney damage and require dialysis.

**Lungs**
The virus can cause pneumonia, in which the lungs become inflamed and fill with fluid. Patients may require ventilation. As the infection progresses, the virus can cause serious lung damage, which can be fatal.

**Intestines**
Roughly 20% of patients report diarrhea as an early symptom. The virus has been found in the lower intestinal tract of some patients.

Sources: Chronicle research, Getty Images
<table>
<thead>
<tr>
<th>Patient State</th>
<th>Descriptor</th>
<th>Score</th>
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<tbody>
<tr>
<td>Uninfected</td>
<td>Uninfected; no viral RNA detected</td>
<td>0</td>
</tr>
<tr>
<td>Ambulatory mild disease</td>
<td>Asymptomatic; viral RNA detected</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Symptomatic; independent</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Symptomatic; assistance needed</td>
<td>3</td>
</tr>
<tr>
<td>Hospitalised: moderate disease</td>
<td>Hospitalised; no oxygen therapy*</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Hospitalised; oxygen by mask or nasal prongs</td>
<td>5</td>
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<tr>
<td>Hospitalised: severe diseases</td>
<td>Hospitalised; oxygen by NIV or high flow</td>
<td>6</td>
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<tr>
<td></td>
<td>Intubation and mechanical ventilation, pO₂/FiO₂ ≥150 or SpO₂/FiO₂ ≥200</td>
<td>7</td>
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<tr>
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<td>Mechanical ventilation pO₂/FiO₂ &lt;150 (SpO₂/FiO₂ &lt;200) or vasopressors</td>
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<tr>
<td></td>
<td>Mechanical ventilation pO₂/FiO₂ &lt;150 and vasopressors, dialysis, or ECMO</td>
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<tr>
<td>Dead</td>
<td>Dead</td>
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</tbody>
</table>
1. Mechanical ventilation

Ventilator unit contains air pressure system and controls

Used air (carbon dioxide) flow from patient

Air (oxygen) flow to patient

Tube inserted into airway

Humidifier to match air to body temperature and add moisture
Dr. Fawcett’s observations on clinical care for persons with COVID19:

Main goal - prevent further damage while the body's immune response fights the infection, by:
• Boosting the immune response through passive immunization (e.g., convalescent plasma)
• A similar treatment may soon be administration of synthetic antibody (e.g., Regeneron).
• A second approach: slow viral replication while natural immune responses “catch up” via:
  • 5 day course of remdesivir.
• However, sometimes the immune response can too exuberant → "cytokine storm."
• Then, corticosteroids, e.g., methylprednisolone, may blunt this excessive immune response.

Two other important goals are:
• Alleviate suffering in patients that are not doing well; and
• Containment in the hospital and community to prevent further spread of the virus to others.

The goal of mechanical ventilation is to support patients in respiratory failure while waiting for an effective, natural immune response and/or while slowing viral replication with remdesivir.
What has been learned?
**Repurposed Drugs**

Existing first line of defense
Studying drugs that are already approved to treat other diseases to see if they are effective to treat COVID-19.

- Ebola
- HIV
- Malaria

**Antibodies**

Critical to treat this season's COVID-19
Y-shaped proteins that stick to the virus SARS-CoV-2. These can be manufactured through recombinant technology and injected into patients to prevent or reduce infection.

- From recovered patients
- Animal produced
- Bio-Engineered from previous viruses

**Vaccines**

Critical to treat a seasonal COVID-19
Vaccines mimic enough of the viral infection to trigger the body's immune response which makes antibodies against the virus.

- Sub-unit of protein shell
- RNA
- Patient's B cell
- Plasma cell
- Makes antibodies

**Steps Replication or Blocks Virus**
The RECOVERY trial provides evidence that treatment with dexamethasone for up to 10 days reduces 28-day mortality in patients with Covid-19 who are receiving respiratory support. We found no benefit (and the possibility of harm) among patients who did not require oxygen.
October 22, 2020

- U.S. Food and Drug Administration approved the antiviral drug Veklury (Remdesivir) for use in patients 12 years of age and older for the treatment of COVID-19 requiring hospitalization.
- Remdesivir should only be administered in a hospital or comparable acute care setting.
- Remdesivir is the first treatment for COVID-19 to receive FDA approval.
- One clinical trial (ACTT-1), conducted by the National Institute of Allergy and Infectious Diseases, evaluated how long it took to recover from COVID-19 within 29 days of being treated.
- Recovery: discharged from the hospital or hospitalized but not requiring supplemental oxygen and no longer requiring ongoing medical care.
- The median time to recovery from COVID-19 was 10 days for the [Remdesivir] group compared to 15 days for the placebo group, a statistically significant difference.

(Note: This drug demonstrably shortened the course of illness. It is not a “cure.”)
FIGURE. Selected community mitigation measures* and COVID-19 case counts† and 7-day moving averages§ — Arizona, January 22–August 7, 2020

- Mar 11: Arizona public health emergency declaration
- Mar 15: Limited public events; school closures
- Mar 19: Limited public events; senior living facility visitation restrictions; closures of restaurants for dine-in, bars, gyms, movie theaters
- Apr 29–May 11: Phased reopening; limitations on retail, cosmetologists, barbers, dine-in services
- May 15: Stay-at-home order lifted; closures expired
- Jun 17: Local officials able to mandate and enforce wearing of masks
- Jun 29: Limited public events: closure of bars, gyms, movie theaters, water parks/recreational tubing facilities
- Jul 9: Reduced restaurant dine-in capacity (50%); social distancing
- Jul 23: Limitations and closures extended
Arizona’s prevention and control measures over the summer months helped slow the spread of COVID-19.

151% up in cases after stay-at-home order lifted.

Number of cases stabilized then decreased after multiple statewide and local prevention measures implemented.

75% down in cases following sustained prevention efforts across the state.

- Mask requirements
- Limited public events
- Closures of certain businesses
The difference between droplet and airborne transmission

Droplet transmission
Coughs and sneezes can spread droplets of saliva and mucus

Airborne transmission
Tiny particles, possibly produced by talking, are suspended in the air for longer and travel further

Less than 5 microns

Droplets

Human hair: 60 - 120 microns wide

Source: WHO

Be Informed:
Know Your Risk During COVID-19
On a scale of 1 to 10, how risky is...

1. Opening the mail
2. Getting restaurant takeaway
3. Pumping gasoline
4. Playing tennis
5. Going camping
6. Grocery shopping
7. Going for a walk, run, or bike ride with others
8. Playing golf
9. Staying at a hotel for two nights
10. Sting in a doctor’s waiting room
11. Going to a library or museum
12. Ending in a restaurant (outside)
13. Walking in a busy downtown
14. Spending an hour at a playground
15. Having dinner at someone else’s house
16. Attending a backyard barbecue
17. Going to the beach
18. Shopping at a mall
19. Sending kids to school, camp, or day care
20. Working a week in an office building
21. Swimming in a public pool
22. Visiting an elderly relative or friend in their home
23. Going to a hair salon or barbershop
24. Eating in a restaurant (inside)
25. Attending a wedding or funeral
26. Traveling by plane
27. Playing basketball
28. Playing football
29. Hugging or shaking hands when greeting a friend
30. Eating at a buffet
31. Working out at a gym
32. Going to an amusement park
33. Going to a movie theater
34. Attending a large music concert
35. Going to a sports stadium
36. Attending a religious service with 100+ worshippers
37. Going to a bar

Texas Medical Association
401 W. 15th St. | Austin, TX 78701-1680
www.txmed.org | twitter.com/txmed | facebook.com/texasmed

Low Risk
Low-Moderate
Moderate
Moderate-High
High Risk
Tips for Reducing Risk of Getting COVID-19

Things that Increase Risk
- No Masks Worn
- Crowded Place
- Indoor Space

HOT SPOT

Things that Decrease Risk
- Masks Worn
- 6 Feet of Space Between People
- Outdoor Space

SAFE SPOT

www.cdc.gov/coronavirus
Face Shields

- A face shield is primarily used for eye protection for the person wearing it. At this time, it is not known what level of protection a face shield provides to people nearby from the spray of respiratory droplets from the wearer. There is currently not enough evidence to support the effectiveness of face shields for source control. Therefore, CDC does not currently recommend use of face shields as a substitute for masks.

- However, wearing a mask may not be feasible in every situation for some people for example, people who are deaf or hard of hearing—or those who care for or interact with a person who is hearing impaired. Here are some considerations for individuals who must wear a face shield instead of a mask:
  - Although evidence on face shields is limited, the available data suggest that the following face shields may provide better source control than others:
    - Face shields that wrap around the sides of the wearer’s face and extend below the chin.
    - Hooded face shields.
  - Face shield wearers should wash their hands before and after removing the face shield and avoid touching their eyes, nose and mouth when removing it.
  - Disposable face shields should only be worn for a single use and disposed of according to manufacturer instructions.
  - Reusable face shields should be cleaned and disinfected after each use according to manufacturer instructions or by following CDC face shield cleaning instructions.
  - Plastic face shields for newborns and infants are NOT recommended.
Thank you

www.deschutes.org/covid-19