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Basics of COVID-19

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Learning Objectives

- Describe the origins of the virus that causes COVID-19
- Identify the clinical signs and symptoms of COVID-19 and risk factors for severe disease
- Describe how someone is diagnosed with COVID-19
- Describe when someone is infectious
- Explain how this virus is transmitted from one person to another

SARS-CoV-2 Virus

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What Is a Coronavirus?

- ***Coronaviruses*** (CoVs) are a large group of viruses
  - You need powerful microscopes to see them
  - *Corona* means crown
- They infect a wide range of mammals and birds
- Some regularly cause mild respiratory illness in people

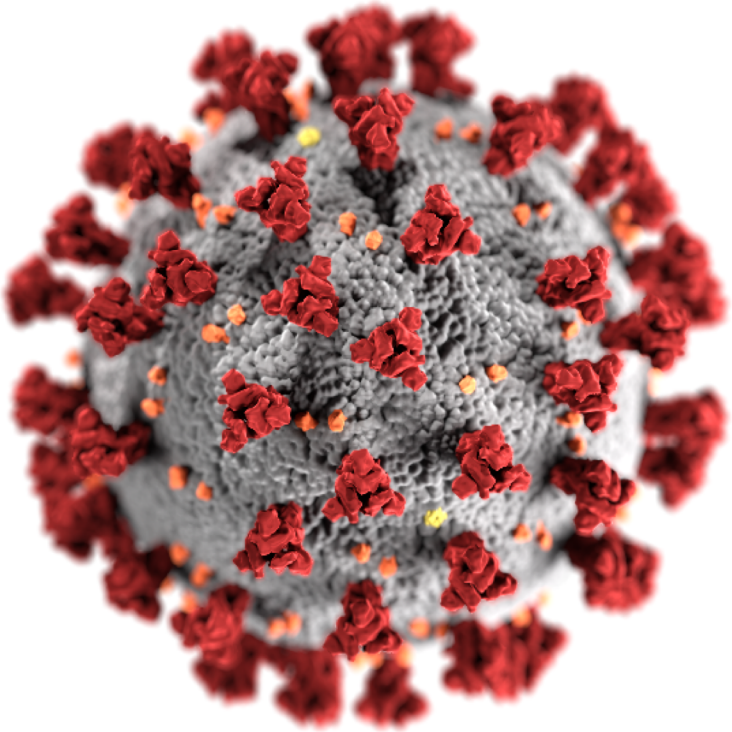


Image credit: US Centers for Disease Control and Prevention (CDC) / Alissa Eckert, MS; Dan Higgins, MAMS.

SARS-CoV-2 Is a New Coronavirus

- SARS-CoV-2 originated in bats
- Special coronaviruses have jumped species and can be transmitted between people
- This is the third coronavirus to have done so since 2002:
  - ***Severe Acute Respiratory Syndrome (SARS)*** CoV emerged in Guangdong, China, in 2002
  - ***Middle Eastern Respiratory Syndrome (MERS)*** CoV emerged in the Middle East in 2012
  - ***SARS-CoV-2*** emerged in Wuhan, China, in 2019

SARS-CoV-2 viruses coming out of cell

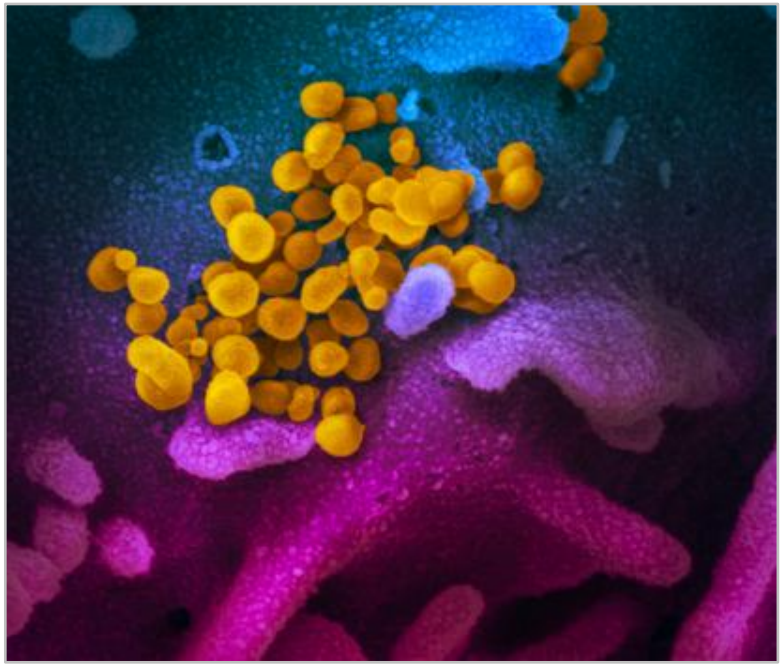


Photo credit: US National Institute of Allergy and Infectious Diseases, Rocky Mountain Laboratories (NIAID-RML).

Natural History of SARS-CoV-2

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What Happens to People After They Get Infected With SARS-CoV-2?

- SARS-CoV-2 is the virus that causes the illness we call COVID-19 (short for “coronavirus disease that emerged in 2019”)
- Not everyone who is infected gets sick
- If someone gets sick …
  - What are the signs and symptoms?
  - How long does the sickness last?
  - How long can infected people spread the virus?
  - Where and how do people shed virus?

Signs Versus Symptoms: General Definitions

- ***Signs*** are objective measurements to characterize illness during a physical exam:
  - Temperature
  - Breathing faster than usual

- ***Symptoms*** are what patients say about how they feel:
  - Fatigue
  - Nausea
  - Loss of taste or smell
  - Muscle ache

- Fever is both a sign and symptom

Signs and Symptoms of COVID-19

- Signs and symptoms can vary widely
  - Some people have no symptoms and are ***asymptomatic***
  - Some people have mild disease
  - Some people have more serious disease that can lead to death

Common signs and symptoms

- Fever (temperature >100.4°F)
- Tiredness (fatigue)
- Chills
- Muscle pain
- Cough
- Loss of taste or smell
- Difficulty breathing
- Headache
- Sore throat

Source: US Centers for Disease Control and Prevention (CDC). Symptoms of Coronavirus. Accessed May 4, 2020.

Specific and Nonspecific Symptoms of COVID-19

- Many symptoms (such as fever, cough, and myalgia [muscle pain]) are ***nonspecific***
  - They are common in COVID-19 and in other respiratory diseases

- Some symptoms are more ***specific*** for COVID-19
  - For example, one third of patients report a recent loss of the ability to taste or smell
  - This is very uncommon in other infections

Severe Signs and Symptoms

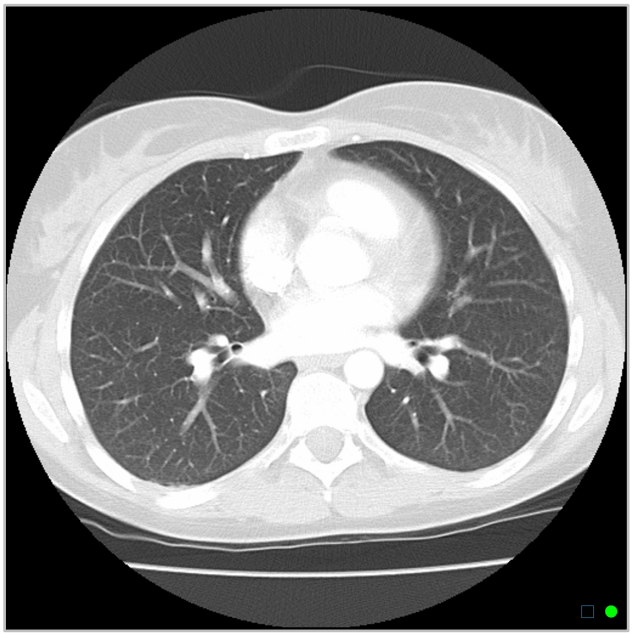
- Some signs and symptoms mean that the disease is becoming more severe (or ***progressing***)
- The most common signs of progressive infection are increased and more severe fevers and increased difficulty breathing

- Patients should immediately seek care if they have emergency warning signs or symptoms, such as:
  - Blue lips or face, which could mean they are not getting enough oxygen
  - Increased rate of breathing
  - Shortness of breath
  - Chest pain when breathing
  - Waking up during sleep with shortness of breath
  - New confusion or difficulty waking up

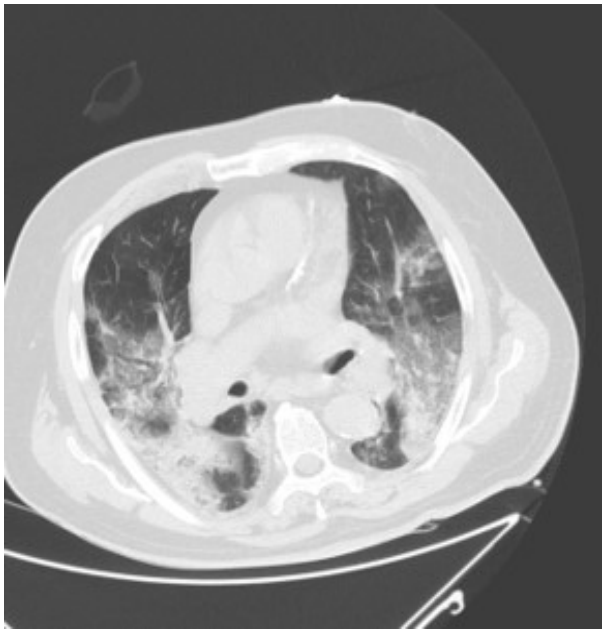
Source: US Centers for Disease Control and Prevention (CDC). Symptoms of Coronavirus. Accessed May 4, 2020.

Effect of COVID-19 on the Lungs

Healthy lungs



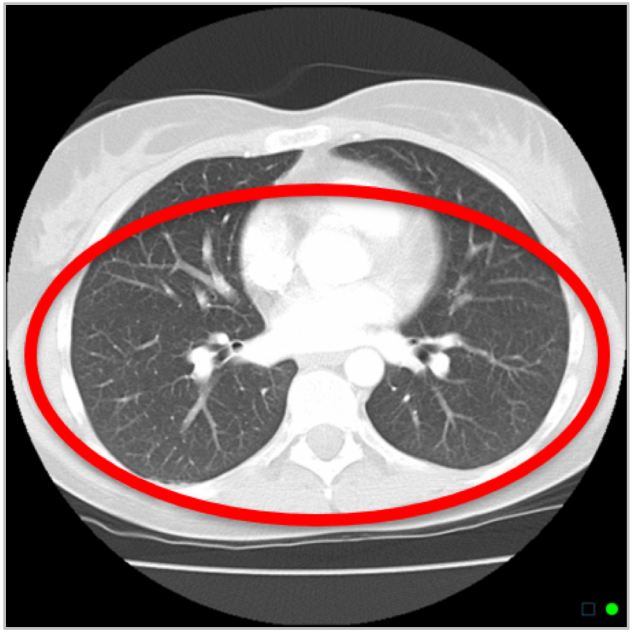
Lungs of someone with severe COVID-19



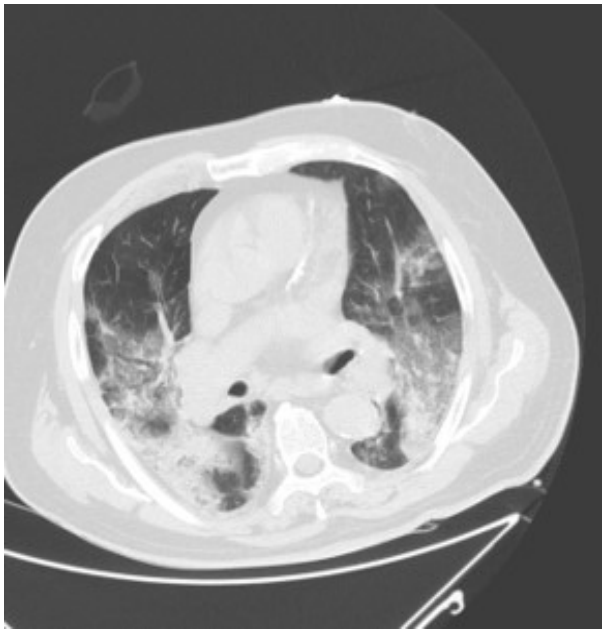
Left: Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 8095.
Right: Case courtesy of Dr Fabio Macori, Radiopaedia.org, rID: 74867.

Effect of COVID-19 on the Lungs: Healthy Lungs

Healthy lungs



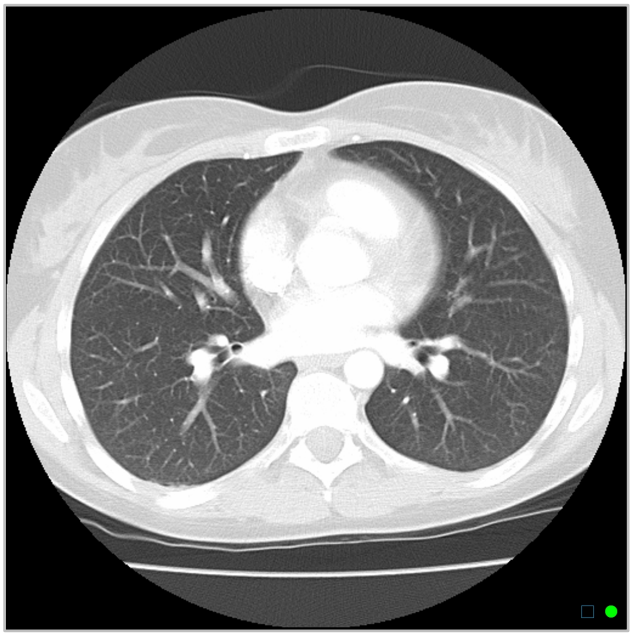
Lungs of someone with severe COVID-19



Left: Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 8095.
Right: Case courtesy of Dr Fabio Macori, Radiopaedia.org, rID: 74867.

Effect of COVID-19 on the Lungs: Congested Lungs

Healthy lungs



Lungs of someone with severe COVID-19



Left: Case courtesy of Assoc Prof Frank Gaillard, Radiopaedia.org, rID: 8095.
Right: Case courtesy of Dr Fabio Macori, Radiopaedia.org, rID: 74867.

SARS-CoV-2 Incubation Period

- The ***incubation period*** is the time from when someone is infected until symptoms develop
- The SARS-CoV-2 incubation period ranges from 2 to 14 days
- 50% of people will become ill by 5 days after they are infected

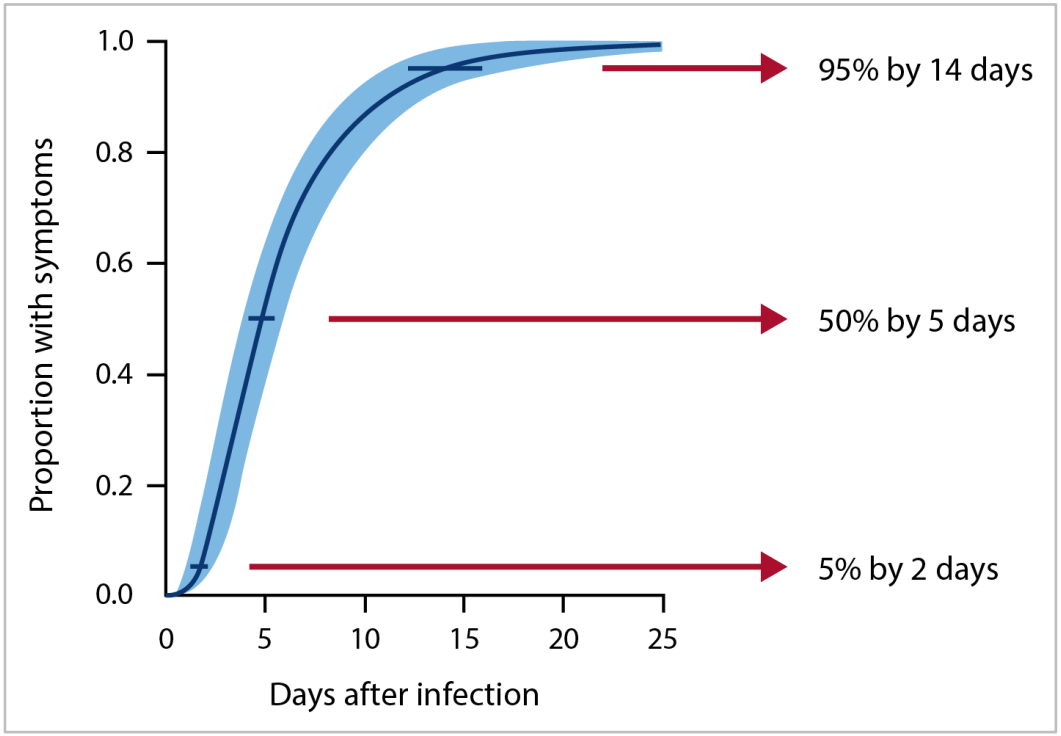


Image adapted by Center for Teaching and Learning, Johns Hopkins Bloomberg School of Public Health, from: Bi, Q., et al. (2020). Epidemiology and transmission of COVID-19 in Shenzhen China: analysis of 391 cases and 1,286 of their close contacts [medRxiv preprint]. Infectious Diseases (except HIV/AIDS). https://doi.org/10.1101/2020.03.03.20028423

SARS-CoV-2 Infectious Period

- The ***infectious period*** is the time during which someone infected with SARS-CoV-2 can transmit the virus to other people

- For people with COVID-19 disease:
  - The infectious period begins 2 days before the start of signs and symptoms of disease
  - The end of the infectious period is defined as when:
    - It is at least 10 days after the onset of illness
    - AND symptoms are improving
    - AND there has been no fever within the past 3 days

- *People who are asymptomatic can also be infectious*
  - For these people, the infectious period is more difficult to define

Timeline of Infection: Incubation Period

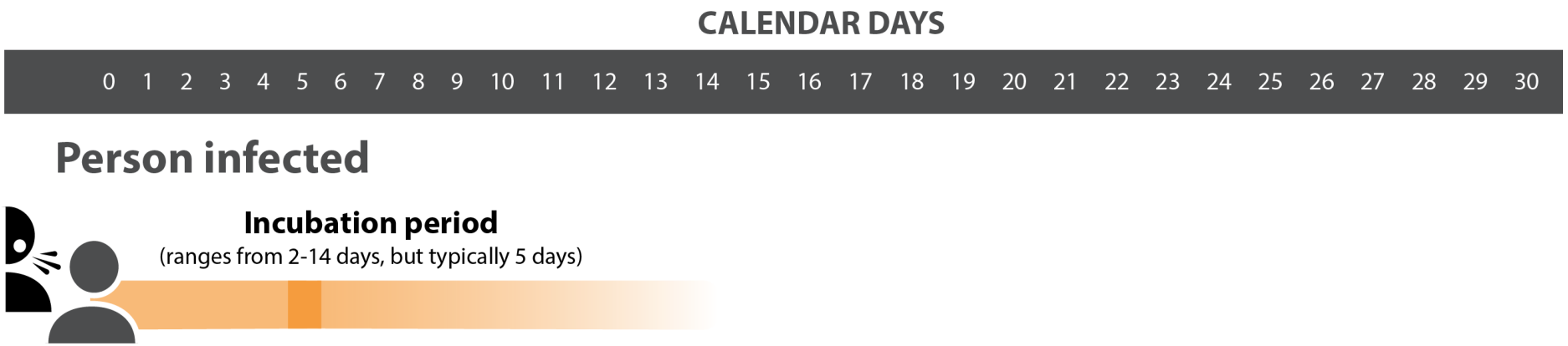


Image source: Center for Teaching and Learning, Johns Hopkins Bloomberg School of Public Health.

Timeline of Infection: Signs and Symptoms

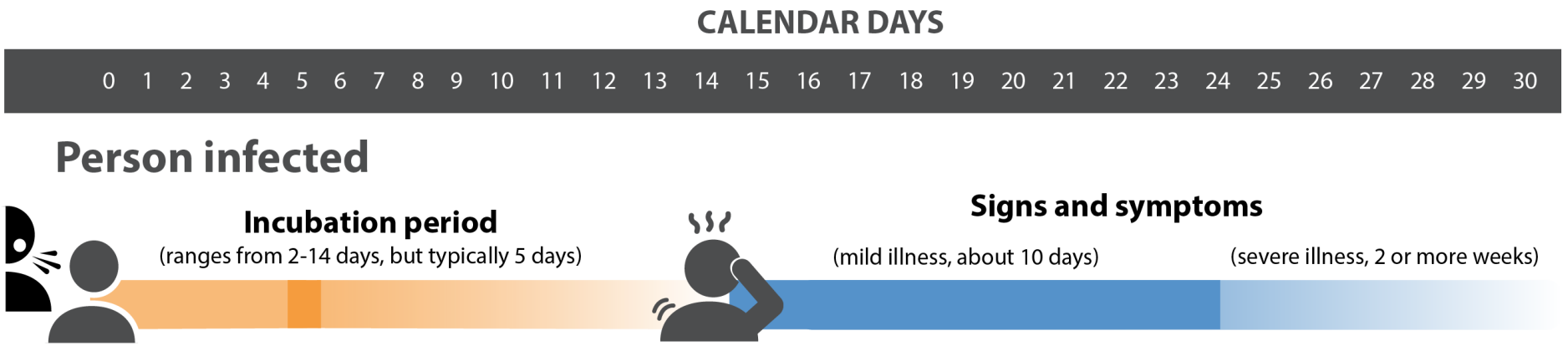


Image source: Center for Teaching and Learning, Johns Hopkins Bloomberg School of Public Health.

Timeline of Infection: Infectious Period

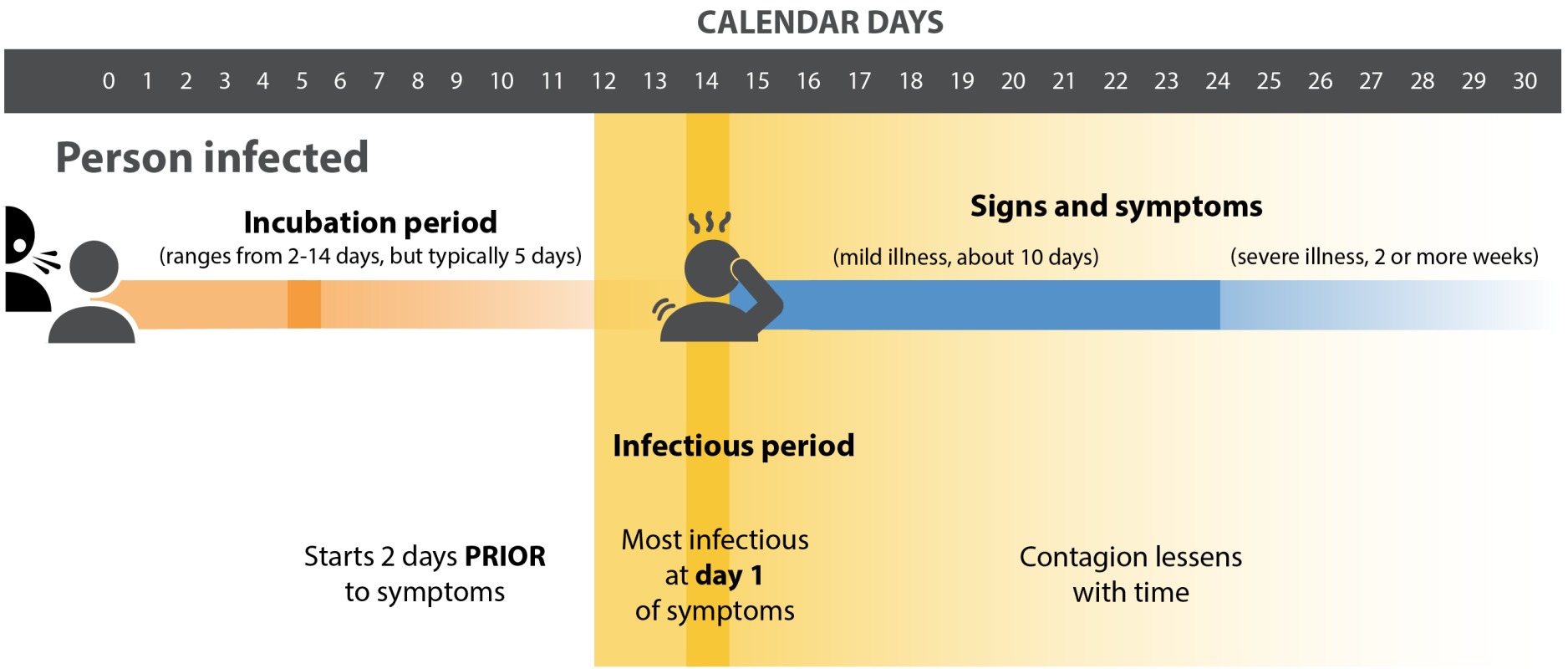


Image source: Center for Teaching and Learning, Johns Hopkins Bloomberg School of Public Health.

Risk Factors for Severe Disease

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Older Age and Obesity as Risk Factors

- Some groups of people are more likely to have severe disease if they get infected
  - Older adults >65 years of age (increasing risk with age)
  - People who are obese

- Some young, healthy people become severely ill
  - Small proportion of infections
  - Children very unlikely to be severely ill

Source: US Centers for Disease Control and Prevention (CDC). Coronavirus Disease 2019 (COVID-19) > People Who Need Extra Precautions > People Who Are At Higher Risk > Groups at Higher Risk for Severe Illness. Accessed May 4, 2020.

Existing Medical Conditions as Risk Factors

- Other existing medical conditions:
  - Diabetes
  - Hypertension (high blood pressure)
  - Any kind of lung disease (asthma, emphysema, chronic obstructive pulmonary disorder [COPD])
  - Heart disease
  - Liver disease
  - Kidney disease
  - Weakened immune system, including a weakened immune system caused by taking steroids or other medications that affect the immune system (note that a person who has HIV that is controlled with medication is not at substantially increased risk)

Source: US Centers for Disease Control and Prevention (CDC). Coronavirus Disease 2019 (COVID-19) > People Who Need Extra Precautions > People Who Are At Higher Risk > Groups at Higher Risk for Severe Illness. Accessed May 4, 2020.

Risk Factors for Death

How the disease can kill	Important risks for death

▶ If the lungs cannot recover, patients cannot breathe on their own
 	
▶ Lack of oxygen can damage the organs in the body, causing increased risk for heart attacks, kidney failure, strokes, and clotting disorders
	▶ Risk for death depends on access to care and general health
	
	▶ Death is rare among young and healthy people
	
	▶ Death is more common among older adults
	  ▶ Of those 65 to 75 years old, 2% to 5% die
	  ▶ Of those 75 to 85 years old, 4% to 10% die
	  ▶ Of those >85 years old, >10% die

Source: CDC COVID-19 Response Team. (2020). Severe outcomes among patients with Coronavirus Disease 2019 (COVID-19)—United States, February 12–March 16, 2020. *MMWR. Morbidity and Mortality Weekly Report*, *69*(12), 343–346. https://doi.org/10.15585/mmwr.mm6912e2

Treatment of COVID-19

- There is no *specific* treatment to cure COVID-19
- Treatment is to support the body's functions until the body's immune system can fight the infection
- Many patients with lung disease require mechanical ventilation (breathing machine, ventilator) to help them breathe
- People who need it will receive support to keep their lungs working so that the body can continue to get the oxygen it needs

Diagnosing COVID-19

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Two Kinds of Tests

- ***Diagnostic tests*** identify virus in the body
  - These are polymerase chain reaction (PCR) tests (also called molecular tests)
  - These tests give a sign that the virus is reproducing in your cells

- ***Antibody tests*** identify antibodies to the virus, usually in blood
  - Antibodies are made by your immune system to fight off viruses or bacteria
  - Some antibodies (IgG) begin to develop when you are sick and can be identified after you recover

- Remember that no tests are perfect!

IgG = immunoglobulin G.

How We Test for Active Infection

- The PCR test is usually done to test people with signs and symptoms
- It detects the RNA (genetic material) of the virus
- Swab is taken from nose, throat, or mouth
  - Specimen typically comes from somewhere in the respiratory tract
  - Saliva can also be tested

- A positive PCR test …
  - Shows that there are virus particles in the sample
  - Means there is active infection
- There are sometimes false negative results
  - Not all people with infection will have RNA in their sample

How We Test for Past Infection

- IgG antibody is the most common antibody test
- The body starts to produce IgG antibodies 10 to 14 days after infection
- Antibody tests are usually performed on blood
- They can be performed after someone recovers or in people who never had symptoms

- A positive IgG antibody test …
  - Shows that you were infected with the virus in the past
  - Does not tell you when you were infected
  - Could mean that you have some protection from future SARS-CoV-2 infection (we are not sure yet)

Timeline of Testing

Diagnostic test—viral RNA detectable in respiratory tract

Past infection—antibodies to virus detectable in blood

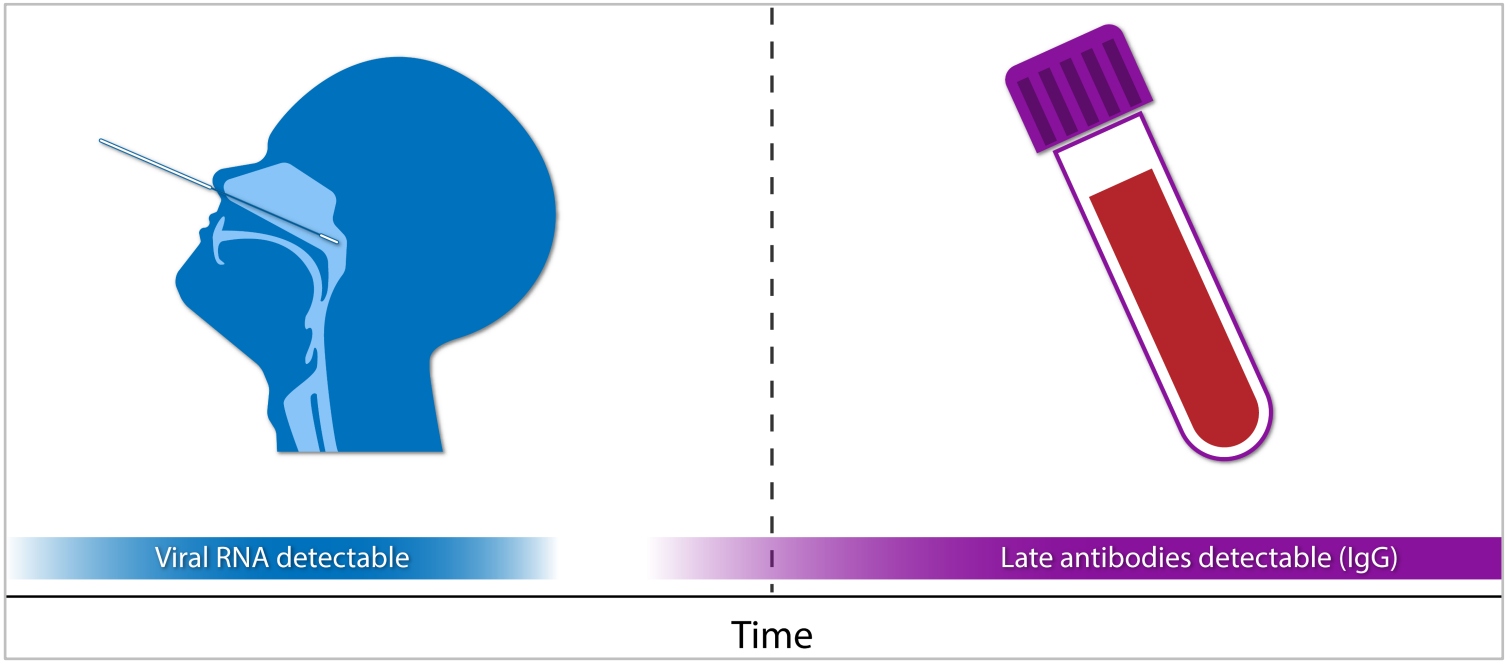


Image source: Johns Hopkins University.

Transmission of SARS-CoV-2

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How SARS-CoV-2 Is Transmitted

First way …	Second way …

► Infected people have the virus in their mouths, noses, and throats
► Droplets come out when we are talking, laughing, coughing, and sneezing
► Those droplets can enter another person's mouth, nose, or eyes
	► Surfaces may have viruses from someone's respiratory droplets
	► Virus can "survive" on surfaces and then contaminate the hands of others
	  ► Hands can transfer virus to your mouth, nose, or eyes
	  ► Hand-washing and cleaning are important!

In hospitals, patients have procedures done that may increase transmission

Infectious Respiratory Droplets Can Travel



- Droplets can …
  - Travel during sneezes, coughs, talking, and singing
  - Travel up to 6 feet
  - Land in the eyes, nose, or mouth of people
  - Land on surfaces
- Mask use can reduce transmission
  - Fewer droplets from infected person

Photo credit: US Centers for Disease Control and Prevention (CDC) / Brian Judd. (2009).

SARS-CoV-2 Is Transmitted Efficiently

- People are infectious before they have symptoms
- Some people never develop symptoms
- We must test symptomatic people and identify their contacts quickly to limit spread

Transmission Is More Likely With Closer Contact

- Physical contact
- Close contact (within 6 feet for 15 minutes or more)
- Shared environment (for example, offices and restaurants)
- Sharing food and bathrooms
- Sharing beds

- Transmission is more likely between people who live together (physical contact and shared spaces)

Living Conditions That Increase Risk for Transmission

- Sometimes called ***congregate housing*—**many people living in close quarters

- Examples:
  - Prisons and jails
  - Group homes
  - Dormitories
  - Shelters

Nursing Homes: Worst-Case Scenario

- Nursing home residents are at high risk for severe disease:
  - Older age
  - Multiple underlying conditions
  - Need for multiple interventions, such as feeding and toileting
- Staff are therefore at increased risk of exposure and infection
- Nursing homes are not hospitals and are not set up for severe infections

Why Stopping Transmission Is So Important

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Timeline of Infection: Infectious Period

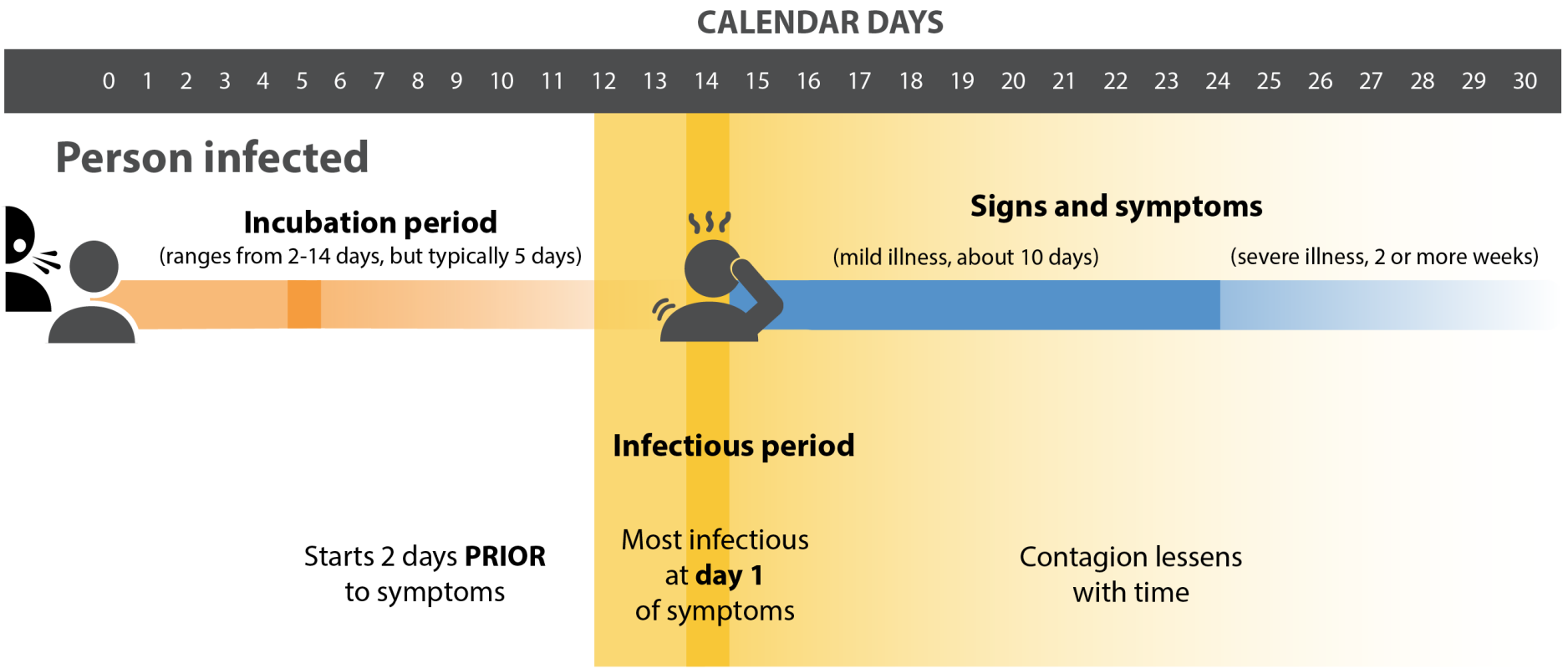


Image source: Center for Teaching and Learning, Johns Hopkins Bloomberg School of Public Health.

Timeline of Infection: Infected Contact

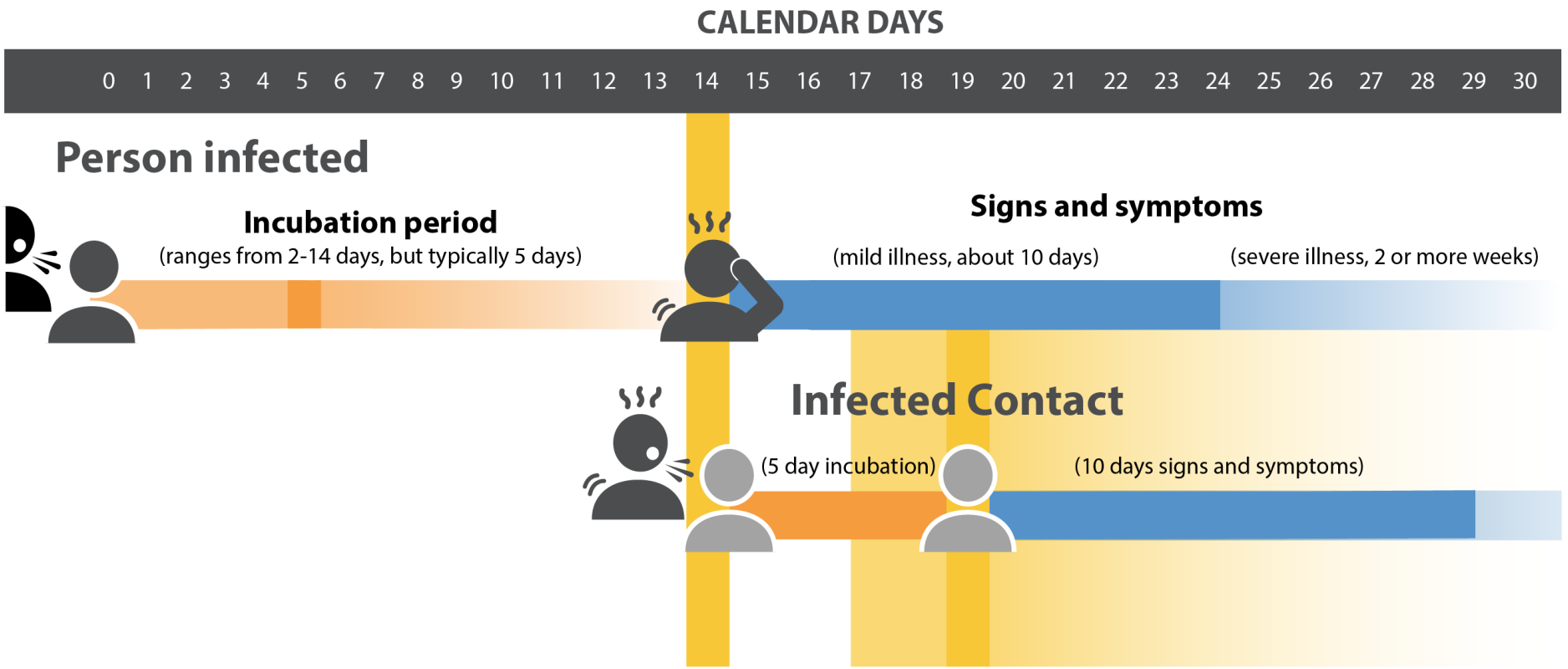


Image source: Center for Teaching and Learning, Johns Hopkins Bloomberg School of Public Health.

Timeline of Infection: Window of Opportunity

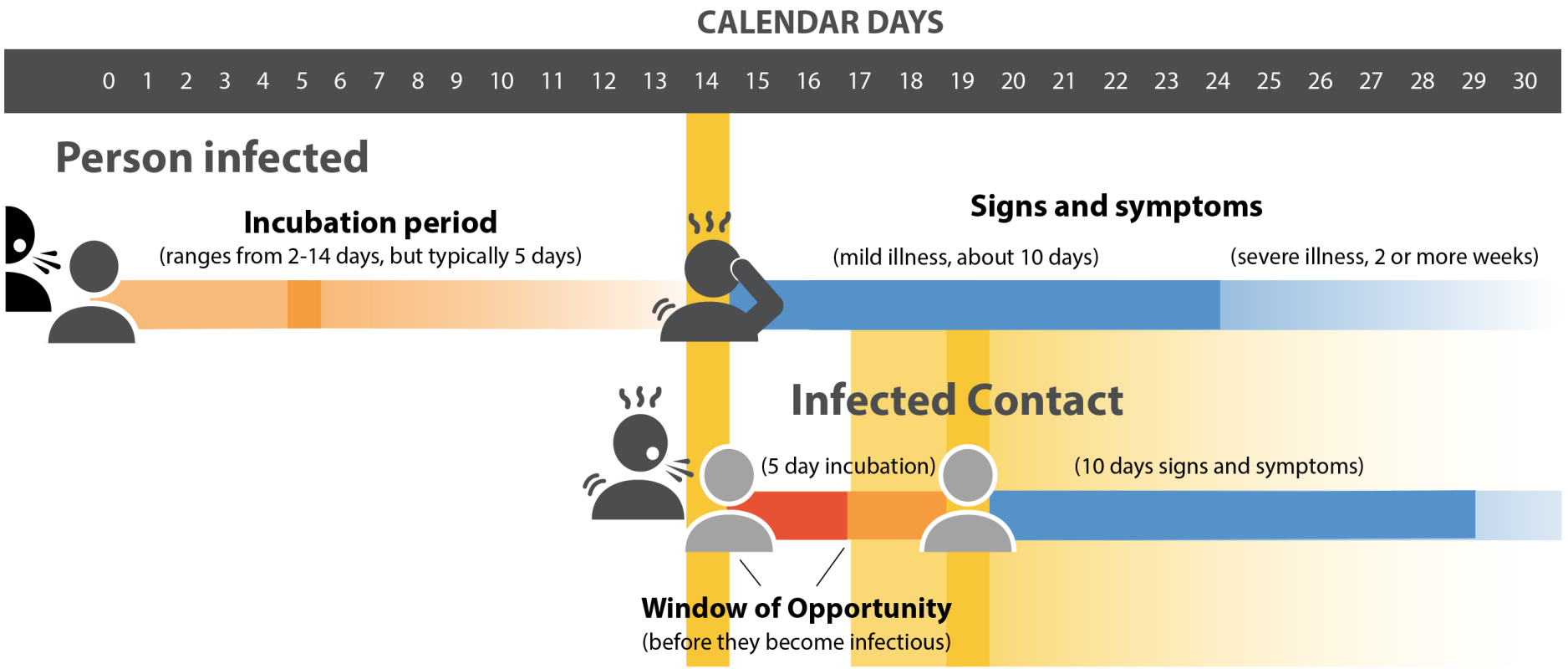


Image source: Center for Teaching and Learning, Johns Hopkins Bloomberg School of Public Health.

Reproductive Number (R0 or R-Naught)

- ***Reproductive number*—**the number of people one infectious person will infect if everyone that person has contact with is susceptible
- This is a good way to measure how fast a disease can spread
- The higher the reproductive number, the more people will be infected

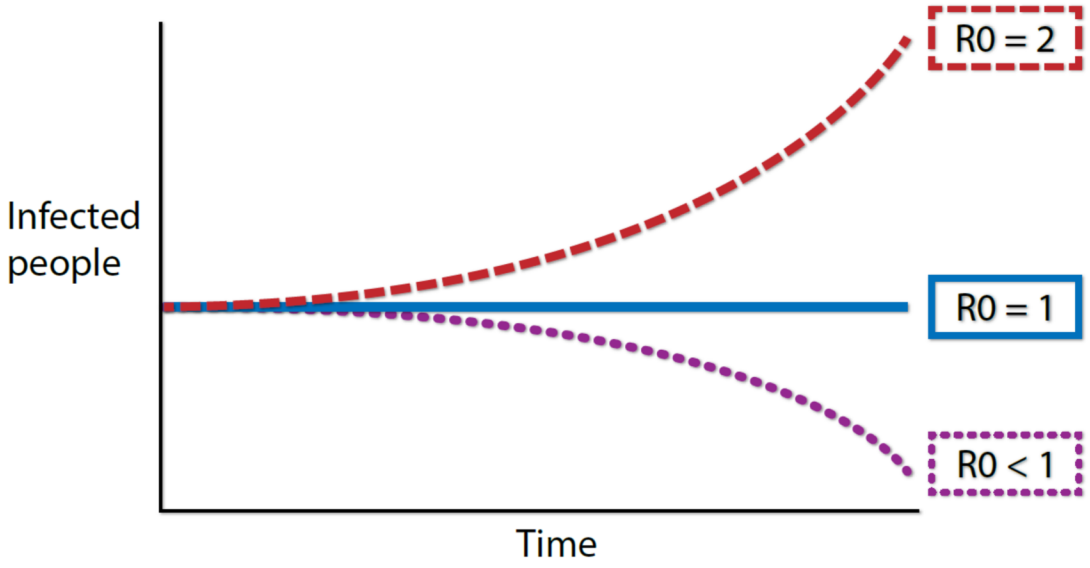


Image source: Johns Hopkins University.

Infectiousness

- How many people will one person infect?

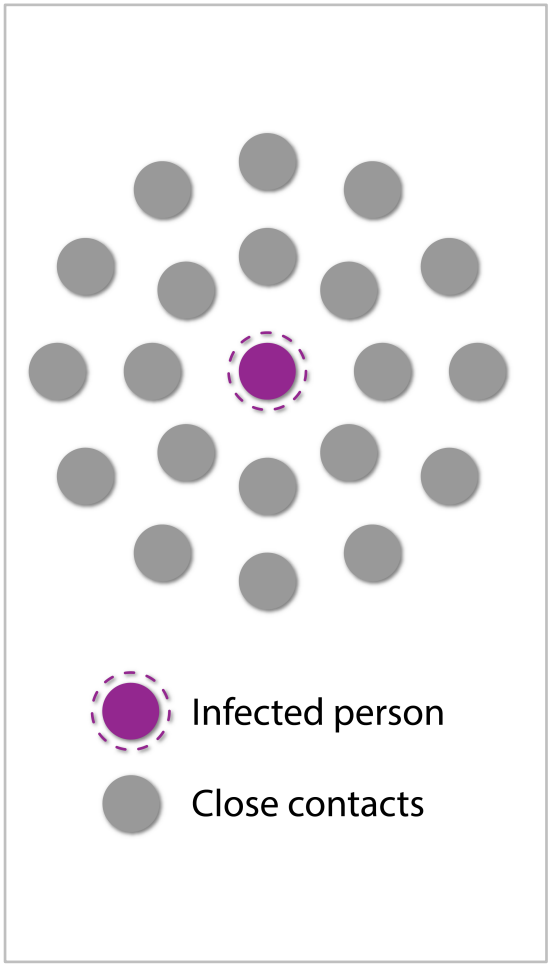


Image source: Johns Hopkins University.
Source: Eisenberg, J. (2020 March 17). R0: How scientists quantify the intensity of an outbreak like coronavirus and predict the pandemic's spread. The Conversation US. Accessed May 4, 2020.

Infectiousness: Measles

- Measles is the most infectious virus (R0 = 15)

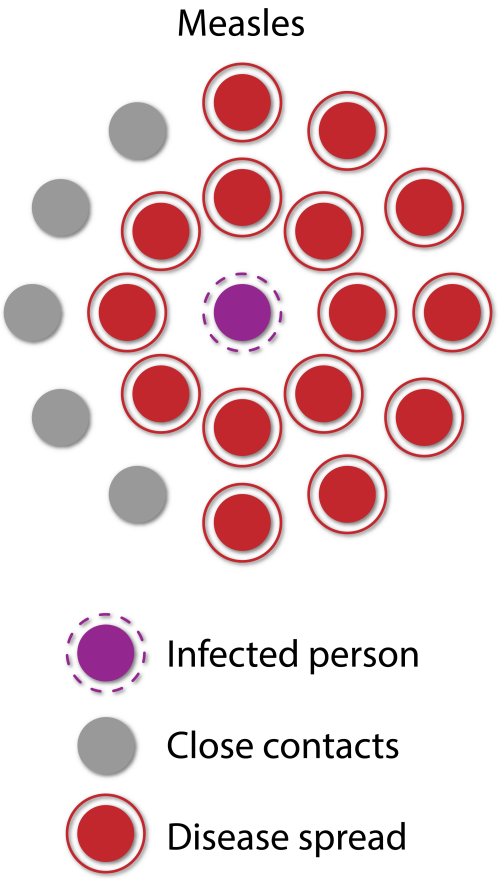


Image source: Johns Hopkins University.
Source: Eisenberg, J. (2020 March 17). R0: How scientists quantify the intensity of an outbreak like coronavirus and predict the pandemic's spread. The Conversation US. Accessed May 4, 2020.

Infectiousness: Middle Eastern Respiratory Syndrome (MERS)

- MERS is not very infectious (R0 < 1)

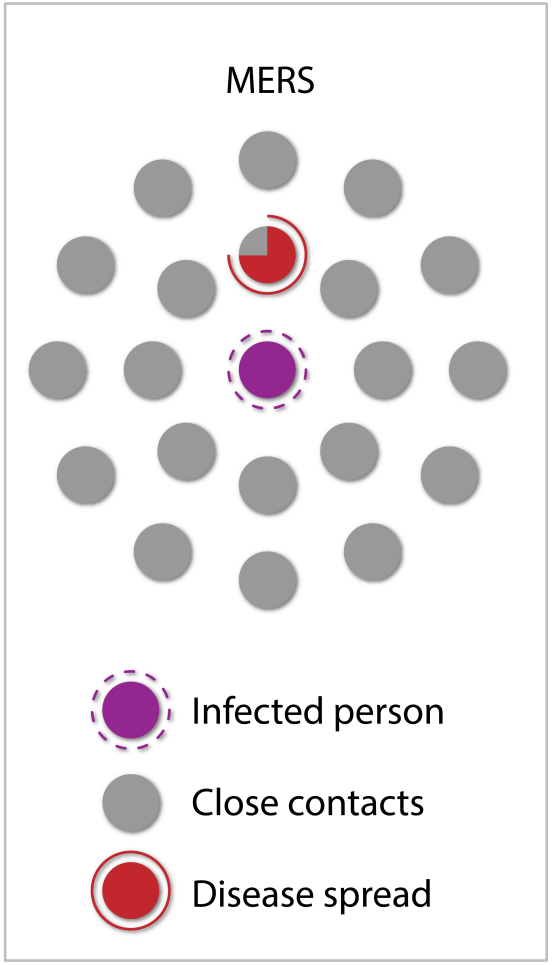


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Infectiousness: SARS-CoV-2 Versus Influenza

SARS-CoV-2 (R0 = 2 to 3) and influenza (R0 = 2 to 3)

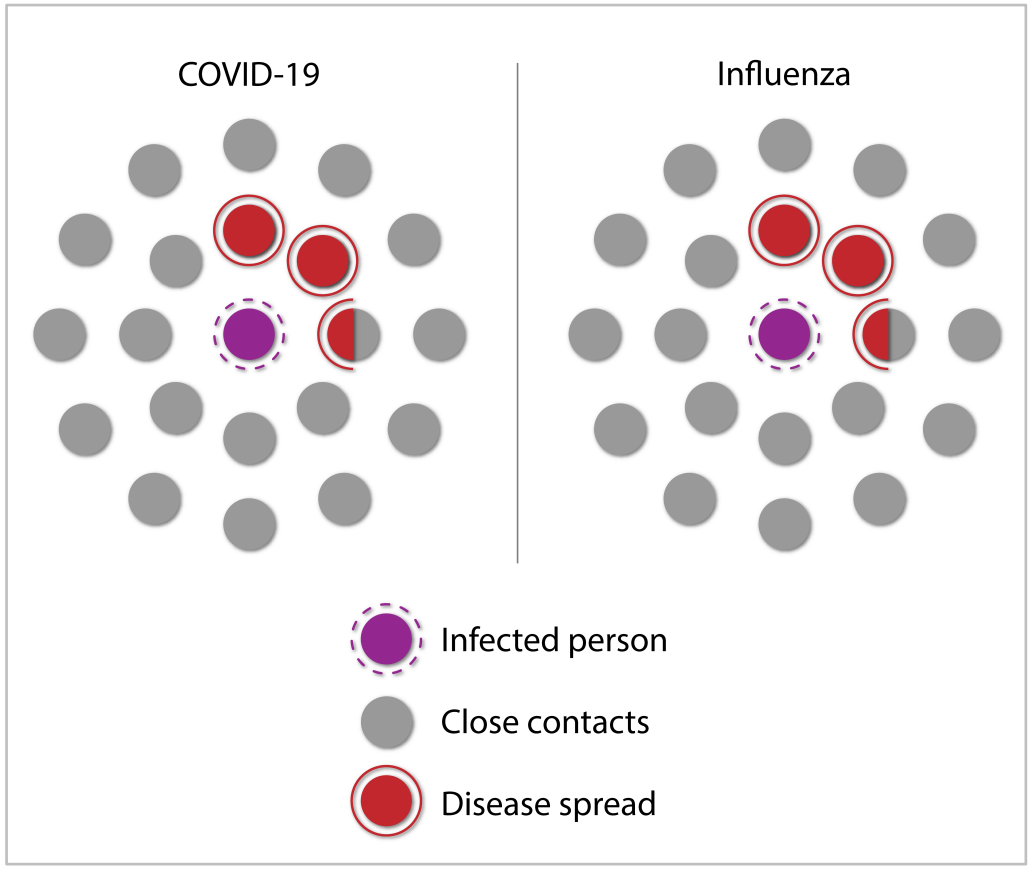


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Even Small Reproductive Numbers Create Large Outbreaks

- If each infected person infects just two people, the size of the outbreak doubles quickly

R0 = 2

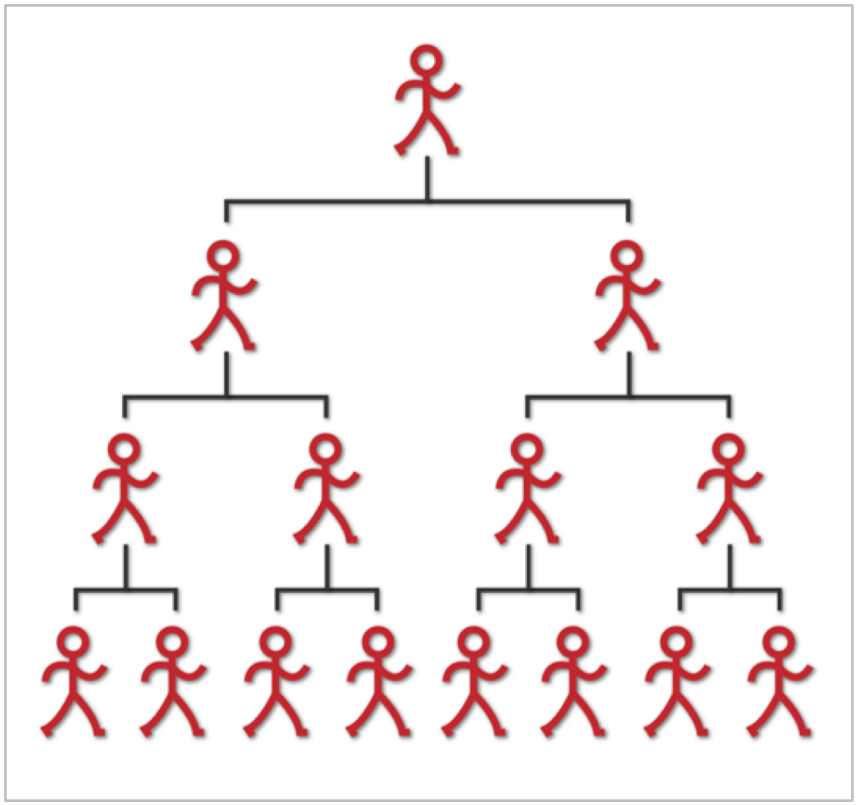


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Source: Eisenberg, J. (2020 March 17). R0: How scientists quantify the intensity of an outbreak like coronavirus and predict the pandemic's spread. The Conversation US. Accessed May 4, 2020.

Impact of Preventing Just One Infection

- If each infected person infects just two people, the size of the outbreak doubles quickly
- Preventing just one infection now can lead to big reductions of cases over time

What happens if we stop each case from infecting just one person?

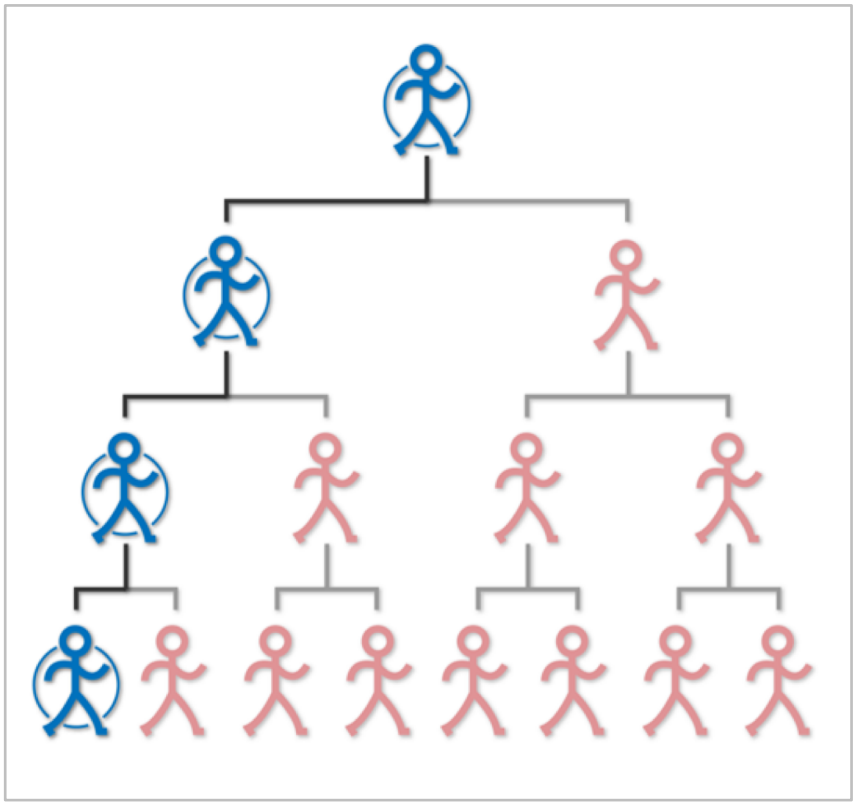


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Summary of COVID-19

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SARS-CoV-2 Is a New Virus

- SARS-CoV-2 is a new virus infecting people and causing COVID-19 disease
- Although some people never develop any signs or symptoms of disease, others are at high risk for severe disease and death
- People at risk for severe disease and death include older adults and people with other preexisting medical conditions

SARS-CoV-2 Testing and Transmission

- There are laboratory tests that can identify if someone has an active infection or if someone has been infected in the past
- People are infectious before they become ill and during their illness
- They can infect other people through their respiratory droplets
- Without any intervention, each person will infect 2 to 3 others
- However, we can dramatically reduce the number of cases if we can prevent transmission