



Teacher Guide 1 - Pandemic

Note: Key terms, NGSS connections, and Teacher Resources are included in this document within each Module Challenge. There are 5 Challenges in this Module:

1. Comparing Covid-19 Outbreaks
2. Hospitalization Rates for the Seasonal Flu v. Covid-19
3. Covid-19 in Connecticut
4. Modeling Disease Spread and Flattening the Curve
5. Summary and Reflection

Module 1: What is a Pandemic?

On an early Friday morning, everyone on the crowded bus is buzzing with excitement for the coming weekend, including high schooler juniors Tash, Ray, and June. As Ray and June argue over who's plans for the weekend will be more exciting, Tash sits quietly between his friends, feeling unusually hot and uncomfortable. Upon arriving at school, the trio heads to the nurse's office, where the nurse informs Tash that he has a fever and warns them about an outbreak of Covid-19 in New Haven. Worried about an outbreak in their community, Tash, Ray, and June google "Covid-19" and find out that it is being called a "pandemic." But what exactly is a pandemic, and how is a disease determined to be one?

Performance Expectations:

- Differentiate between a pandemic and epidemic.
- Analyze and interpret epidemiological data.
- Perform calculations in order to accurately compare data.
- Create graphical representations of data.
- Identify and use credible sources to find data to support a conclusion.
- Model disease spread and learn how preventative measures impact outbreak intensity.

**NGSS Connections:****Scientific & Engineering practices:**

- *Analyzing & Interpreting Data*
- *Developing & Using Models*
- *Mathematics & Computational Thinking*
- *Obtain, Evaluate, Communicate Information*

Disciplinary Core Ideas: Not Emphasized**Crosscutting Concepts:**

- *Patterns*
- *Scale, Proportions & Quantity*
- *System & System Models*

Key Terminology:

- *Pandemic*
- *Epidemic*
- *Outbreak*
- *Transmission*
- *R0 (R-naught)*
- *Disease modeling*

Professional Opportunities:

- Epidemiologist - Albert Ko
- Healthcare workers - nurse
- Biostatistician
- Computational Biologist

Challenges:

1. Comparing Covid-19 Outbreaks
2. Hospitalization Rates for the Seasonal Flu v. Covid-19
3. Covid-19 in Connecticut
4. Modeling Disease Spread and Flattening the Curve
5. Summary and Reflection



Challenge 1: Are All Covid-19 Outbreaks Equal?

Learning Targets:

- Differentiate between a pandemic and an epidemic.
- Analyze and interpret epidemiological data.
- Perform calculations in order to accurately compare data.
- Identify and use credible sources to find data to support a conclusion.

Estimated Time: 30 minutes

1.1 Read: “Twentieth-Century Lessons for a Modern Coronavirus Pandemic”

https://jamanetwork.com/journals/jama/fullarticle/2765379?guestAccessKey=c6665fa1-6366-426c-9214-b6c572163921&utm_source=twitter&utm_medium=social_jama&utm_term=3390220233&utm_campaign=article_alert&linkId=89972692

1.2 Read and Reflect

The story continues: (picture of kids)

It’s another weekend with nowhere to go. June and her brother Ruben already took their dog for *another* walk and baked yet *another* loaf of bread. Now sitting on the couch, June’s phone dings with another news alert about Covid-19, she sighs, “more news about coronavirus, how long is this pandemic going to last?”

Ruben looks up from his gaze after staring at Insta and remarks, “well, it is a pandemic after all.” As he finishes this statement, June and Ruben’s older sister Carla walks into the room and challenges him. “Do you even know what a pandemic is?”

“Of course I do!” he declares.

“Okay, then, what is it?” asks Carla.

“Yeah, Ruben, what does it mean?” June adds.

Rubin states his definition, “It’s a . . . it’s a . . . it’s an outbreak of a disease . . . that is . . . that is .



.. really big!”

June and Ruben don’t *really* understand how an epidemic differs from a pandemic. Their older sister Carla just finished her first year in a graduate program in public health and took two classes on [epidemiology](#). She knows the difference.

“Okay,” Carla says, “the Ebola outbreak in West Africa a few years ago was, as you described Ruben, really big, but it wasn’t a pandemic. It was only an epidemic. What’s the difference?”

Ruben scratches his head and gives his older sister a glare. He’s certain she knows the answer and knows she is testing him. “I don’t know, tell me.”

“Yeah, Carla, enlighten us,” June adds.

“Why don’t you look it up?!” Carla retorts.

- **Reflect and Discuss: Both pandemics and epidemics involve outbreaks of diseases, but what is the difference between a pandemic and an epidemic?**

1.3 Read-on: “So what did the article say?” Carla asks June referencing the news alert that popped up on her phone a few minutes ago.

“Oh, it is a report about how Covid-19 outbreaks are different in countries across the world. It describes how case numbers and death rates vary,” June says. “But when I look at Table 1, it seems confusing, because the numbers are all over the place. Like the article says that the current outbreak in Peru is much worse than the outbreak was in Italy, but the numbers don’t make much sense to me.”

“Numbers aren’t always presented in a way that allows you to compare them. It’s important to make sure you are comparing apples to apples. Let’s look at it together,” Carla suggests, suddenly willing to use her new expertise.

Table 1. Confirmed Covid-19 cases and mortality for five selected countries. Number of people with confirmed cases of Covid-19 and number of Covid-19 associated deaths by country¹.



Country	Confirmed Cases	Deaths
Germany	191,768	8,899
Italy	238,720	34,657
China	84,624	4,639
Peru	257,447	8,223
United States	2,312,302	120,402

¹As of June 23, 2020 3:00 AM EDT, Johns Hopkins University Coronavirus Resource Center,
<https://coronavirus.jhu.edu/data/mortality>

“Ah, I see what’s happening here. They are only presenting the total case number and that doesn’t say much,” Carla declares. “You can’t tell from that data how big the outbreak is in each country.”

“Okay, but which of these countries has the biggest outbreak?” Ruben asks.

- **Reflect and Discuss:** What additional information do you need to know in order to answer Ruben’s question? Hint: “big” is a relative term.

1.4 Read-on:

“We learned in school this year that in order to validly outbreak sizes, epidemiologists normalize the numbers so you can compare them.” Carla details further, “you can represent the case number as ‘per 100,000 people in a population.’ Remember, the population is the number of people who live in a country.”

Ruben asks, “Do we have the information needed for this calculation? Where could we find it?”



How could we represent that information on our table?”

- a. **Research:** Find the information needed to answer Ruben’s questions.
- b. **Calculate and Represent on Table:** Determine the number of cases per 100,000 people in a population (case/100k pop) for each country listed in Table 1 on June 23, 2020.
- c. **Conclude and Discuss:** On June 23, 2020, which country had the highest case/100k pop? The lowest?

1.5 Read-on

“Oooooh!” June exclaims as the concept seems to click. “The numbers of deaths also can’t be compared. It really makes more sense to look at the number of deaths relative to the number of cases in a country.”

“Yes, June, that’s exactly right!” Carla says enthusiastically. “You can make a ratio from these two values.”

- a. **Calculate and Represent on Table:** Determine the fatality-case ratio on June 23, 2020 for each country (expressed as a percentage).
- b. **Conclude and Discuss:** Which country had the highest fatality-case ratio on June 23, 2020? The lowest?

(Ruben’s Picture)

“That makes total sense now.” Ruben says. “Want a slice of bread?”

1.6 Reflect & Discuss:



Use Q & A Format Here:

Question	Hints
<p>a. Based on your above calculations, decide which country has the biggest outbreak?</p>	<p>Consider population size, case number, or number of deaths. Which is most important when making this decision? You will need to define the word “big.”</p>
<p>b. Why do you think that the case-to-death ratios vary so much by country?</p>	<p>For instance, Germany’s ratio is very low and Italy’s is very high. What variables contribute to this discrepancy?</p>

Stories in the Field:

Info about a Career in Epidemiology:

- CareerOneStop.org - Epidemiologist
<https://www.careeronestop.org/Toolkit/Careers/Occupations/occupation-profile.aspx?keyword=Epidemiologists&onetcode=19104100&location=UNITED%20STATES&onet=19104100>

Yale Faculty Highlight: Dr. Albert Ko is a medical doctor and an epidemiologist at Yale University Medical School. Dr. Ko studies the spread of infectious diseases caused by microorganisms. He is currently the leader of the Covid team working with Ned Lamont, the Governor of Connecticut. Dr. Ko explains how Covid-19 is transmitted [here](#).

Challenge 2: Are there more hospitalizations with the Seasonal Flu or Covid-19?

Learning Targets:



- Differentiate between a pandemic and epidemic.
- Analyze and interpret epidemiological data.
- Perform calculations in order to accurately compare data.
- Identify and use credible sources to find data to support a conclusion.

In This Lesson (NGSS):

Scientific & Engineering practices:

- *Analyzing & Interpreting Data*
- *Mathematics & Computational Thinking*
- *Obtain, Evaluate, Communicate Information*

Crosscutting Concepts:

- *Patterns*
- *Scale, Proportions & Quantity*

Estimated Time: 30 minutes

Watch : Vox - “Coronavirus is not like the flu. It’s much worse.”

<https://www.youtube.com/watch?v=FVIGhz3uwuQ> [6:31]

2.1 Read

The story continues: (picture of kids)

One afternoon, June and her siblings, her brother Ruben and older sister Carla, are sitting around the family room of their home with the TV tuned in to a local channel. A preview for the evening news comes on and the newscaster asks in a serious, but dramatic voice,

“Hospitalization rates for Covid-19 are on the rise, could the number of hospitalizations outnumber those for last year’s seasonal flu?”

“Wait a minute,” Ruben says, “I thought this pandemic is more serious than the seasonal flu. I



didn't realize that people are hospitalized with the flu so often."

"Yeah," June agrees, "I know lots of people who have had the flu and they miss a few days of school, but then they are fine."

"Well, just like we are seeing with Covid-19, some people are more vulnerable than others and end up with more serious medical conditions from the flu," Carla describes inserting her knowledge of public health. Carla just finished her first year of a masters program in public health.

"My friend Ray has a cousin who is a nurse at the hospital in New Haven and apparently, there have been a ton of hospitalizations for Covid-19 in the last few months and at times it's been overwhelming," June says.

"Yeah, it doesn't seem like the seasonal flu overwhelms hospitals the way that Covid-19 has," Ruben comments.

2.2 Investigate & Analyze

Part 1. Comparing hospitalizations from the seasonal flu and COVID-19

"Let's look at the data and see what the numbers say," Carla suggests. And she pulls up a few sources of data, two are compiled by the Centers of Disease Control and one by the NYTimes.

Seasonal Flu 2018-19* CDC:

<https://www.cdc.gov/flu/about/burden/2018-2019.html#:~:text=CDC%20estimates%20that%20influenza%20was,the%202018%E2%80%932019%20influenza%20season>

COVID-NET CDC: https://gis.cdc.gov/grasp/covidnet/COVID19_5.html

US Coronavirus data NYTimes:

https://www.nytimes.com/interactive/2021/us/covid-cases.html?pageType=LegacyCollection&collectionName=Maps+and+Trackers&label=Maps+and+Trackers&module=hub_Band®ion=inline&template=storyline_band_recirc

*Why are we using the data for the 2018-19 season of influenza? This is the most recent data set finalized by the CDC, which means the numbers are set. Also, the COVID pandemic has impacted the last few flu seasons due to social distancing and mask wearing.



“June, why don’t you look up the number of hospitalizations for last year’s seasonal flu, and Ruben, you can look at the number of hospitalizations for COVID-19,” Carla directs them to the websites.

Use the websites to answer each question below about hospitalizations for the 2018-19 season of influenza and for Covid-19.

- a. **Conclude:** Which age group had the largest number of hospitalizations due to influenza in the 2018-19 season?
- b. **Calculate and Conclude:** Which age group had the largest hospitalization *rate* (per 100,000) during the entire 2018-19 flu season?
- c. **Reflect and Discuss:** If your answers to a and b are different, explain what could account for this difference.
- d. **Investigate:** What was the percentage of patients hospitalized with COVID-19 for the week ending 09-Jan-2021 (the week with the greatest number of hospitalizations in the pandemic so far) who were 65+? How about the percentage of people who were 0-4?
- e. **Compare:** How do the percentages you found in part d compare to the percentages of people in the same age groups hospitalized with the seasonal flu in 2018-19?
- f. **Discover:** Using the NYTimes coronavirus data, find the chart under “US Trends” that illustrates the all time number of hospitalizations during the pandemic. Use this chart to find 7-day average hospitalizations on Jan. 9, 2020.
- g. **Compare:** Compare the number you identified in part f to the total number of hospitalizations for the entire flu season of 2018-19.

Part 2 - Hospitalizations before and after wide-spread vaccination

Carla reflects on this flu comparison and then on how the landscape of the pandemic has changed, “unlike in the winter of 2020-21, we now have several vaccines for COVID-19 that are effective at preventing severe COVID-19. This surely has impacted hospitalization rates.”

“Are you sure? It seems like there are still a lot of COVID-19 cases these days,” Reuben says.

“Well, let’s look at what the data says,” Carla replies as she pulls up yet another CDC website with hospitalization data.

CDC Hospitalization Data:

<https://covid.cdc.gov/covid-data-tracker/#new-hospital-admissions>

Use this website to answer each question below about hospitalizations for COVID-19 before



and after wide-spread vaccination.

a. **Investigate:** Using the graphic to search by jurisdiction, find current 7-day average for new hospital admissions for the week of Dec. 31, 2020 to Jan. 6, 2021 for the following jurisdictions:

- i. United States
- ii. Connecticut
- iii. Mississippi

b. **Compare:** Again using the graphic, find current 7-day average for new hospital admissions for the week of Aug. 18, 2020 to Aug. 24, 2021 for the following jurisdictions:

- i. United States
- ii. Connecticut
- iii. Mississippi

By October of 2021, according to the NYTimes, about 70% of residents of Connecticut had been fully vaccinated compared to 44% of residents in Mississippi.

2.3 Reflect & Discuss:

Use Q & A Format Here:

Question	Hints
a. Do the seasonal flu and Covid-19 seem to affect population groups similarly?	Are all ages affected equally?
b. Do you think the seasonal flu or COVID-19 is a bigger burden on hospitals?	Estimate the number of hospitalizations due to COVID-19 over a month, several months, or year.
c. What preventative measures are in place for the seasonal flu that impact hospitalization rates?	How is the flu prevented? Also, are there treatments that exist for the flu?
a. Did hospitalization numbers change between January and August of 2021?	Where did they decrease or increase?



<p>a. Does the data on hospitalizations support the idea that vaccinations prevent severe COVID?</p>	<p>Factor in the vaccination rates when comparing hospitalizations in different jurisdictions.</p>
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Professional Opportunities: Nurse

Info about a Career in Nursing:

- CareerOneStop.org - Registered Nurse
<https://www.careeronestop.org/Toolkit/Careers/Occupations/occupation-profile.aspx?keyword=Registered%20Nurses&onetcode=29114100&location=UNITED%20STATES>



Challenge 3: What about Covid-19 in Connecticut?

Learning Targets::

- Analyze and interpret epidemiological data.
- Create graphical representations of data.

In This Lesson (NGSS):

Scientific & Engineering practices:

- *Analyzing & Interpreting Data*
- *Developing & Using Models*
- *Mathematics & Computational Thinking*
- *Obtain, Evaluate, Communicate Information*

Crosscutting Concepts:

- *Patterns*
- *Scale, Proportions & Quantity*
- *System & System Models*

Estimated Time: 30 minutes

3.1 Read:

The State of Connecticut Department of Public Health keeps detailed records of the Covid-19 outbreak in the state. All data and statistics are publicly accessible and the numbers are broken down by location (town or county), age, race and ethnicity. You now have the opportunity to find the raw data and to represent the data graphically so that it is easily compared. This data is useful for **biostatisticians** and for other public health officials who advise the government about the local outbreak.

3.2 Access and Graph Data:

Use the CT Dept of Public Health webpage <https://portal.ct.gov/Coronavirus> and navigate to the page including all of the raw [data](#). Once within a particular data set, you can opt to “Configure Visualization” in the top right corner of the data set. This will bring you to a platform where you



can select a graph type and the variables you would like to illustrate on the graph. Use this platform to construct graphs as described below. You can: use the graph visualization feature on the CT portal website, download the raw numbers to a spreadsheet, or you can make the graphs by hand.

When constructing a graph, remember to:

- Include axes or data labels with units (for example, time can be expressed in days or months and cases can be expressed as people or /100k population)
 - Give your graph a title that tells the reader what the graph is representing
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- a. Construct two pie charts:
 1. Illustrating the confirmed cases in CT broken down by race and ethnicity.
 2. Showing the number of deaths in CT broken down by race and ethnicity.
 - b. Construct two bar charts:
 3. Showing the total number of cases broken down by age group.
 4. Indicating the total number of deaths broken down by age group.



3.3 Reflect & Discuss:

Use Q & A Format Here:

Question	Hints
<p>a. Does the Connecticut case data indicate that there are major differences in the number of cases when looking at different races and ethnicities?</p>	<p>Which race and ethnicity has the most cases in CT, which has the least? Is this consistent with the demographics of the State of Connecticut or are certain races or ethnicities affected disproportionately?</p>
<p>b. What does your graph indicate about age and the likelihood of contracting or dying from Covid-19?</p>	<p>How does age affect the recovery from Covid-19?</p>

Biostatistician: A Typical Day - Tara Maddala Career Girls Role Model

https://www.youtube.com/watch?time_continue=30&v=u0A-gwpsQd8&feature=emb_title

Challenge 4: How can we flatten the curve?

Learning Targets:

- Analyze and interpret epidemiological data.
- Perform calculations in order to accurately compare data.
- Identify and use credible sources to find data to support a conclusion.
- Model disease spread and learn how preventative measures impact outbreak intensity.

**In This Lesson (NGSS):****Scientific & Engineering practices:**

- *Analyzing & Interpreting Data*
- *Developing & Using Models*
- *Mathematics & Computational Thinking*
- *Obtain, Evaluate, Communicate Information*

Crosscutting Concepts:

- *Patterns*
- *Scale, Proportions & Quantity*
- *System & System Models*

Estimated Time: 45 minutes

4.1 Read: R0: How scientists quantify the intensity of an outbreak, The Conversation
<https://theconversation.com/r0-how-scientists-quantify-the-intensity-of-an-outbreak-like-coronavirus-and-predict-the-pandemics-spread-130777>

4.2 Watch: Vox - “Coronavirus is not like the flu. It’s much worse.”
<https://www.youtube.com/watch?v=FVIGhz3uwuQ> [6:31]

4.3. Read & Calculate: In the article, “R0: How scientists quantify the intensity of an outbreak” the authors illustrate how the R0 value affects the spreading of an infectious agent. The R0 (pronounced “R naught”), the basic reproduction number, is a mathematical estimate of how infectious a disease is and indicates the number of people an infected individual will go on to infect.

Consider the R0 values for Covid-19 and the seasonal flu, rounded to 2 and 1.5, respectively.



- a. **Calculate:** After three rounds of infection with Covid-19 (one infected individual infects 2 people, and they infect 2 people and so on), how many people are infected with Covid-19? Repeat this calculation for the seasonal flu with an R_0 of 1.5.
- b. **Calculate:** With Covid-19, if one of the two people infected by the original infected person quarantines and is completely isolated, how many people are infected with Covid-19 if you perform the same calculation as in question Q1?

4.4 Model Disease Spread: There is a whole branch of science based on computation or the use of numbers and computers to analyze scientific events. Computational biologists often construct models of biological phenomena, such as how an infection spreads through a population. This information can be very useful in predicting the severity of an outbreak or in determining what measures a community may need to take to curb or lessen the impact of an outbreak. In this challenge, you will now use a model for the spread of Covid-19 through a population.

- a. **Navigate:** to the following website to model the Covid-19 Disease Curve
<https://www.jacobkelder.com/infection-model/>
- b. **Set the Parameters:** population size 1000, initial-infected 1, infected-chance 10%, average-recovery-time 20, and social distancing 0%. Press set and then go.
- c. **Conclude:** How many people in the population become infected by the virus? How many people are unaffected? (Be careful here and make sure to read the correct values!)
- d. **Reset the Parameters:** Now, set the parameters as you did in part b, but change social distancing to 50%. Press set and then go.
- e. **Reflect and Discuss:** How many people in the population become infected by the virus with 50% of the population social distancing? How many people are unaffected?

4.5 Hypothesize, Design, and Investigate: Using the website in section 4.4 above, design an experiment to test one or more of the other variables in the model (infection chance and/or recovery time). Start by making a hypothesis of how you think the variable will impact the number of people in the population who become infected with the virus. Remember that hypothesis statements are *measurable*. Run your experiment and report your results.

4.6 Reflect & Discuss:



Use Q & A Format Here:

Question	Hints
<p>a. What data or numbers are the most important to know in order to accurately estimate the spread of a pandemic infection?</p>	<p>1. What variables impact the collection of this data?</p>
<p>b. Is R-naught a fixed number for a particular disease or does it change?</p>	<p>Don't forget the environment. What factors can impact R0 during an outbreak?</p>
<p>c. How does social distancing influence the spread of an infection through a population?</p>	<p>Using the modeling website, did you notice that even a small amount of social distancing made a difference in the infection curve?</p>

Stories in the field: Computational Biologist

Info about a Career in Computational Biology:

CareerOneStop.org - Bioinformatic Scientist

<https://www.careeronestop.org/Toolkit/Careers/Occupations/occupation-profile.aspx?keyword=Bioinformatics%20Scientists&onetcode=19102901&location=UNITED%20STATES>



Challenge 5: Review & Reflect

Estimated Time: 15 minutes

5.1 Review

a. Answer: Based on the information you learned in Module 1, which is an example of a pandemic? (Select all that apply)

- 1918, H1N1 virus (“Spanish Flu”)
- 1957 H2N2 virus (“Asian Flu”)
- 2009, H1N1 virus (“Swine Flu”)
- 2019, coronavirus (“COVID-19”)

b. Navigate: To Medline Plus (<https://medlineplus.gov/>). Find “Health Topics,” and locate “Coronavirus Infections.” Which institutions or websites are listed to get more information on this topic?

[Free answer text]

(Key: Center for Disease Control and Prevention (CDC) or the National Institutes of Health (NIH))

c. Research: Use one of the resources above provided by Medline Plus (CDC or NIH). Write down on piece of information you learned about how COVID-19 is spread:

[Free answer text]



5.2 Reflect & Discuss

Use Q & A Format Here:

Question	Hints
If the seasonal flu virus changes every year and it has a global spread, why is it not considered a pandemic?	This about scale and geography. What is unique about a pandemic?

Other Teacher Resources:

Watch: What this chart actually means for COVID-19 [8:20]

<https://www.youtube.com/watch?v=fgBla7RepXU>

Watch: Exponential growth and epidemics [8:56]

<https://www.youtube.com/watch?v=Kas0tlxDvrg>

Explore and Analyze: Coronavirus in the U.S.: Where cases are growing and declining

https://www.nationalgeographic.com/science/2020/05/graphic-tracking-coronavirus-infections-us/?cmpid=org=ngp::mc=crm-email::src=ngp::cmp=editorial::add=SpecialEdition_20200904&rid=1E38AC52025ACF4B21103B3CB391CDD7