

# Model a Disease Outbreak

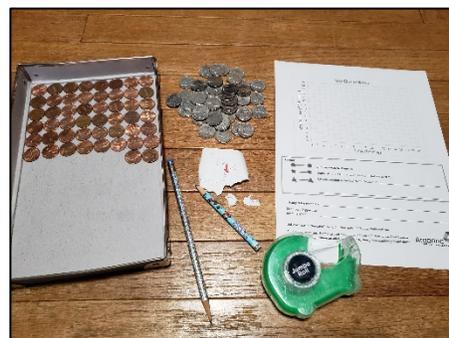
Make a model of a disease outbreak and share it with Argonne Education

Argonne scientists use models to understand how a disease can spread. These models imitate scenarios that could happen in the real world so that scientists can better understand them. Models can also help us figure out ways we could slow down an outbreak.

How do diseases spread to lots of people so quickly? What are things we can do to slow down an outbreak? Using models, we can answer these questions and more. In this activity, you will make a model of a disease outbreak and design your own solution.

## Materials:

- “My Outbreaks” sheet & pencil
  - Print ours from the last page or make your own.
  - If you know how, you can also use a computer to graph.
- 50 pennies and 50 nickels
  - You may substitute anything similar that is small and slides around easily.
  - Examples: washers, dry beans, paper clips, pasta colored with markers.
- A small tray, shoe box lid, or other flat-bottomed box
  - When your pennies (or other items) are spread flat, they should cover about half the area of the bottom.
- Scrap paper to tear into small pieces
- Extra pencil and tape



## Introduction:

In a model, we use things (objects, numbers, simulated people in a computer, anything!) to imitate what happens in the real world. For this physical model, we will use coins to represent people and a tray to represent your community. Nickels will represent sick people and pennies will represent healthy people. You will start with all healthy people, but then one person becomes sick. Watch and record how the disease spreads as people move around in your community (you shake the tray), people meet up (the coins touch), and new people become sick (pennies get swapped for nickels).

In this activity you will:

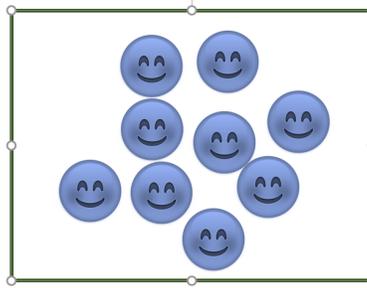
- Step 1: Build and run a basic model of a disease’s spread across a community
- Step 2: Experiment with what would happen if you had to do a quarantine (isolate a sick person).
- Step 3: Build and run your own model. Share it with Argonne Education!

## Step 1: The Basic Model

If you had a community of 50 people and one sick person joined your community, how fast could the disease spread? Let's set up a model community to find out:

### 1) Set up your healthy community:

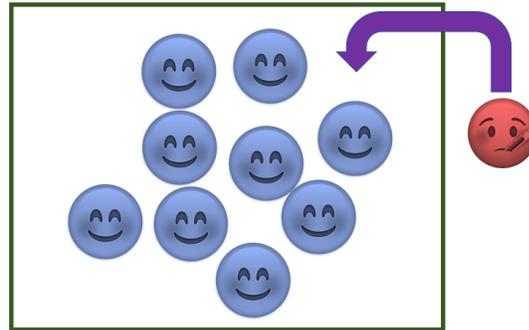
- Spread out 50 pennies in a tray. These represent healthy people.



*What does this mean in the real world? All people in this community are healthy!*

### 2) Get your outbreak started:

- Swap one penny with one nickel. This represents one infected person coming into your community.



*What could this mean in the real world? Maybe someone visited their relative in another town and came back sick!*

- Record the total number of sick people on your graph.
  - The horizontal x-axis represents time (shakings). We haven't done any shaking yet, so time (shakings) is zero.
  - The units on the vertical y-axis are the total number of sick people, so here the total 1.
  - Graph the point (0,1).

### 3) The outbreak spreads:

- Shake your tray 5 times back and forth to represent people mingling in the community. Stop and set down your tray. We will record this as one "shaking".
- If any penny is touching a nickel, it is now "infected."
  - Swap out newly infected pennies for nickels.



*What does this mean in the real world? The sick person just has a little cough, no big deal. He or she just goes about their day - going to school, participating in soccer practice, attending birthday parties, etc. - and everyone else is going about their day as well. How many people did this one person infect that day?*



If you have a lot of new infections, you can tear off little scraps of paper and place them on the infected pennies to mark them. Then swap the infected pennies out for nickels. Try to place your new nickels in the same spots where you removed the infected pennies.

- Record your data on your graph.
  - The horizontal x-axis represents time (shakings). The first time you shake your tray (5 times back and forth) counts as 1 shaking, so this value is 1.
  - The units on the vertical y-axis are the **total** number of infections, meaning the **total** number of nickels now in your tray. Count the nickel(s) you had before and the new ones you just added.

4) **STOP AND THINK:** How many times do you think you will need to repeat this procedure until all of the pennies are nickels (all of the people are infected)? Give your numerical answer here: \_\_\_\_\_.

5) **Repeat Step #3 to represent the spread of infection:**

- Shake the tray. Try to use the same number of shakes and amount of force each time.
- After each period of shaking and switching pennies (healthy) to nickels (infected), record the total number of nickels present on your graph.

*When pennies are near other pennies, what does this mean in the real world? Healthy people run into other healthy people. No problem! No one gets sick.*



*When nickels are near another nickel: sometimes a sick person runs into another sick person. For this disease, you can't get sick with the same thing again! So, these people don't change, but go back into the community and go about their day.*

- Stop when all pennies have changed to nickels (meaning everyone is infected) or after 18 shakings.

## Step 2: What Would Happen with a Loose Quarantine?

Put yourself in the position of scientist, politician, health care provider, or community advocate. You want to come up with an *intervention* – something we can do as a community to slow the outbreak. Someone has suggested that we quarantine the sick individuals at home. This means when you find out someone is sick, you put this person in isolation at home until they are healthy again. But you know from your expertise that quarantines are tough to maintain. For example, healthy people might have to care for the sick, individuals might not realize when they get infected, and the disease could still escape into the general population. Can you show with your model what would happen if the quarantine was not perfect?

**1.) Set up your community with 1 sick person in a “loose” quarantine.**

- Place 50 pennies in a tray, and this time tape down a pencil to “wall off” part of the community. Use a pencil that doesn’t go all the way across; because the quarantine is not perfect, the disease can escape. Tape it down well - it will need to hold up to a lot of shaking! Move 5 pennies into the walled-off part, and then swap one out for a nickel.



*What could this mean in the real world? Let's say we tell the sick person to stay home (behind the barrier), with their family members caring for them, but the family has to go out now and then to work, get medicine and food, etc. This is why the pencil barrier doesn't go all the way across!*

**2.) Run your model & record your results**

- Record your total number of infected people on the graph using different symbols (see legend).
- Shake your tray and run through the steps as before until your outbreak is over.

## Step 3: Design Your Own Intervention Model to Share with Argonne Education

As a scientist, politician, healthcare provider, or community advocate, you know there are other interventions you can do. Your goal is to slow the spread so that hospitals are not overwhelmed with sick people at once. This is also known as “flattening the curve.”

You could ask people to do “social distancing”: you can tell people to stay further apart and to stay home as much as they can. Also, you know there are people that are developing a vaccine. But, it will take time to get it to everyone, so imagine if we could only vaccinate 1/4 of the people to start out. You could also start randomly testing people (you don’t have enough resources to test everyone) and quarantine any sick people you find from the rest of the community.



**1.) Pick one intervention (social distance, vaccine, random testing) or create your own.**

- Change your model to simulate your intervention. Think of things you could potentially change to simulate different interventions – use a different tray (larger or smaller), put up new barriers, tape boxes together, mark or replace some of your coins with a different kind of coin to show they are different in some way, shake more or less, etc. – creativity is encouraged!
- Make sure to explain what *intervention* you think your change would represent in the real world, and what you did to change your model (see “My Outbreaks” sheet).
- Run your model and record results on your graph.

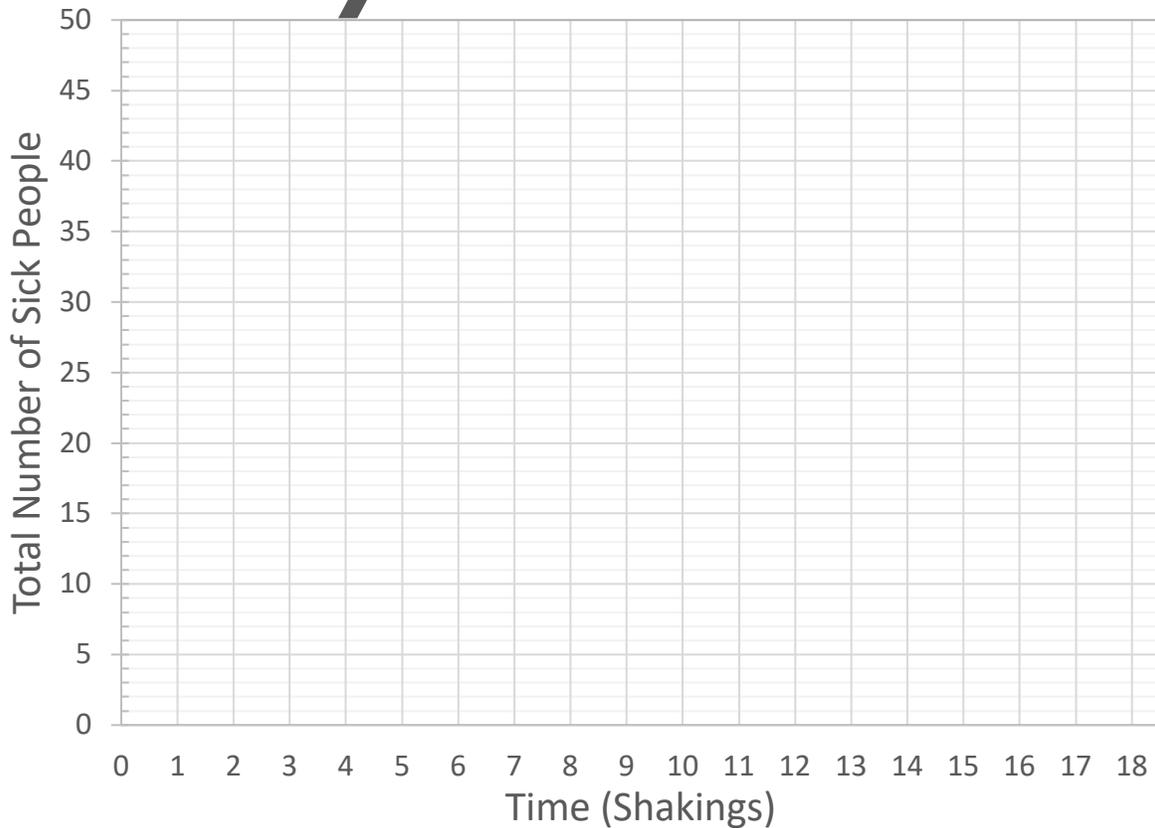
**2.) Share your idea with Argonne!**

- Take a picture of how you changed your model as well as your graph sheet. Send it to us at [learninglabs@anl.gov](mailto:learninglabs@anl.gov) or ask an adult to Tweet it @Argonne #ArgonneAtHome.

## Extensions

- Make a new graph of your data that only plots “new” infections! What is different about this view?
- Want to try something a bit more similar to what Argonne scientists do? Check out our other activity on using computers to model outbreaks, designed for advanced and curious students!

# My Outbreaks



## Legend:



Outbreak with No Controls



Outbreak with a Quarantine (isolation – but not perfect)



My Intervention in the Real World Would Be: \_\_\_\_\_.

\_\_\_\_\_

I changed the model by: \_\_\_\_\_.

(Examples: bigger tray, more barriers, etc.)

Did you “flatten the curve” or not? Either way, share your work with us!

Take a picture of this sheet and your new model, and send it to Argonne Education at [learninglabs@anl.gov](mailto:learninglabs@anl.gov) or have an adult tweet it out to @Argonne and #ArgonneAtHome.