

Outbreak scenario
13th Annual Mathematical Modeling and Public Health Workshop
Tuesday, March 5, 2024

Kabuka, a quiet suburban town, has been rocked by a sudden outbreak of mink pox, and you have been called in as a team of public health experts to contain the outbreak. Kabuka's population is primarily young and healthy. While mink pox is typically not lethal, especially among younger people, it causes small pimples that are filled with contagious pus allowing it to spread from person to person. While the pimples are barely visible initially, when they dry up, they can leave a scar, which the locals call "spot-face". Kabukans are extremely conscious about their image. The thought of having scars on their faces is really scaring people. There is full blown panic in the town, everyone is freaking out, businesses are being disrupted and people are afraid to send their children to school.

Upon arrival in Kabuka, you get briefed by local public health officials on the observed trends among patients. The outbreak started around four weeks ago and the number of new cases is increasing every week. They notice that on average, patients carry the infectious pimples for approximately 10 days. Also, they notice that on average, every infected individual is transmitting to two new individuals ($R_0 = 2$). Importantly they noticed that once individuals recover from mink pox, they cannot be reinfect.

Not far from Kabuka is the neighboring town of Nirvana, whose population is older. Officials are worried that the disease will spread to Nirvana, which could be a problem because the disease can cause serious illness in older people. Nirvana is well known for its peanut butter beer, which Kabukans love. Every weekend, scores of Kabukans flock to the Tavern Pub in Nirvana to enjoy peanut butter beer and have a good time. However, the Nirvana locals have heard rumblings about "spot-face" and the once peaceful town has been gripped by fear. This is a major concern!

In your teams you will discuss the following questions and report back to the local public health agency so that they can begin to implement a swift outbreak control plan. You have 5 minutes to discuss amongst your team, and please appoint a new member of your team to give your feedback for each question.

1. The local agency wants to set up a surveillance system to start to understand who is infecting whom and some of the factors that are placing individuals at risk of mink pox.
 - a. They come to you for advice on what data they should collect to aid their surveillance.
 - b. What additional information would you like to know to set up an outbreak surveillance system?

2. The local officials would like to know what to expect if this outbreak continues without any intervention. You and your colleagues decide to employ a standard SIR model to demonstrate this. However, you need to define two important parameters beta (β) and gamma (γ). Remember: $R_0 = \beta/\gamma$



- a. Justify to your colleagues why an SIR model is appropriate in this context!

- b. Calculate the values for beta and gamma, based on the summary provided by the local public health officials
 - c. Bonus question: How would you incorporate differences between young and old people into the SIR model?
- 3. There is growing anxiety that the outbreak will spread to Nirvana and cause an even bigger public health emergency among the older population. Your colleagues seek your advice on non-pharmaceutical interventions that can be implemented to prevent the spread of the disease to Nirvana and beyond. What intervention(s) do you propose? What are the advantages and disadvantages of your chosen strategy?
- 4. Quietly, local experts are worried that young people in a neighboring community are infected but not reporting. One of the local folks has a clever idea, instead of creating panic by screening people in neighboring towns, why don't we track recent activity on social media to see if there are searches related to mink pox? Again, they turn to you for advice.
 - a. Do you think that this approach is a good idea? Why or why not?
 - b. What websites should they consider in their search and why?
 - c. What are the ethical considerations of using this approach?