**Infectious Disease Modeling Using Dynamic Compartmental Models in R: SMDM Short Course**

**22 October 2023**

**In-Class Exercise**

**Background:** You are the chief health officer in the isolated city-state of SMDMopolis, which has its first ever documented case of **Virus X.** Virus X is an emerging infectious disease. You review the limited literature from past outbreaks in other locations and find:

* People tend to develop symptoms 5 days after being exposed to the virus and feel better 2 weeks after developing symptoms. No evidence of subclinical transmission has been documented.
* In previous outbreaks, contact tracing studies have found that the average infected person infected between 3 and 5 other people. Because of the high population density of SMDMopolis and airborne transmission of Virus X, you expect that transmission could be at least this high, and up to 2x as high, in this outbreak.
* While Virus X is not generally fatal, left untreated, people often experience long-term side effects that can disrupt daily life.
* In previous outbreaks, which tended to last 1-2 months, there were no documented instances of someone acquiring Virus X twice. However, one study found that antibody levels wane substantially 3 months after recovery.
* There are no biomedical interventions to protect someone against Virus X, and treatment does not reduce infectiousness. A vaccine is under development but will not be available for several months at the earliest.

SMDMopolis’ chief demographer tells you that there are 10,000 people living in the city-state. Last year, there were around 120 new births and 120 deaths documented in the population.

**Questions:** The head of state in SMDMopolis, President Beate Sander, has asked you to assess the likely spread of Virus X over the next 300 days, until the vaccine might become available. She is particularly interested in best- and worst-case scenarios, given uncertainties about the likely rate of spread in the population, and has asked you to investigate:

1. The cumulative number of infections absent intervention.
2. The likely size and the timing of the epidemic peak, so she can make appropriate decisions regarding treatment supply.

President Sander is also considering instituting a policy of isolation for people with symptoms. She is wondering (again, for best- & worse-case scenarios):

1. Whether an immediate, but less effective (daily rate of 0.5) isolation policy will prevent more infections than a delayed response (by 3 weeks) with higher (rate=0.9) coverage?
   * Will either isolation policy effectively control the outbreak?
2. How the answer to question #3 varies if a vaccine becomes available earlier than anticipated (at day 75)?
   * Hint: Try to think about how you could answer this question without actually modeling vaccination. You can assume that once available, the vaccine effectively controls the epidemic.