Analyzing the role of Virginia healthcare facilities in the spread of MRSA

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Goal

- Can we understand the spread of antimicrobial-resistant (AMR) infections within healthcare settings?
- Want to do the following:
  - Use a patch model to track this spread between members of the community and healthcare facilities in Virginia

Background

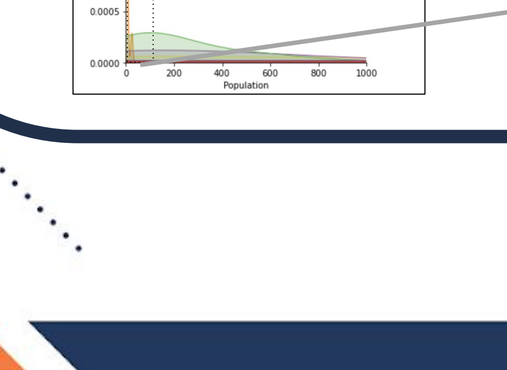
- Methicillin-resistant Staphylococcus aureus (MRSA) is one of the most common AMR bacteria
- AMR organisms are a top-10 global public health threat as declared by the WHO
- Estimated 2.8 million AMR infections per year along with 35,000 deaths (CDC)
- MRSA can spread asymptomatically for long periods of time, most well-known for spreading in healthcare settings and being life-threatening

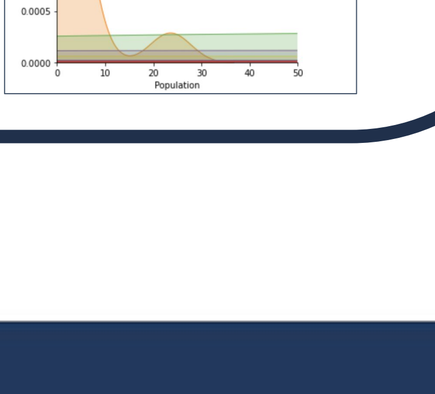
PatchSim Model

- Software created by Dr. Sirini Venkatramanan used to simulate the spread of an infection within 'patches' of a population through the SEIRS stages of an infection
- PatchSim takes two main file inputs, a travel matrix and a patch populations file, which are explained below
- Specific exposure, infection, recovery, and waning rates are used as parameters

Travel Matrix

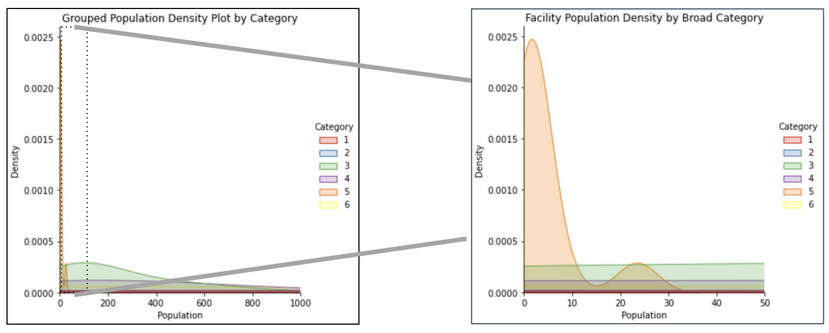
- Tracks the weekly movement from patch to patch
- Our patches are either Virginia counties or healthcare facility tuples defined as (broad category, county code)
- Created from ACS commuters data (2011-15) and Virginia insurance claims data (2016-21)
- We were only using Virginia facilities at first, but were dropping around 20% of the claims per year
- Included bordering states (MD, KY, NC, TN, WV) and DC
- The facilities outside of Virginia are represented with (broad category, state) tuples





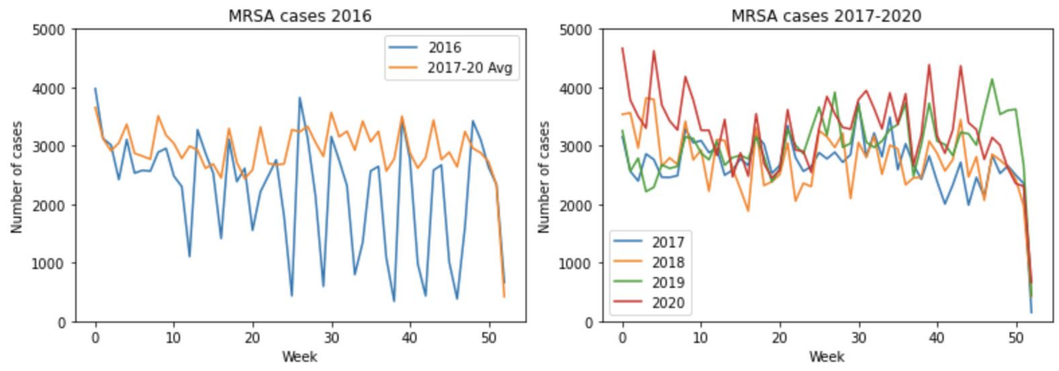
Facility Populations

- The populations of healthcare facilities aren't publicly available, so we assume that facility populations are the max number of claims for each patch in a single week
- We had to remove the 'transport' category from the overall patches due to the small population size for those facilities



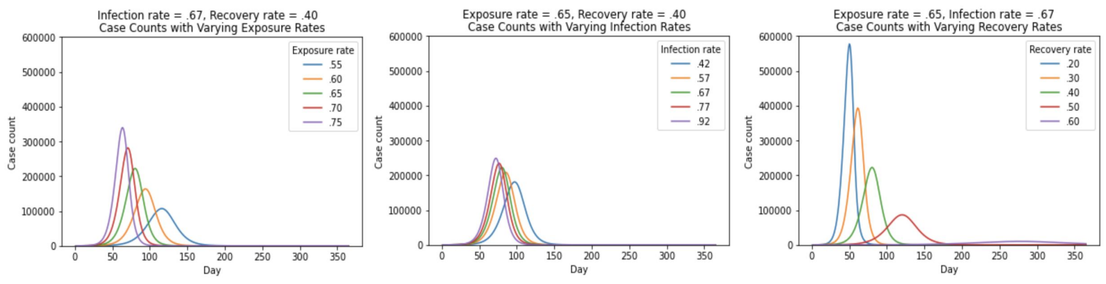
Prepare ground truth

- To be able to simulate the spread of MRSA through our newly generated patches using the PatchSim software, we need to know the MRSA exposure, infection, recovery, and waning rates
- To find these, we will attempt to find the rates that output the case counts as close to actual case numbers as possible
- While we don't have the exact number of cases of MRSA due to the high asymptomatic nature of the infection, we used our claims data to aggregate confirmed case counts per week
- 2016 MRSA counts are volatile but 2017-20 appear useful



Calibrating PatchSim

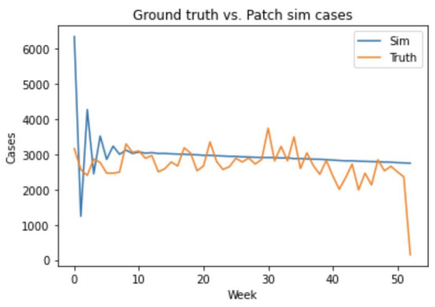
- To be able to calibrate the model simulation to the ground truth case counts, we need to understand how changing each rate affects the PatchSim output (2016 matrix input)



- The following is our first attempt at matching the PatchSim output to the ground truth values

Model Parameters:

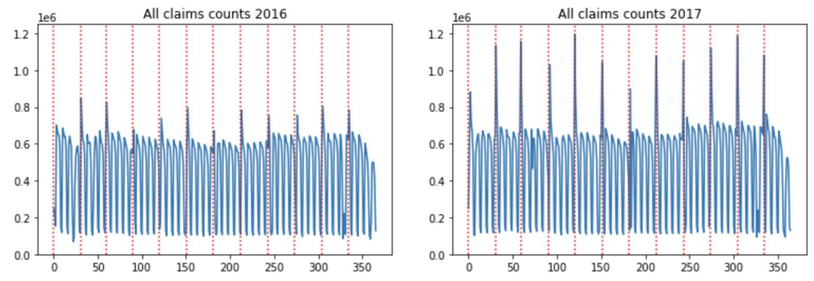
Exposure rate: 0.80
Infection rate: 0.80
Recovery rate: 0.80
Waning rate: 0.05



- We used 2017 ground truth MRSA counts for this plot because it is closer to traditional infection spread

Future Work/Questions

- Want to investigate the inconsistent claims records
- The following shows how, for both 2016 and 2017, the number of claims reported on the first day of each month were much higher than the rest of the days



- Have to search more on ground truth trends due to imbalance in claims reporting
- As we continue to study the data, we want to find the best way to move past this challenge that could affect the accuracy our results