A Case Study of a Covid-19 Cluster Using

the CovidSIMVL Simulation Model Tool

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INTRODUCTION

At BlueBell Childcare in an urban area, with 5 staff and approximately 15 children from age 3 to 9, a staff member tested positive on Dec 24, and as usual, the information below is sketchy and incomplete. However, they form the constraints for the simulation modelling of a local cluster with specific dynamics, which leads to the question of how this might affect the family members of the staff and students, and any connection that they might have to the connected workplaces, especially if they are Long Term Care, or an Emergency Department.

The Data Constraints

This is what was collected:

Dec 18 Worker A and worked E work together.  
  
Dec 21 Worker A works at childcare centre (Cloverdale childcare).  Overlap with 2 other staff ( B, C)  
  
Dec 22, 23 Workers B and C overlap with worker D  
  
Dec 24 Worker A gets symptoms  
  
Dec 27 Worker A receives positive test result  
  
Jan 3 Daycare tells all workers to get tested as they were contacted by Island Health.  
  
Jan 3 or 4? Daycare informs families of exposure event and closes for the week.  Recommendation from Island Health to test all 3-5 year olds.  All other children watched for symptoms.  
  
Jan 5- worker E tests negative  
  
Jan 5- we know 5 children test positive but all were asymptomatic, all under 5 years old  
  
Community spread event: Sometime after Jan 3, One of the workers got her family tested and 3 more adults and 4 children in family all test positive.  (I don't know if this is a single household family, or if 'cousins' got together or if this is a blended family of 2 households?)  
  
Alf just reported, as of January 8 there are 16 known cases.

The Goals of this Inquiry

CovidSIMVL is an agent-based simulation model which can be considered a sandbox in which parameters and populations can be readily modeled to study behaviors and interactions. It is not intended to be a predictive model for IRL (“In Real Life”) situations, but this cluster provided a challenge to back-fit the parameters to the data, and to then look forward to examine the implications for within family transmission, and transference of Covid to other spaces. The viral temporal dynamics model of Xi is built into the CovidSIMVL program.

Without loss of generality, and without attempting to find more about the BlueBell Childcare IRL situation, we will proceed to make assumptions in constructing the simulation model to understand its dynamics.

METHODOLOGY

We create a population of staff, children and their families, with a daily schedule, which we follow slavishly in the simulation, without regard to weekends or holidays. When the staff and children are not in the Universe 0 (BlueBall ChildCare), we send them to the HOME Universe (U8), in which transmissions occur not just based on touch, but only if the potential transmission would be between family members.

We create three additional Universes – Long Term Care (Universe 1), Emergency Department (Universe 2), and a Community (Universe 7).

The simplifying relationships are as follows:

When students, staff and family members are not in other places, they are at HOME (with intra-family transmission at all times possible).

Students and staff only go to BlueBell Childcare or HOME. Their family members also always stay HOME, except for 4 individuals who are visitors (2) and staff at Long Term Care (2). Their hours are 2 hrs from 9 to 11am for visitors, and 8 for staff from 7am to 3pm.

There are six persons who go to ED daily – 3 patients who go for 4 hours, and 3 health care workers who work 10 hrs a day.

The Long Term Care facility is populated by 50 residents who do not go away from it.

The Emergency Department has a different set of 50 patients designated to the present in seven different days. These days were set by trial and error to capture a staff or patient who might have become a transmitter from the BlueBell-family nexus.

The following describe the schedule of movement between HOME and the BlueBell Childcare for these persons.





The other persons are placed into their Universes (LTC = Universe 1) and

Emergency Department = Universe 2 at initialization for LTC, and at the designated times for each group of 50 unique individuals.

The first set of trials are run to establish parameters such that the dynamics of the simulated epidemic is consistent with the data. The data above specifies:

Dec 24 as T0 index case is symptomatic

Dec 27 T3 receives positive test result

Jan 5 T12 5 children test positive

Jan 3 – Jan 8 T11-T16 3 adults, 4 children who are family members test positive

Jan 8 T16 16 known cases in this cluster

Using the console.log function, CovidSIMVL records each transmission in terms of who was infected by whom, at what generation (Gen24 = Day 1), and in what Universe this took place. Thus, we can backfit parameter so the data above, as best as we can.

At this point, we note that the BlueBell Childcare Universe is the primary place which generates transmissions and the newly infected more than the HOME Universe as it is constrained to permit transmissions only among family members, and no family is larger than four, this being the family structure.



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A detailed description of CovidSIMVL can be found in [ ].

Following the establishment of parameters which produce results that approximate the data constraints, we then move to the next step of the project.

It should be noted that CovidSIMVL is stochastic, and uses random Pareto-like distributions for proposed physical movements within the arena of interaction of agents. The size (Hazard Radius) and the mobility (Mingling Factor) of an agent affects the overall likelihood of touching after a move (by all agents synchronously). The Childcare and the Family Universes are closely coupled dynamic systems, as the increased activity of one generates more active agents for the other, which may result in more activity for the first system. As they are both stochastic in their operations, the results of trials using particular parameters for each Universe is uncertain in terms of its location in the probability envelope of behaviors of the two systems.

Using a set of parameters that roughly satisfy the data constraints, we then observe the behaviour of the family transmissions, and of the movement of the Covid epidemic into LTC, and into ED, and the aftermath of these movements.

In this set of trials, we have allowed the infected and symptomatic persons to mingle till they become asymptomatic and inert after 13.2 days (according to the averages from the Xi model). CovidSIMVL has the ability to globally simulate isolation after so many days of symptoms, but we will reserve this work for a later set of trials.

RESULTS

The LTC and ED and Community Universes are one-way destinations that do not feed back into the nexus of ChildCare Family, although it is possible that a patient or staff in the ED for the short period that they are receive a secondary transmission from one of these visitors, who come together in the Emergency Department (ED). Any infected members of the ED population would need the viral dynamics period of time to become an active transmitter, so that infection is not possible for the transient patient and health care worker.