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Preliminary estimates of hospitalisation numbers for the August 2021 outbreak, assuming we stay in Alert Level 4

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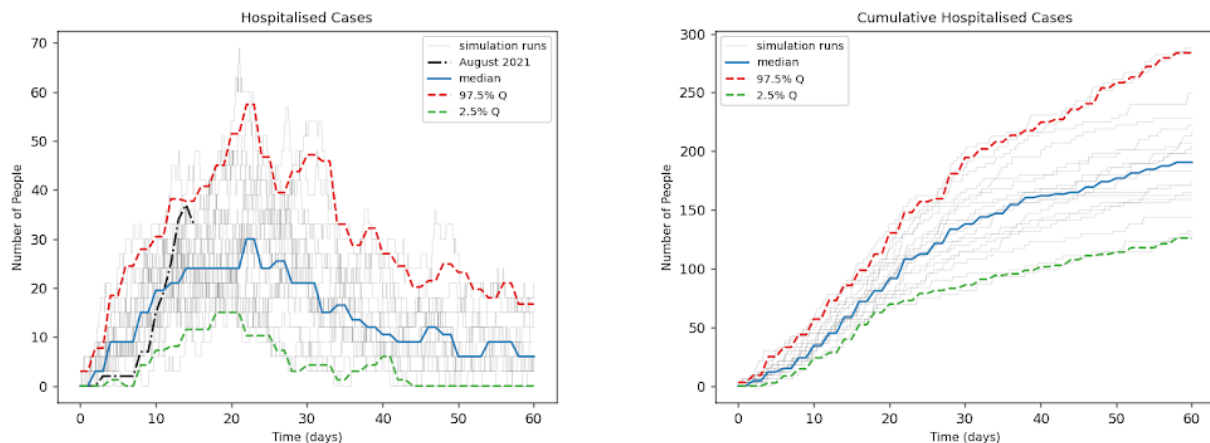
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Introduction

We use the contagion network model^{1,2} to project case numbers and thus hospital and critical care numbers for the current Auckland outbreak of August 2021, with current vaccination coverage. The simulations used here model spread through a population with the demographic composition for Auckland. Hospitalisation rates are then shifted to account for the case data from the current outbreak, where the majority of infections to date are Pasifika, for whom the hospitalization rate is around 2.7–3 times higher³.

The estimates for number of people needing hospital and critical level care each day (for our baseline length of stay estimates) are provided in Figures 1a and 2a. Figures 1b and 2b show the cumulative number of cases needing hospital level and critical level care. As indicated, these numbers are based on several assumptions, some of which are discussed further below, and we recommend treating these as potential underestimates for risk planning purposes. Specifically, we are currently (at of September, 2021) implementing adjustments to the contagion model to better reflect the spread of cases through a predominantly Pasifika population, and to better represent the updated test-trace-isolate (TTI) and Alert Level 4 policies for the Delta variant.

These projections indicate, based on an average length of stay of around 6 days, approximate peaks of 30-60 cases in hospital (not including in ICU) on any given day, and between 200-300 total (cumulative) cases needing hospitalisation over the first two months post-detection. We also project approximate peaks of 10-20 cases in critical care (ICU) on any given day and around 30-60 total (cumulative) cases needing critical care over the first two months post-detection. These are based on cases staying in ICU around an average of 16 days, depending on recovery.



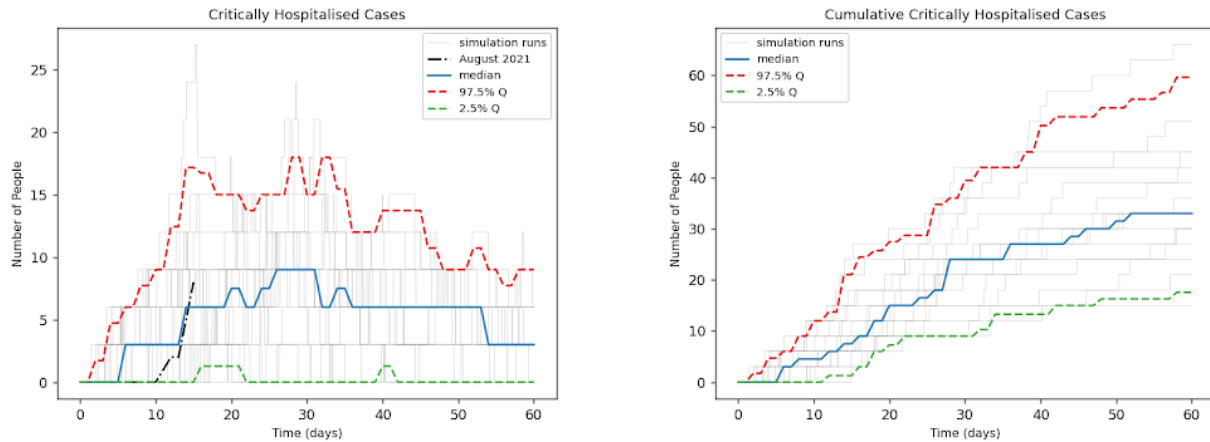
(a) Estimated number of cases in hospital (non-critical) through time, based on typical length of stay of around 6 days. The daily number of hospitalised cases from the 1pm briefings are shown in black dot-dashed line. Doubling the length of stay can be expected to roughly double the peak cases. **(b)** Cumulative number of cases needing hospital level care throughout the outbreak. Note that if we achieve elimination faster than the scenarios considered in Figures 4 and 5, this cumulative curve would flatten sooner.

Figure 1. Hospital Level (non-critical) Care

Key Limitations

These simulations assume a mean length of stay in hospital of around 6 days for cases that do not require critical care; a preliminary sensitivity analysis of our results indicates that the projected peak cases in hospital on any given day changes roughly proportionally to change in length of stay. For example, assuming a mean length of stay of double the assumed period (i.e. 12 days) leads to our estimate for the peak number of cases in hospital increasing by a factor of just less than 2. Doubling the average length of stay would be expected to lead to conservative estimates of the peaks of around 60-120 active cases in hospital (not including ICU) on any given day, i.e. double the peak obtained with the shorter length of stay. Applying a factor of 1.5 leads to estimates of around 45-90 active cases in hospital. Doubling the length of stay in critical care would also lead to an approximate doubling of the peak active cases in critical care. The cumulative case estimates for both hospital and critical level care are unchanged, however, since these depend only on hospital admissions, not length of stay.

These simulations also do not include updated TTI policies in response to the Delta variant, or increased community symptomatic testing rates. This means that although we capture the initial peak of the outbreak well, these simulations may be



(a) Estimated number of cases in critical care through time, based on typical length of stay of around 16 days. The daily number of cases in ICU reported in the 1pm briefings are shown in black dot-dashed line. Doubling the length of stay can be expected to roughly double the peak cases.

(b) Cumulative number of cases needing critical (ICU) level care throughout the outbreak. Note that if we achieve elimination faster than the scenarios considered in Figures 4 and 5, this cumulative curve would flatten sooner.

Figure 2. Critical Level Care

biased towards taking too long to eliminate (having a longer tail). If this outbreak eliminates sooner (has cases dropping faster) than in Figures 4 and 5 this would just mean that the cumulative curve would flatten slightly earlier, it would not affect the peak capacity requirements which occur in the earlier stages of the outbreak.

Model Assumptions

- Simulated outbreaks were seeded by setting the state of randomly selected individuals in the Auckland region as *exposed*. This results in simulated scenarios that represent the average demographic composition of Auckland, rather than the specific demographic features of the August 2021 outbreak, which includes a large fraction of cases amongst Pacific Peoples. Thus, we apply a correction factor to the model output for hospitalisation in order to account for the increased rates of hospitalisation for Pacific Peoples who represent the majority of cases (over 70%) in the current outbreak.
- We use vaccination coverage (by age band, sex, ethnicity and a DHB of residence) for counts of two-dose vaccinations as at 27th of July, 2021. Due to the period of two to three weeks that is necessary for vaccination to take full effect, these numbers correspond to the population who were protected by the vaccine around late August 2021.
- We know Pacific Peoples have higher hospitalisation rates (estimated 2–3 time higher³) and are the primary population currently affected in the August 2021 outbreak. Comparison between hospitalisation to date, with simulation output from the same period suggests that a factor of around 3 is an appropriate multiplier.
- Our number of cases hospitalised/critical care on any given day are strongly dependent on assumed recovery times, if the estimated recovery times are too short, the currently hospitalised/critical care case numbers (Figures 1a and 2a) will be under-estimates, especially as the outbreak proceeds.
 - Our model currently assumes that hospitalised cases occur at an average of 5 days after symptom onset, and will then either recover or need critical care.
 - Hospitalised cases that recover will remain in hospital for an average of 6 days.
 - Hospitalised cases that go on to need critical care will move into critical care for an average of 2 days after hospital admission.
 - For cases that recover from critical care, it will take an average of 16 days.

- Cases that die in critical care will die in an average of 9 days.

More recent literature indicates that Length of Stay in hospital is often longer than 6 days for non-ICU and longer than 18 days for ICU. Preliminary sensitivity studies of our model indicate that changes in the number of peak cases scales approximately linearly with changes in length of stay. For example, doubling length of stay leads to around double the peak active cases in hospital.

- We use age-based estimates for the proportion of hospitalised cases that will need critical care based on numbers from the OpenABM model⁴.
- Cases that need critical care will either recover or die. We use age-based estimates for the proportion of critical cases that will die, based on numbers from the OpenABM model⁴.
- The simulations in this report use estimated disease parameters, for the Delta variant of SARS-CoV-2 — this includes a hospitalisation rate of approximately twice that of the wild-type variant. Parameter choices for Alert Level 4 interventions are based on StatsNZ Household Labour Force Survey estimates for the proportion of workers working outside of their homes at AL4 in 2020⁵; transmission reduction estimates due to estimates of test-trace-isolate (TTI) processes are based on data from Ministry of Health from 2020.

Assumed state progression

Our assumed state progression (HQ = hospitalised non-critical; CQ = hospitalised, critical) is shown in Figure 3. Cases that enter critical care must first progress through a ‘hospitalised (but not critical care)’ state before progressing to critical care. This means that the cumulative critical care cases (Figure 2b) are a subset of the cumulative hospitalised cases (Figure 1b). However, the number of currently hospitalised cases (Figure 1a) only counts those cases not needing critical care. The number of cases needing critical care is shown in Figure 2a. This means that the total number of cases in hospital (non-critical and critical) is the sum of Figures 1a and 2a.

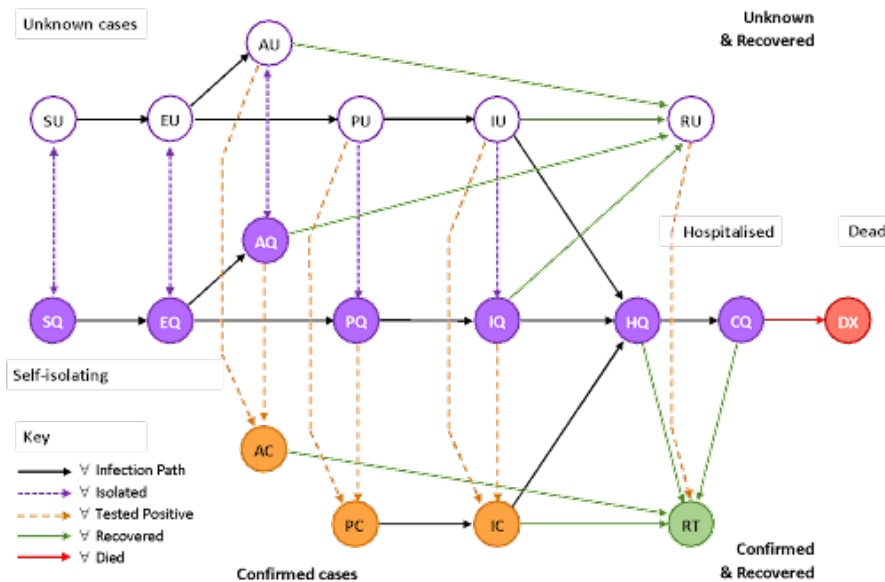


Figure 3. State diagram showing model assumptions.

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Appendix: Model simulation results

Our hospitalisation rates are estimated from the simulations retained after conditioning on confirmed case data from the start of the August 2021 outbreak, until August 31st 2021. These simulations, and thus the projections, assume that Auckland stays in Alert Level 4 until the outbreak is contained. Figures 4 and 5 show the scenario considered.

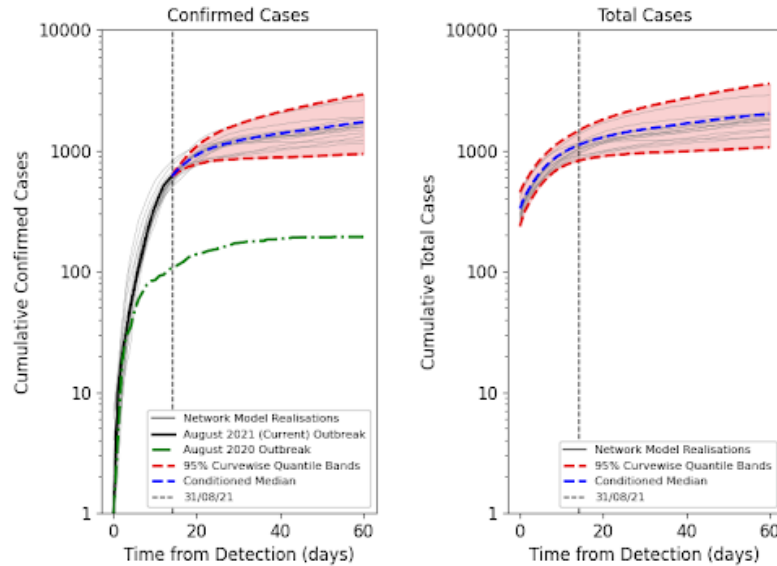


Figure 4. Cumulative confirmed case numbers and cumulative total case numbers, conditioned on confirmed case data up until 31/08/21.

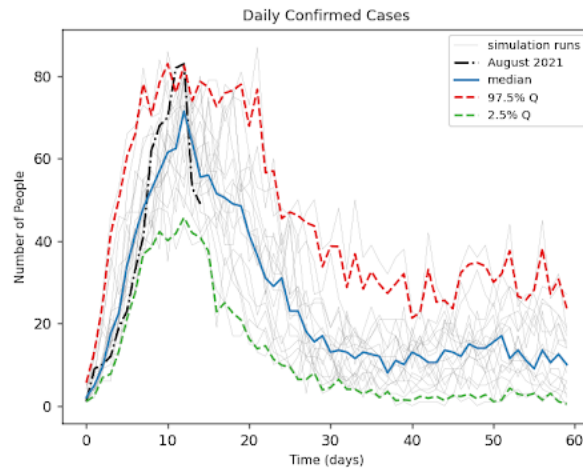


Figure 5. Daily new confirmed case numbers from network simulations, conditioned on confirmed case data up until 31/08/21. The confirmed new case numbers from the 1pm briefings are shown as the black dot-dashed line.