Update for Assemblywoman Lifton

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Cornell COVID-19 Mathematical Modeling Team
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This document was prepared by the Cornell COVID-19 Mathematical Modeling team to update Assemblywoman Barbara Lifton on two points of importance: the rise in national COVID-19 cases during the month of July and the projected impact of the Cornell reopening decision on the Greater Ithaca community. This follows a broader discussion between President Martha Pollack and Assemblywoman Lifton and also mirrors questions asked by others.

We begin by summarizing the efforts of the Cornell COVID-19 modelling team since the publication of our June 15th report. We then provide updates on these two points with pointers to the analysis upon which they are based.

Overview of Modeling To Date

The June 15th report detailed our compartmental simulations for the re-open of Cornell's fall semester. The model is based on the progression timeline of COVID19 and it was adjusted to fit the reality of Cornell campus. By understanding people's interactions on campus and with the Greater Ithaca community, the report supports how a rigorous surveillance testing program could make an on-campus semester safer than a virtual one. The challenge of a virtual semester is that with limited adherence to surveillance testing, the virus spreads rapidly among returning students. Compliance with surveillance testing can quickly identify cases, allowing us to isolate individuals and use contact tracing to control the spread of the virus.

Since the release of the June 15th report, we have continued to refine our model and design policies to maximize the safety of the Cornell and Ithaca communities. In an addendum to the original report, we studied parameters and assumptions in the model in which the broader community was especially interested. Specifically, we discussed:

- Alternative methodologies for estimating contacts / day and transmission rate
- The effectiveness of increased test frequency in mitigating the effect of higher-than-modeled contacts / day
- The effect of non-compliance with testing
- The effect of offering testing to virtual instruction students

In addition to the addendum, we have continued to work on four key areas:

1. Understanding the effect of Cornell's reopening on Greater Ithaca (one of the questions addressed here)
2. A more comprehensive model for testing students upon arrival (necessary to account for NY State's mandatory quarantine and the rise in national cases)

3. Optimizing test frequencies within the Cornell community to improve health outcomes by testing groups at higher risk more frequently

This work necessitated the development of a more detailed model that explicitly considers interactions between the Cornell community and the Greater Ithaca Area, and also interactions between and among groups in the Cornell community (e.g., undergraduates in high-density housing, student-facing faculty & staff, etc.). The quantification of their interactions is based on people's daily routine under different circumstances. This is described in detail here.

Because this model is more detailed and uses several subpopulations instead of one, it necessarily has different outcomes than the model in the June 15 report. Moreover, using a more realistic model in which the rate of infections from Greater Ithaca into the Cornell community, incorporating new information about local transmission during the month of July, and employing a more refined targeted testing plan that uses more test capacity together result in better health outcomes than the June 15th report. In particular, while the June 15th report's nominal scenario resulted in 1200 infections and 16 hospitalizations within the Cornell community, this more detailed model results in 900 infections and 9 hospitalizations in the Cornell community. We discuss outcomes in Greater Ithaca along with fatalities below.

General Assumptions & Limitations

All of our published work can be found here. When reading any of our analyses, please keep in mind that all estimates of infections and hospitalizations are sensitive to changes in the underlying parameters and that we have significant uncertainty about these parameters.

When modelling the fall semester, we make some assumptions about compliance with social distancing and mask-wearing. First, we assume that the Ithaca community continues to socially distance and adhere to mask-wearing at a similar rate to the summer. Second, we assume that returning students are less adherent to social distancing and mask-wearing than Ithaca residents.

We do not explicitly model fatalities because there is a dramatic difference between no fatalities and 1 or more, but our models and knowledge have limited ability to distinguish between these possibilities. Several challenges limit our ability.

- First, infection fatality risk varies dramatically based on age, other health conditions and access to healthcare. Moreover, it is hard to estimate (WHO 2020) because asymptomatic infections are often underreported. These two factors cause estimates to vary widely (Ioannidis et al., 2020).
- Second, the population likely to be infected is, in large part, young and healthy and has good access to healthcare, making the risk of fatality per infection quite low. As a result, the overall number of infections is small enough that 0 deaths is a reasonable possibility. At the same time, risk of fatality varies dramatically with the age of the individual and other risk factors. If infection struck a group of vulnerable individuals, this could easily

lead to 1 or more deaths. Which of these two possibilities will win out is unfortunately beyond our ability to say.

With this said, one can get a sense for fatalities by multiplying the number of hospitalizations by the fatality rate among those hospitalized as reported by the CDC (for those 18-49 years old: 2.0%, 50-64: 9.8%, ≥65 years: 28.1%). As you can see, estimates vary widely based on the age of those hospitalized. They would vary even more widely if we further divided the 18-49 age group.

Question 1: Elevation in National Cases in the Month of July

Now, we begin with the first of the two questions raised by Assemblywoman Lifton that we address in this document: What is the projected impact of the national rise of Covid cases?

This refers to the fact that COVID-19 cases rose in the US in the month of July relative to June. While national confirmed cases have fallen from their peak on July 17 and seem to be on a downward trajectory, they are nonetheless high relative to June, May, and earlier months.

This was discussed in detail during the Cornell University Faculty Senate meeting on Wednesday, August 6th 2020. A link to Professor Frazier's slides can be found here. Audio of the meeting can be found here.

We summarize this discussion here.

- First, it is important to separate what is happening in other states from what is happening here in Tompkins County.
- Data from Tompkins County Health Department suggests that roughly half of the local confirmed cases during the peak period in July were infected outside of Tompkins County. This, coupled with the subsequent decline in cases, suggests that local transmission is actually quite low, with an R0 below 1.
- We have similarly seen prevalence that is quite low among the several thousand students tested so far by Cornell. This is despite the fact that we do not yet have Cornell's behavioral compact in place or regular mandatory asymptomatic screening.
- We believe, based on the modeling work we have done, that this behavioral compact and asymptomatic screening will be more than enough to control transmission as students return.
- The other risk is the rise in national prevalence leading to an increased prevalence among students as they return. We have conducted an in-depth analysis of Cornell's gateway testing program. We find that it is able to identify a large fraction of positive cases among incoming students and that asymptomatic screening is able to control any cases that are missed in the initial gateway testing.

Question 2: Projected Impact on the Greater Ithaca area

We now address the second question raised by Assemblywoman Lifton: What is the projected impact [of Cornell's reopening] on the Greater Ithaca area?

To study the impact of Cornell's reopening, we compare two scenarios: residential instruction (where Cornell reopens); and virtual instruction (where Cornell does not). The difference in health outcomes between these two scenarios is the effect of reopening.

We use the model described above that is more detailed than the one in our June 15 report and includes Greater Ithaca as well as groups within the students, staff and faculty at Cornell. Details of this model, including residential and virtual instruction, are here.

Under this version of the residential instruction model, testing is offered at different frequencies to different groups, based on a set of frequencies that are similar to what Cornell may offer in the fall. Individuals are modeled as complying with 90% of requests to be tested.

Under virtual instruction, staff and faculty along with some research-focused graduate students stay on campus. They are tested regularly (with 90% compliance) and are subject to the behavioral compact. Based on survey results and discussions with local landlords, we also model several thousand (here, roughly 5K) students returning to Ithaca to live while taking classes virtually, outside of the control of the university. In a departure from the June 15th model, we assume that Cornell offers twice-weekly testing to these students, but only 20% comply. Each test-compliant student attends half of the offered test dates through the entire semester. The non-test-compliant students choose not to be tested. All unmonitored students live off campus. Transmission for these unmonitored off-campus students is reduced relative to what off-campus students would experience during residential instruction due to reduced population density in Collegetown, but elevated due to reduced compliance with social distancing and masks (which Cornell cannot mandate to these students). The net effect is a modest reduction in transmission relative to residential instruction, before accounting for testing.

When considering the decision to reopen, there are two opposing forces that govern the impact on Greater Ithaca. First, re-opening Cornell brings back more students to Ithaca which increases the amount of interaction, risking higher transmission. (Though critically, even if Cornell did not re-open, several thousand students would likely nonetheless return to take classes virtually.) Second, with a re-opening of campus, the university gains the legal ability to enforce compliance with social distancing, mask-wearing, and crucially, surveillance testing. (A link to Cornell's behavioral compact can be found here.) As mentioned previously, surveillance testing quickly identifies cases, allows us to isolate individuals and use contact tracing to control the spread of the virus. Our model indicates that the impact of this second force strongly dominates the first and results in a safer environment for both the students, staff and faculty at Cornell as well as Greater Ithaca.

Figures 1 through 4 below show results for four different outcomes in four different scenarios. First, within each of the residential and virtual scenarios, we consider our main scenario

(“virtual”, “residential”) as well as two alternate scenarios in which undergraduates and graduate students primarily taking classes are less compliant with masks and social distancing (“virtual, less compliant”, “residential, less compliant”). This elevates their transmission rates. We consider infections and hospitalizations for Cornell students, staff and faculty (“Cornell Infections / Hospitalizations”) and for Greater Ithaca without these Cornell students/staff/faculty (“Greater Ithaca Infections / Hospitalizations”).

We show outcomes with a dot in the middle of an error bar. Our simulation is random, and so produces different output with each run. The dot indicates the median outcome across a number of runs of our simulation: half of simulation runs have an outcome above this value. The top tip and the bottom tip of each line correspond to the 90% quantile and 10% quantile respectively, and give a sense of the variability across simulation runs.

There are two key takeaways from the graphs that we present:

1. The Ithaca community should be safer under a Cornell re-open scenario
2. Under a re-open scenario, the risk of students adhering to social distancing less than expected is better managed

First, we see that less compliance with the behavioral compact results in somewhat worse health outcomes, as more contact leads to more transmission.

Second, we see that there are significantly fewer infections and hospitalizations under residential instruction for both Cornell and Greater Ithaca. In particular, Cornell’s reopening improves health outcomes in Greater Ithaca (excluding Cornell) by roughly 700 infections and 20 hospitalizations. Cornell’s reopening also improves health outcomes within the Cornell students, staff and faculty living in Ithaca by roughly 5K infections (many of which are in the unmonitored student population engaged in virtual instruction) and 40 hospitalizations. This is because transmission within the unmonitored student population is high enough to lead to an epidemic within this community when asymptomatic testing is removed, despite the presence of optional testing and the modest reduction in contacts due to reduced density. This epidemic then infects others within Greater Ithaca and other students, staff and faculty. While R0 within Greater Ithaca is small enough to prevent these infections from creating a widespread epidemic, they nevertheless create significant negative health outcomes.

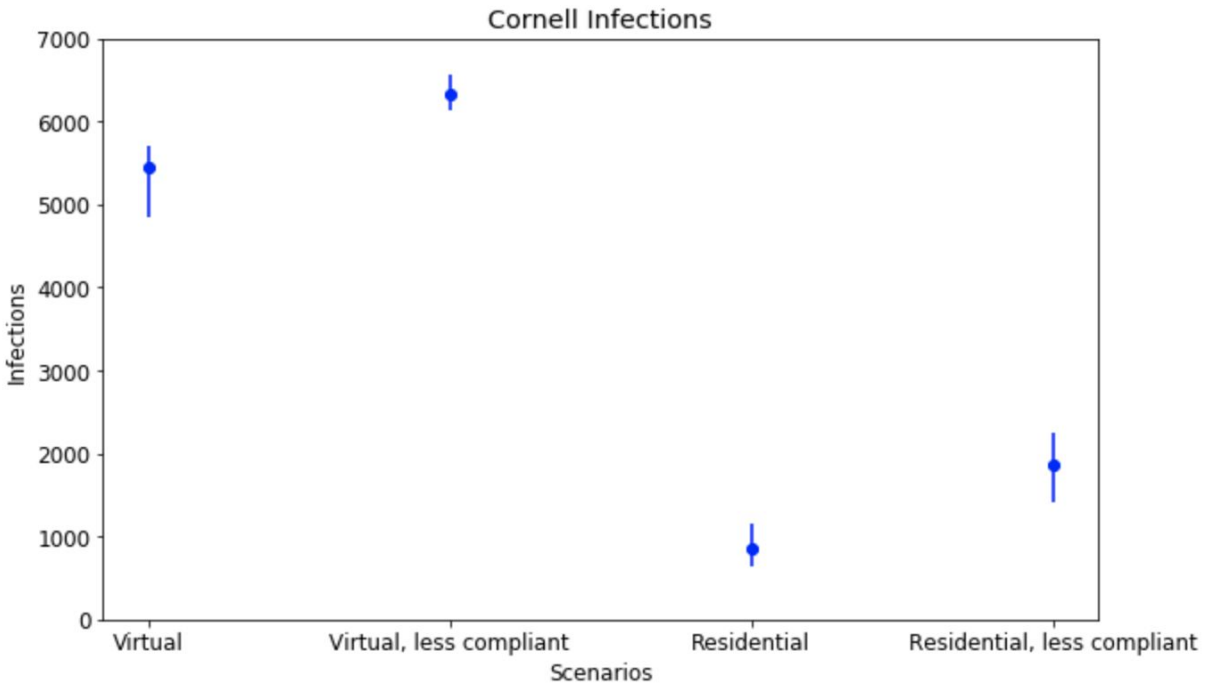

Figure 1: Infections within Cornell students, staff and faculty.

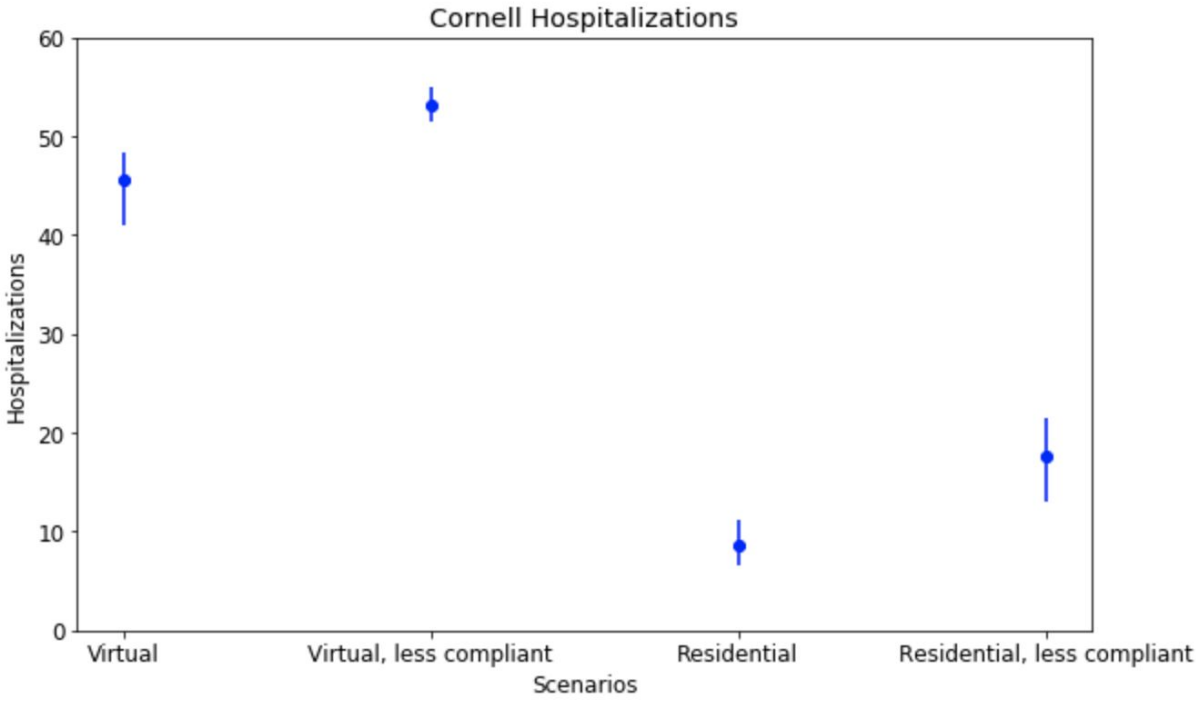

Figure 2: Hospitalizations within Cornell students, staff and faculty.

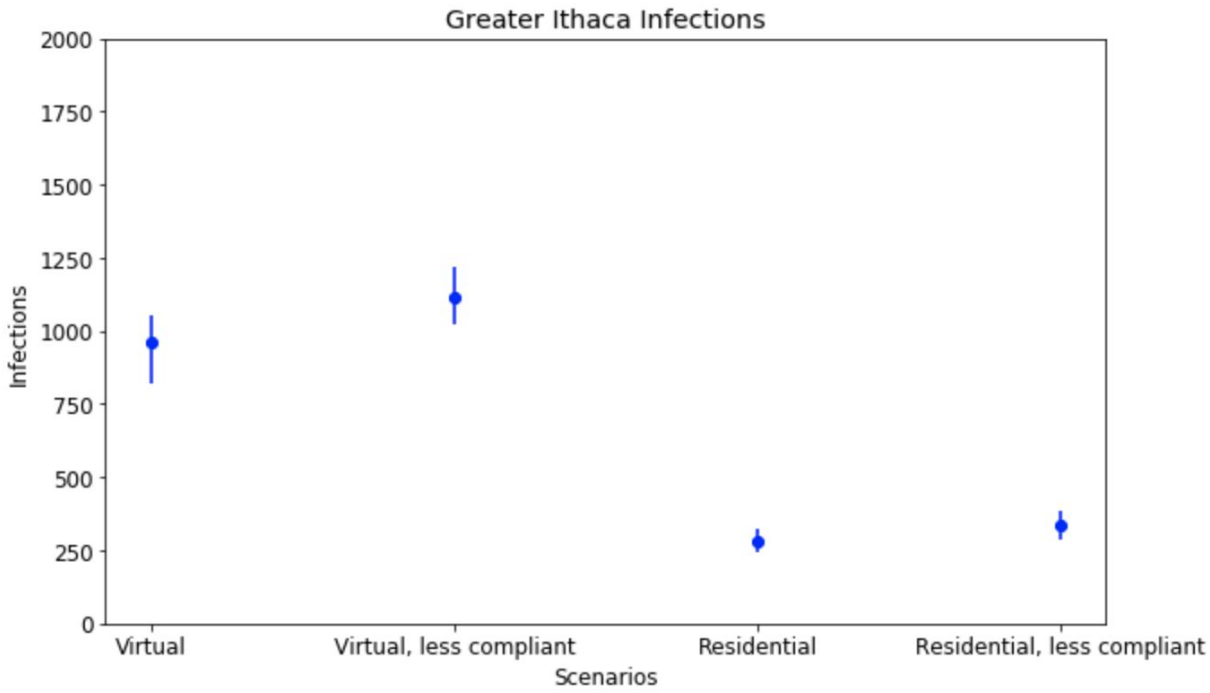

Figure 3: Infections within Greater Ithaca, excluding Cornell students, staff and faculty.

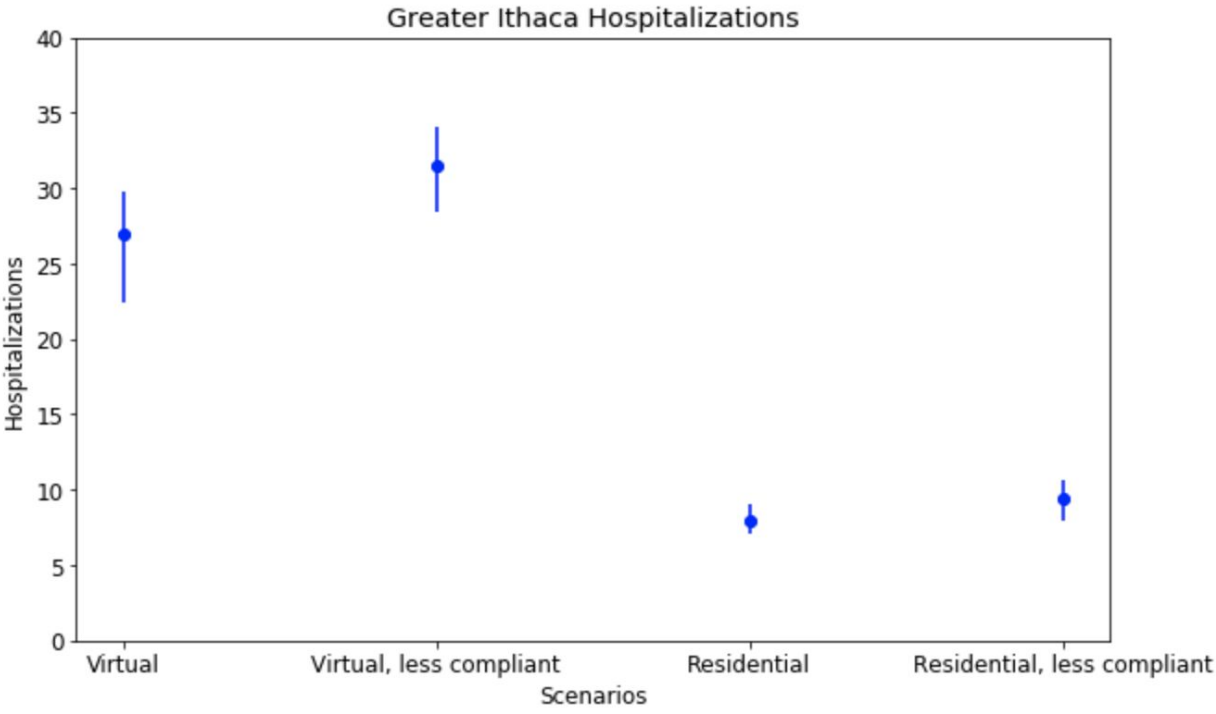

Figure 3: Hospitalizations within Greater Ithaca, excluding Cornell students, staff and faculty.

Appendix: Discussion between Assemblywoman Lifton and President Pollack

Assemblywoman Lifton asked:
What are the projected effects of a projected 1,200+ new COVID-19 cases in the Cornell community on the spread of the virus in the Ithaca and Tompkins County community, and on communities beyond the borders of Tompkins County where many people in the local workforce live? What is the projected number of additional cases, hospitalizations and deaths in the surrounding community and region due to Cornell reopening?

President Pollack responded:
Dr. Peter Frazier, who conducted modelling of Cornell's campus is currently working to model the transmission from Cornell faculty, staff and students to individuals in the greater Ithaca area not affiliated with Cornell. Dr. Frazier hypothesizes that, based on the numbers in our current model, the number of cases in Cornell faculty, staff and students resulting in infections of individuals not associated with Cornell will be quite small. This is due in large part to the testing program Cornell has established, which will quickly identify asymptomatic individuals, place them in isolation and allow the Tompkins County Health Department to conduct contact tracing to minimize the spread to others. Cornell will release Dr. Frazier's new model once it is complete.

Assemblywoman Lifton followed up to ask:
A number of local residents are interested in updates from Dr. Frazier's re-modeling team, as they incorporate fresh data about spikes in other states, new ideas about how the modeling can be done, or changes in the underlying assumptions. Can you provide an update on Dr. Frazier's current analyses that could have an impact on the larger community?