Fighting the Pandemic with Data: A Case Study at Cornell University

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Government response to the COVID pandemic has been chaotic. Past experience was no longer a reliable guide as decisionmakers were faced with unfamiliar tradeoffs and hard-to-quantify risks. Governments' masking, testing, distancing, and vaccination policies varied substantially, perhaps as much due to the cognitive biases of decision-makers and their constituents as to differences in circumstances. Consequently, history may show that the human toll, in terms of both excess mortality and economic losses, was significantly larger than it needed to be. We argue in this talk that, collectively, we can do better and that scientists and engineers can help.

In a microcosm of this broader world, administrators at Cornell University were challenged by similar questions. Would it be safe to invite students back in the fall 2020 semester? If so, what interventions would ensure safety? Would students comply with distancing and masking restrictions? Would arriving students import and serve as hosts to a viral epidemic that would later explode into the faculty, staff, and larger community?

Opinions were divided. Many residents in the town felt that reopening the campus would be profoundly dangerous. Others felt that not doing so would decimate residents' ability to earn a living, separating local businesses from their student customers and leading to layoffs among university employees.

An interdisciplinary group of engineers, scientists, healthcare providers, and university administrators, the speaker included, came together to make the best decisions they could, supported by science and data. We offer their experience as a case study in how technical experts can support policy decisions under pressure and to demonstrate the effectiveness of pandemic mitigation strategies developed there that can still be more broadly used.

It was understood that simply asking students to wear masks and maintain social distancing might not be enough to prevent an outbreak. The scientific literature suggested that testing students and empolyees regularly and isolating positive individuals might catch asymptomatic spreaders and provide significant protection against viral spread. At the same time, leaders in the College of Veterinary Medicine realized that a substantial capacity to conduct polymerase chain reaction (PCR) tests for virus, ordinarily used to test dairy cows and other animals, could be used to test for SARS-CoV-2. Leaders hypothesize that this testing capability could be significantly expanded through pooled testing: samples from multiple individuals could be pooled together and a single PCR test performed. If the pooled test came back negative all samples would be deemed negative. Otherwise individual followup tests would be conducted.

It was unclear, however, whether this plan would work. Perhaps parties would be too large, tests would be too inaccurate, willingness to mask or test would be too low, test volumes or quarantine requirements would be too large, or the virus would simply be too infectious.

A mathematical modeling effort, led by the speaker, tried to understand whether this plan would work. The accuracy of modeling predictions was fundamentally limited by significant uncertainty about parameters and sensitivity of outcomes to these parameters. Nevertheless, modeling showed that even under pessimistic assumptions about parameters, testing would be able protect the population against a large outbreak (Figure 1). Moreover, there were several thousand students who were likely to return to the area, even if instruction were all online, and for whom testing, social distancing, and masking would have been difficult to mandate. Analysis showed that these students would be at significant risk of experiencing an outbreak and that opening for in-person instruction would actually be safer than remaining closed.

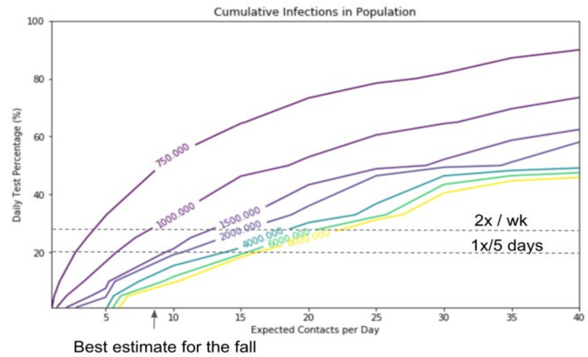

Figure 1: Predicted cumulative number of infections in the Cornell population vs. two key parameters: the fraction of the population that would be tested per day and the number of contacts that students would have per day. Despite uncertainty about the number of contacts, enough testing was likely to keep the number of cases low.

Supported by this analysis and a significant effort to communicate with and receive feedback from the community, the university decided to reopen for residential instruction. Modeling and data supported additional decisions, such as the testing frequencies for student and employee groups and the amount of quarantine and isolation housing to reserve.

Reopening was successful. Fewer than 300 cases were reported over the 2020 fall semester, significantly fewer than many other open univerities of comparable size.

Data, science, and modeling continued to support the pandemic response. Data infrastructure was built to collect cases detected through asymptomatic screening and other channels and a team of leaders and data scientists review this data on an ongoing basis to tune interventions. This data has enabled adjustments to test frequencies that test higher-transmission student groups more often, planning for contact trace staffing and housing capacity for quarantine and isolation, targeted incentives to improve test compliance, and other highly effective decisions that have significantly enhanced the community's safety.

In the talk, we will focus on the key components of this effort enabling success: technical expertise, communication, responsiveness, collaboration across disciplines, analyses that understand non-technical context, using several models rather than just one, model interpretability, access to data, and staying aware of the fast-moving scientific literature. We will also advocate for the use of pooled testing as an effective strategy for protecting at-risk populations. We hope that these experiences inspire other technical experts to help leaders make decisions supported by science and data, whether it be in fighting the pandemic or beyond.

Reading List

- MI Kotlikoff, ME Pollack, Why Cornell will reopen in the fall, Wall Street Journal (2020)
- Cornell COVID-19 Modeling Team, Covid-19 Mathematical Modeling for Cornell's Fall Semester, Cornell University (2020)
- JT Chang, FW Crawford, EH Kaplan, Repeat SARS-CoV-2 testing models for residential college populations, Healthcare Management Science 24, 305–318 (2021)