COVID-19 Predictive Modeling and Public Policy

Laisser-faire versus Lock Down

As governments, firms and individuals cope with the COVID-19 pandemic, a critical resource is a complete understanding of how the SARS-CoV-2 virus propagates through the population, generating illness, hospitalizations, ICU bed utilization, and death. Data and modeling are key instruments in how governments and their citizens address the pandemic and plan for the future.

With its world-leading forecasting software, Futurcast™, Futurion is devoting its expertise to help governments and citizens understand how the virus propagates and, significantly, how different public health measures can affect infection, hospitalizations and death. With our technology used by the pharmaceutical industry to forecast health needs around the world and relevant databases, we built a custom-made tool to model the virus spread under different public health measures, ranging from little to enforced stay-at-home orders.

Our results illustrate the need for strong public health measures to not only save lives but shorten the period before normal or near-normal life can resume, with all the social and economic consequences that follow. In fact, our modeling suggests that enforced stay-at-home order can decrease death by more than ten-fold and shorten recovery to near-normal life by months.

Here, we discuss the nature of viral propagation through exponential growth, public health measures and their effects, and the results of the Futurcast COVID-19 model.

Exponential Growth and COVID-19

Exponential growth is similar to a pyramid scheme. Imagine one person with COVID-19. For simplicity, assume that an infected person remains contagious for only one day. Suppose that this single contagious person infects 3 others on the first day. Then on the second day, each newly infected person will in turn infect another 3 people for a total of 9 infected individuals since those infected previously are no more contagious. The third day, the total new infections become 27, 81 on the fourth day, 243 on the 5th day, 729 on the 6th day, 2187 on the 7th day, and so on. On the 10th day, 59,049 would be infected if the probability of infection is 100%. If we started, instead, with 100 infected individuals on the first day, then after only 10 days, there would be 5,904,900 new infections.

For COVID-19, a person remains contagious from 14 to 25 days, depending on one of four degrees of disease severity (from mild (no symptoms), to moderate, severe and critical). That is, in the mildest cases, a person may exhibit no symptoms for 14 days and yet still be contagious for that entire period. From a study of previous infections and data collected to date in respect of COVID-19, the probability that an individual who has contact with an infected person and takes no special precautions is generally accepted to be around 14%. We can reduce that rate by taking measures, such as physical distancing and stay-at-home orders, depending on the type and degree of enforcement of these measures.

We also know that, like most infectious diseases, different people react differently to infection. In the case of COVID-19, for example, data suggests that people over 80 years of age have a 60% chance of having a severe reaction – leading to hospitalization – and a 15% chance of dying. These same seniors have a 18% likelihood of being in a critical condition that entails a 50% chance of mortality, and so on.

Whenever an infected person dies, or is hospitalized, or is removed from the population having been 'locked down', we can assume that he or she is then unable to infect any individual in the future nor get infected.

In building the Futurcast COVID-19 tool, we took into account the random nature of the infection process as well as public health measures taken, such as the extent of diagnostic testing to identify infected persons, physical distancing and stay-at-home orders.

The Situation in New York State

We chose to apply the Futurcast COVID-19 model to New York state population data as it has become the epi-center of COVID-19 in the world at this time. Governor Andrew Cuomo has given universal visibility to the plight of greater New York City with his daily televised news conference.

We obtained the key data on the four degrees of severity of the disease from a synthesis of the Chinese experience compiled from various data published studies and presented by Dr. Toni Choueiri of the Dana-Farber Institute. We calculated the percentage of individuals within each age group experiencing each of the four degrees of severity from data collected in South Korean. We considered six age groups: 0 – 39, 40 – 49, 50 – 59, 60 – 69, 70 – 79, 80 and older.

In these simulations we have chosen to impose no capacity limitations to health care resources in order to estimate the required needs in hospital and ICU beds.

Scenarios:

The interactive nature of the tool allows us to specify numerous alternative scenarios representing the implementation, at different times, of a variety of public health policies. We present here the results of five key scenarios reflecting different measures that may be taken as follows:

I. **Laisser-faire**: Letting COVID-19 follow its course until it washes out of the population.

II. **Social distancing:** Measures such as keeping a 6-foot separation between individuals, limiting the size of gatherings, limiting travel between regions etc. which are estimated to reduce by half (14% to 7%) the probability of infection transmission from one person to another.

III. **Early sheltering under social distancing**: Social distancing measures followed by a total lockdown of all individuals over 70 after reaching 100 deaths and for all other individuals, after 1,000 deaths.

IV. **Late sheltering under social distancing**: Social distancing measures followed by a total lockdown of all individuals over 70 after 1,000 deaths, for those between 40 and 69, after 10,000 deaths, and for those less than 39, after 15,000 deaths.

V. **Extensive random testing under social distancing**: 100,000 daily random tests to identify infected individuals that are then isolated and removed from the active population.

It is important to note that the concept of lockdown is that of a mandatory confinement with no physical interaction with the outside world, no visitors, no stepping out to do groceries, no meeting family members, remaining in a state such that a locked down person may no longer infect another individual or be infected. We assume that some individuals carrying out essential functions (medical care, food and goods transport, grocery and food delivery, sanitation, etc.) will continue.

The Futurcast Forecast:

The table below presents the outcome of running the model under the above five scenarios given the population of New York State (near 20,000,000) and its age distribution.

	Population Infected	Number of deaths	Duration in Days	Peak at Day	Peak Hosp Beds	Peak ICU Beds
I. Laisser-faire (14%)	**85%**	**300,000**	**140**	**73**	**534,000**	**103,600**
II. Social distancing (7%)	**56%**	**191,600**	**380**	**200**	**130,000**	**26,200**
III. Sheltered Early (7%)	**1.3%**	**1,580**	**185**	**150**	**2,300**	**300**
IV. Sheltered Late (7%)	**16%**	**15,360**	**240**	**185**	**15,800**	**2,600**
V. Diagnostic Testing (7%)	**49%**	**172,000**	**410**	**220**	**108,000**	**20,500**

Observations

Unfortunately, it took time for countries to conclude that a laisser-faire scenario is politically and humanly impossible even if it has a less damaging impact on the economy. This laisser-faire attitude could have led, in the US, to over 5,000,000 deaths given the 300,000 forecasted for New York state. The more science and exponential nature is in doubt, the more this attitude will prevail.

What is important to note are the limits of social distancing. Although these measures, as demonstrated by this data, flatten the curve and put a reduced strain on health care resources in terms of required ICU beds, the level of mortality remains in the hundreds of thousands with an unsustainable duration of the pandemic.

What might be a surprising result is the small impact of extensive testing (100,000 random tests a day) under social distancing in order identify and lock down those to be infected. Even if we double the number of tests per day, we only decrease mortality by 6.9% or 12,000 individuals in our example.

What the forecasts reveal is that strict sheltering is the only policy prescription that reduces the length of the pandemic and mortality in a significant way. The

earlier it is implemented, the lesser the impact of the pandemic from a health, social and economic perspective.

To put in place such a lockdown is not an easy logistical and political proposition. Public transportation would be stopped. No direct physical contact would be allowed. Social interactions would be limited to social media tools. Essential services would only be truly essential. Short of a miracle drug, there is nothing else that can ensure a quick return to normal with little mortality.

Conclusion

We are confident of the reliability of the forecasts given the available information. We can only infer this reliability from the mortality data since the cases reported in the media are limited to those individuals tested and not to the entire infected population.

Applying the Futurcast COVID-19 model under a laisser-faire scenario for the province of Ontario results in a projection for April 30th that is in line with the 6,000 number of deaths forecasted by the province for same date under a do-nothing scenario.

What is extremely important to note is that the Futurcast COVID-19 model predicts for Ontario around 140,000 deaths as of May 30 under the same scenario! Again, how can this growth happen in 30 days? This is exponential growth with no constraints.

Finally, although our governments may be a few weeks late in adopting the necessary measures, there is still time to save hundreds of thousands of lives.

This modeling effort is not cast in stone. It is constantly evolving with new information and it is our plan to update our forecasts on a weekly basis.

About Futurion

Futurion is a privately-held organisation that, since 1985, has devoted all its efforts to the development and implementation of operational and strategic forecasting technology. Its software systems are used in all industries, with a special knowledge base application for existing and pipeline pharmaceutical products.