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# U.S. Coronavirus Surge Forecast

*Lincoln Healthcare Leadership, Southport, CT*
*March 23, 2020*

Lincoln has developed a simple model to help predict the weekly size of the coronavirus "surge." See accompanying Excel spreadsheet: U.S. Coronavirus Surge Model

In developing this model, we have leaned on others' analyses and estimates, and have used publicly available data. It is not a sophisticated epidemiological model, and is knowingly slightly inaccurate in some respects. But it is meant to give a ballpark estimate of the potential surge numbers, and allow someone to easily experiment with input parameters and see how they affect the surge size.

**Assumptions:**

We assume a "natural" infection rate of 2.5 (c) – each infected person infects 2.5 others in a normal societal situation. We then apply a "suppression factor" (d) – quantifying how much our societal isolation measures are able to suppress the infection rate. We assume each person is infected for three weeks – but only infectious during week one. Column (f) shows the new weekly infections, (g) is new recoveries, and (h) is total recoveries.

We assume the following institutionalization rates: hospitalization, 15% (i), ICU use 5% (j), ventilator use (2.5%).

We assume a 2% death rate. Some epidemiologists estimate this will be closer to 1%, but relying on Tomas Pueyo's analysis that shows the more a country's healthcare system is overwhelmed by the coronavirus, the higher the virus' lethality, and considering that our own healthcare system is now likely to be overwhelmed, we use a 2% figure here.

**Simulation:**

What we've shown here is an aggressive (and we would consider successful) "rolling lockdown" simulation for the U.S. Beginning the week of March 9, and reaching its apex eleven and twelve weeks later, May 18 and May 25, the US implements successively more impactful societal lockdowns, suppressing the virus' spread from 90% to just 25% of its natural spread. What is critical to stopping the virus' spread (to flattening the curve) is to be able to successfully reduce the actual infection rate (e) to 1.0 or below, which this model does, from the April 20 week to the June 8 week.

After the June 8 week, we simulate a moderate opening up of societal lockdowns…towards what we could call "vigilant distancing", combined with widespread testing and tracing, and allow the actual infection rate to drift back up to 1.0, thereby allowing the virus to spread at a steady level (what Pueyo calls "the dance").

Let's look at the weekly deaths in this forecast, which peak during the 21-day period of May 4 – May 18 weeks, at 11.6K deaths per week. In a normal U.S. flu season, with say 40K deaths nationally, spread out over say five months, you would see a flow of about 2K deaths per week. This simulation forecasts a flow of coronavirus patients of about 12K per week, six times the rate of a normal flu season. And this

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underestimates the impact on our healthcare system in two important ways. First, this is national, and does not account for geographic differences. It appears that hot spots like NYC could see 5X or more the national average flow rates per capita. Secondly, this is a respiratory virus that has a higher utilization of the ICU and, especially, ventilators than the flu. (2X the need? 3X?)

For these reasons, this simulation, as "successful' as it models getting control over the virus' spread over a three month period, also shows a very serious crisis about to rock our healthcare system – even more acutely in some geographies.

Once we get to June, this model shows a vigilant distancing policy controlling the virus' spread to about 114K new infections allowed per week (6 ml per year), after the surge curve was flattened out at about 5 ml infections. We would incur an ongoing 2.2K weekly deaths, which, matching a typical flu season rates, could be sustainable for our healthcare system if we have several months to be able to increase our ICU capacity and manufacture many more ventilators.

**Contact:**

David Ellis
President & Founder
Lincoln Healthcare Leadership
dellis@lincolnhc.com
(203) 644-1703