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Stanford Medicine-Engineering Partnership Launches an Interactive Model to Facilitate COVID-19 Response Planning for Hospital and Regional Leaders (4/1)

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Abstract

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What is the message? Interactive online tools can help local hospital and public health officials understand and plan for the number of people in their area that are likely to

require hospitalization for COVID-19.

What is the evidence? Publicly available data, including the most recent data on COVID-19 hospitalization rates by demographics, used to project local hospitalization numbers in an online tool. **Link to model: https://surf.stanford.edu/covid-19/**

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The Need for Projections in Planning

Hospitalizations related to COVID-19 could exceed hospital capacity in many areas of the United States without appropriate local preparations. One of the greatest obstacles to implementing local policies to handle such a surge of COVID-19 hospitalizations is that local leaders have to plan for exponential growth of a highly transmissible pathogen with a 3- to 14-day lag between infection and hospitalization. A simple model that captures these dynamics and projects hospital bed demand a few weeks ahead helps local leaders meet this challenge.

To prepare adequately, local officials need to know how many people in their area will likely need to be hospitalized for COVID-19 and how this compares to the supply of intensive care and acute care beds. Most people infected with COVID-19 are asymptomatic and the proportion of infections that require hospitalization differs substantially between age groups. [1] Moreover, U.S. counties vary significantly in their population age, as well as in their available hospital resources. [3, 4] Projecting the local need for hospital beds requires understanding these risk factors and accounting for the susceptibility of the local population. [2]

Early projections of the potential impact of COVID-19 on local hospitals have forced governmental action; however, the policies implemented across states and counties vary widely. [1, 5] Such differences lead to important variation in disease propagation across counties. Understanding this variation at a regional level is important to coordinate planning related to the employment of public health policies and the utilization of limited healthcare resources.

The Projection Model

Sources of Data

To facilitate local planning, we built a simple model to estimate the proportion of people in each US county that would need hospitalization given a symptomatic COVID-19 infection. We used the age distribution of the county per the U.S. Census and conditional infection severity rates from the Imperial College COVID-19 Response Team. [2, 6, 7] The model compares the estimated number of individuals requiring hospitalization in the next several weeks to the publicly known numbers of intensive and acute care beds in the region, including length of stay data [8, 9].

Availability and Example Output

To enable use by hospital and public health officials, the model is deployed online as an interactive tool that quickly generates estimates of the number and rate of severe, critical, and mortality case rates for one county or a set of counties. These time series are presented with the number of intensive care and acute care hospital beds available in the corresponding region.

Figures 1 and 2 depict examples of outputs from the model.

Figure 1: *Screen capture of model (https://surf.stanford.edu/covid-19/, accessed on March 29, 2020) with permission of authors. Example output showing the model output simulating an intervention that changes the growth rate of COVID-19 hospitalizations on April 20. The plot is a hypothetical situation and not a forecast for any county.*

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This tool allows healthcare providers and policy makers to estimate ICU and Acute Care bed demand for COVID-19 patients. The tool is only designed to project hospitalizations when a small proportion of the overall population has been infected (<20%) and does not account for community immunity. See the Documentation tab for methodology.

- X county has 1,573,714 people aged 0-59 and 348,486 people aged 60+.
- This area has 1318 acute beds and 266 ICU beds. By default, we assume 659 acute beds and 133 ICU beds are available for COVID-19 patients (50% of total). You can modify the # of beds available to COVID-19 patients in the inputs. See Documentation tab for data source.
- Assuming no changes to the doubling time, the number of people requiring ICU beds will exceed the number of available ICU beds in 25 days.
- Assuming no changes to the doubling time, the number of people requiring acute beds will exceed the number of available acute beds in 28 days.
- If interventions lead to the input change in doubling time, then the number of people requiring ICU beds will not exceed the number of available ICU beds in the next 30 days.
- If interventions lead to the input change in doubling time, the number of people requiring acute beds will not exceed the number of available acute beds in the next 30 days.

Graphical Representation | Tabular Representation

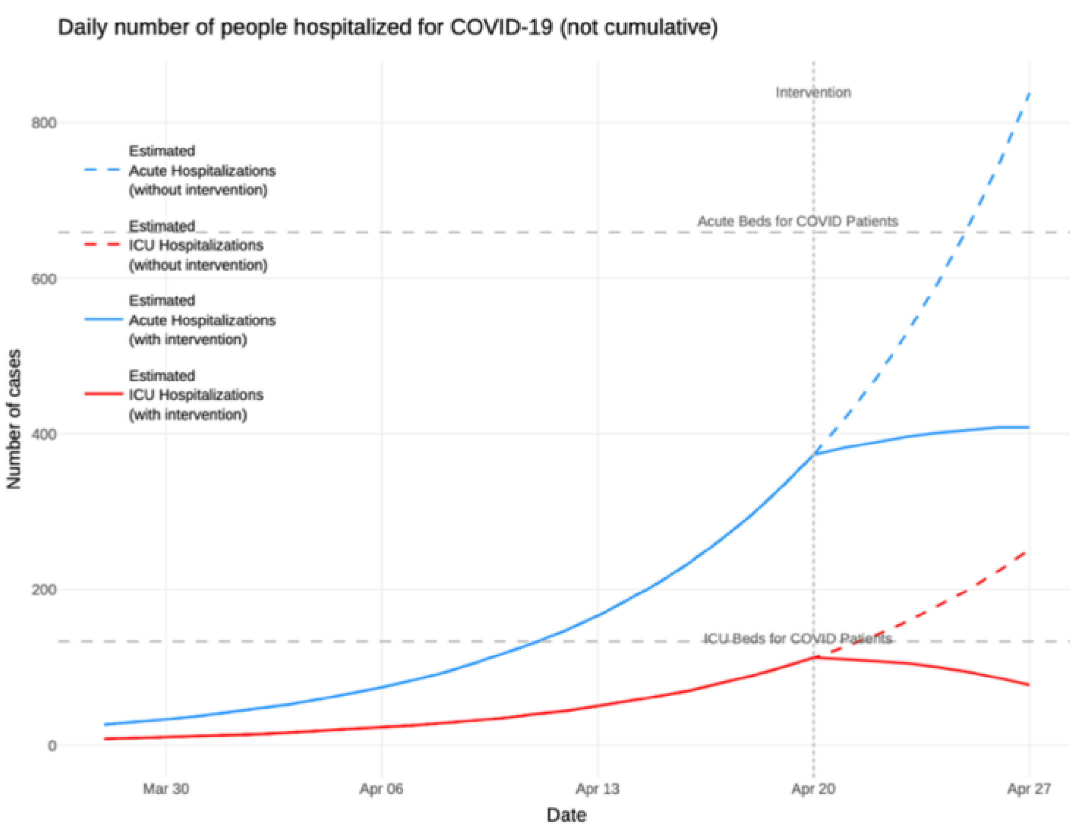
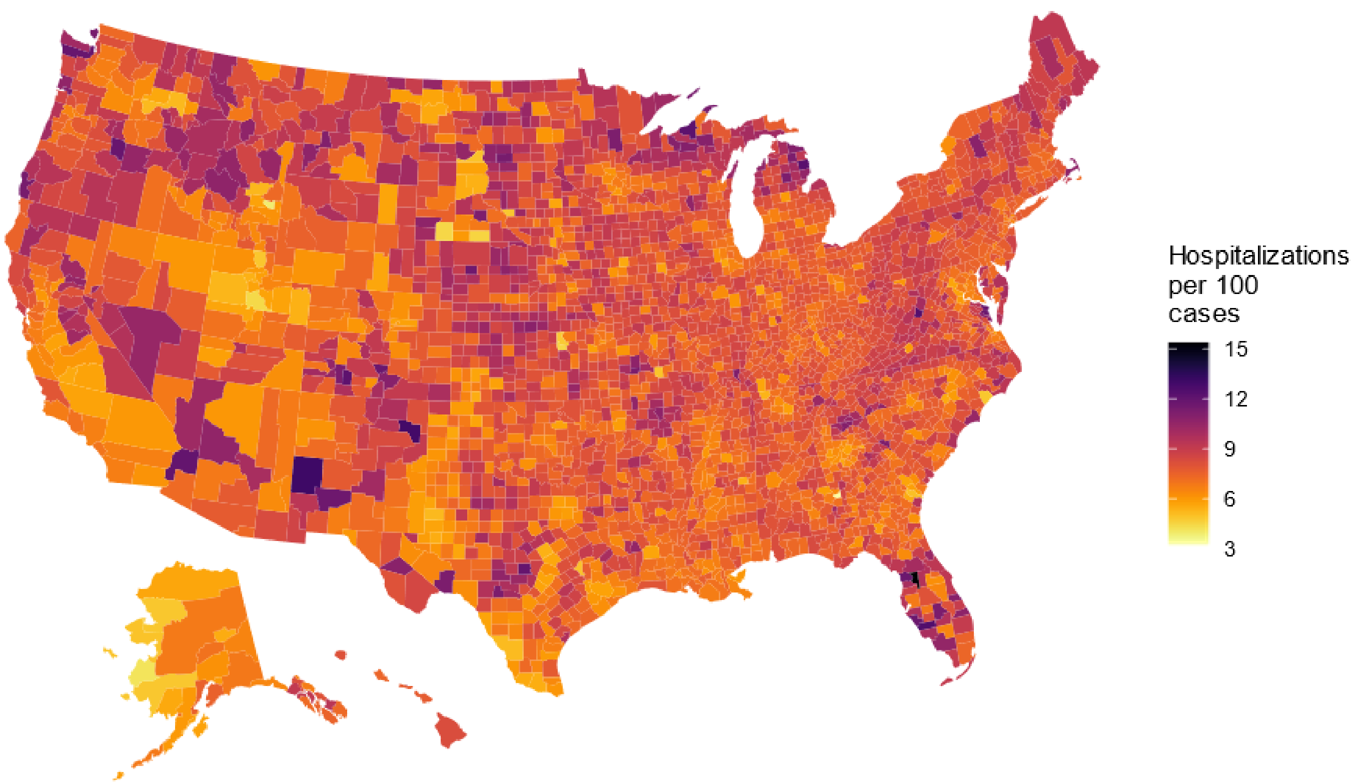


Figure 2: *Screen capture of tool (https://surf.stanford.edu/covid-19/, accessed on March 29, 2020) with permission of authors.*

Expected number of hospitalizations per 100 symptomatic cases
(based on the age distribution of the county population)



Link to model: https://surf.stanford.edu/covid-19/

Updates

As local officials gather new data on the spread of COVID-19, the model allows them to adjust the inputs to the model and generate new and better projections. For example, hospital length of stays (and intensive care length of stays) may vary based on the unique population characteristics within a county. Similarly, current disease burden and/or public health measures may be importantly different across counties.

The large uncertainty around the numbers of people infected and its growth rate make it difficult to evaluate projections generated by more complex epidemiological models. The model allows users to tailor basic input parameters such as hospital length of stay and the impact of public health interventions, such as social distancing, to slow the spread of the virus for a specific county or combination of counties.

When researchers publish new epidemiological data, the model is updated by those maintaining it with new conditional hospitalization rates and their associated length of stays. The model errs on the side of simplicity and transparency in order to better communicate the underlying calculations and uncertainty to non-specialist policy makers.

Estimating Disease Propagation

An important secondary feature of the model is the ability to estimate disease propagation based on the doubling time of hospitalizations, complementing and contrasting the doubling time of confirmed cases. As the rate of confirmed cases in the U.S. is likely to significantly shift with adjustments in testing criteria and testing capabilities, a hospitalization-based model offers advantages to estimate hospitalization needs in the context of a fluctuating landscape of symptomatic and asymptomatic cases. As new epidemiological data become available, the model is updated by those maintaining it with new age-specific rates of disease, disease severity and hospitalization along with hospital length of stay.

Looking Forward

Given current constraints on hospital resources, it is imperative to achieve collaborative operational planning and research across the public and private sectors. While hospitals may emphasize the impact of COVID-19 at their individual facility, our model estimates the impact at the regional level. Understanding the regional impact facilitates coordination of planning between public health and hospital leaders facing an extraordinary challenge.

Improved situational awareness enables regional and state leaders to be prepared to tackle the considerable variation in disease penetration and impact across counties. These conversations are facilitated by the ability to study several counties in a region and to vitally understand the sum of the parts that make up the whole.

Acknowledgments

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