Issue Brief

Healthcare Surge Capacity Planning—Modeling as a Decision-Making Tool for Public Health Officials

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OVERVIEW

Modeling allows health officials and policymakers to make decisions based on future projections. States are using an array of COVID-19 modeling tools to inform community mitigation and hospital response strategies; however, differences in the inputs, assumptions, and data systems may result in different forecasts. This brief will help states understand how projections are calculated across several models, each of which have been cited by the media and used or developed by state/territorial health officials and ASTHO alumni. Although there are at least a dozen models in use across the nation, the four cited in this brief represent a sample that is designed to forecast hospital capacity at the regional or state level.

COMPARISON OF MODELS

Models	**Harvard Hospital Capacity Data**	**Penn Medicine COVID-19 Hospital Impact Model for Epidemics (CHIME)**	**IHME (University of Washington) Hospital Resource Use Project Tool**	**COVID ACT NOW**
Inputs	Population infection rate of 20%, 40%, or 60%, each modeled over either six, 12, or 18 months. Hospital capacity: Total hospital beds, ICU beds, available and potentially available beds Demographics: Adult population; population age 65+ Treatment capacity:	• Regional population • Hospital market share • Currently hospitalized COVID-19 patients • Date of the first hospitalized case • Doubling time before current date (number of days for number of cases to double) • Social distancing (percent reduction in social contact)	Confirmed COVID-19 deaths by day (WHO website, local & national government data). Hospital capacity and utilization data (states). Observed COVID-19 utilization data (select locations).	Population and demographics. Number of total hospital beds. Addresses various scenarios, including: • Limited action • Three months of shelter-in-place (poor compliance) • Three months of shelter-in-place (strict compliance)

	• Projected number infected, hospitalized and needing ICU • Hospital/ICU beds needed, X months • Percentage of available and potentially available hospital/ICU beds needed, X months • Percentage of total hospital/ICU beds needed, X months)	• Hospitalization percentage • ICU percentage • Ventilator percentage • Average hospital length of stay • Average days in ICU • Average days on ventilator		• Three months of lockdown • Do nothing: Current historical trends continue
Assumptions	Hospitalization rates (19% hospitalization rate for those under age 65, 28.5% hospitalization rate for those 65 and older) ICU rates (3.6% ICU rate for those under age 65, 8.1% ICU rate for those 65 and older) 12-day hospital stay	Hospitalization rate: 5% ICU rate: 30% of admissions Mechanical ventilation rate: 30% of admissions Infectious period: 14 days	Social distancing measures use the New Zealand Government's Alert System Level 4 with the assumption that locations that have instituted less social distancing than the measures outlined will enact the remaining measures within 7 days. With each model update, the assumption of full implementation of social distancing is reset. Any delay will be reflected in the estimated number of deaths and burden on hospital systems.	Four-day hospital stay 7.3% hospitalization rate; 1.1% case fatality rate; 1.0% fatality rate increase if hospitals are overloaded. 66% hospital beds unavailable for COVID-19 due to being occupied; 207.9% emergency bed capacity built over two months. 16-day recovery period; two-day non-contagious incubation period; two-day contagious period.
Outcomes	Bed capacity data Localized estimates of available beds	Projected number of new admissions: • Inpatient hospital admissions • ICU admissions	Deaths Hospital bed and ICU occupancy Ventilator use	New infected and current infected Recovered or died Predicted hospitalized

	Beds needed to accommodate patients over the coming months Where hospitals might find additional bed and ICU bed capacity Other shortages that might need addressing	• Patients requiring ventilation Projected running totals, accounting for discharges: • Inpatient hospitalizations • ICU admission • Patients requiring ventilation		Cumulative infected and cumulative deaths Available hospital beds Predicted chance of infection
Data sources	Data sources available online.	Assumptions are based on research by Verity et al.	Available for download.	See above and available online.
Limitations	Challenges in identifying mild cases mean that severe cases may be overestimated. Only short-term acute care and critical-access hospitals were included. Occupancy rates are calculated using an annual average; occupancy rates fluctuate throughout the year. The model only considers infections among adults. The model assumes uniform infection rates across time (no spikes/dips in new cases).	The model is based on number of regional COVID-19 cases, which may be under-counted due to challenges identifying mild or asymptomatic cases.	The model assumes strict social distancing compliance. The forecast (which assumes continued distancing) only covers the next four months and does not predict how many deaths there may be due to later resurgence, or if social distancing is not implemented.	Inputs and assumptions are based on estimates (some are informed guesses; others are informed by early data). Hospital-stay estimate is extremely conservative, as the current consensus is 10 days. Demographics and hospital bed counts are from 2016-2018. Uncertain of outcomes if COVID-19 is not fully contained or if it is reintroduced from another country.
Forecast	If 20% of the population were infected, approximately 95% of U.S. hospital beds would be full. If 40% of the population were infected, the country would have to more than double	This model can be used for any region; however, the published data only reflects Penn Medicine's catchment area. For that region, the model indicates that a 30% reduction in social contact will reduce the doubling	As of April 1, the model estimates 93,765 deaths through August 4. The model shows peak hospital resource use on April 15. Nationwide deaths are also	As of March 27, the model shows peak hospitalizations (835,818) on May 2 and 792,238 deaths through May 22, should current trends continue.

	available hospital beds by freeing up existing beds or adding new ones. If 60% of the population were infected, the country would need seven times the number of available hospital beds than it currently has.	time to 6.6 days, implying a daily growth rate of 11.1%. New hospitalizations, ICU admissions, and ventilated admissions would peak on May 12.	projected to peak on April 15, escalating to 2,2214 deaths per day (range of 1,106 to 3,321). Predictions also suggest the first day when the range of daily COVID-19 deaths is expected to fall under 100 could be June 28.	Model offers a state-specific map of hospitalizations varying across interventions.
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ADDITIONAL RESOURCES FOR STATES

The following resources offer additional information for state/territorial health officials to assess current best estimates of COVID-19 counts, as well as additional data points that can guide assessments on the impact of state policy:

- CDC PPE burn rate tracker – for individual facility use
- U.S. health weather map – tracks trends in observed and atypical fevers across the U.S. down to the county level.
- Case tracking tools:
    - CDC: Cases in the U.S.
    - Johns Hopkins University: Coronavirus COVID-19 global cases map
    - CNN: State-by-state breakdowns of U.S. coronavirus cases
    - NPR: Tracking the spread of the coronavirus in the U.S.
- *The Lancet*: Influenza modeling tools

For questions or feedback, please email preparedness@astho.org.