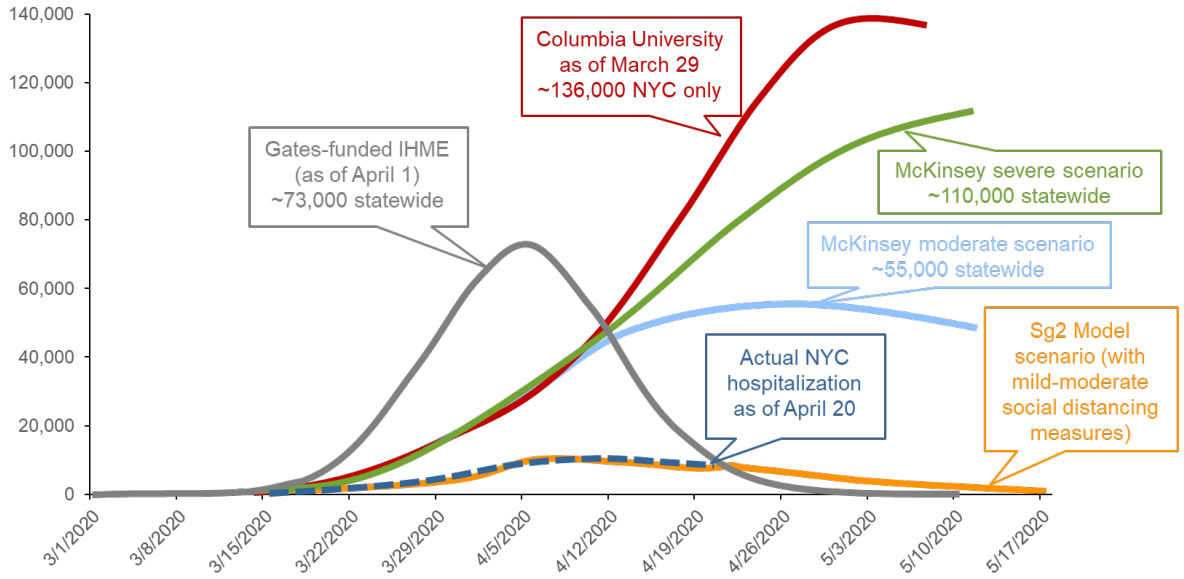
Sg2 COVID-19 Surge Demand Calculator: How Accurate Has It Been?

Document purpose. The Sg2 COVID-19 Surge Demand Calculator hospitalization curves satisfactorily match actual data reported from New York City, NY, San Francisco, CA, Chicago, IL, Albany GA, and San Antonio, TX. This document demonstrates how closely the match is for the 5 markets, outlines how the actual data show some trends that the model did not anticipate, and reviews important lessons that were learned in building the model and observing actual coronavirus disease 2019 (COVID-19) cases.

Comparing frequently cited models. Models frequently cited by the White House and the state of New York overestimated census and bed need projections. Reasons for the overestimates are twofold. Said models did not include the impact of social distancing measures or, if included in the modeling, the expected impact was lower than what was observed. In addition, the projected hospitalization rates used in these models applied cited case-positive hospitalization rates from the international literature to the projected total infected population rate estimates. Case-positive rates are known to be much lower than the total infected rates due to limited testing and the number of people in a population who have COVID-19 but are asymptomatic. Recent serologic testing in California and New York estimate the number of infected to be tenfold higher than the reported case number (positive tests) for those markets. In addition, Sg2 applied market specific, age-adjusted COVID-19 hospital rates to the infected population to get a more accurate projection of the infected population that would require hospitalization (please see Appendix for more information on age-adjusted, case-based hospitalization data and critical care rates). **See below for a comparison of the Sg2 model for New York City and models presented in a recent press conference by Governor Andrew M. Cuomo.**



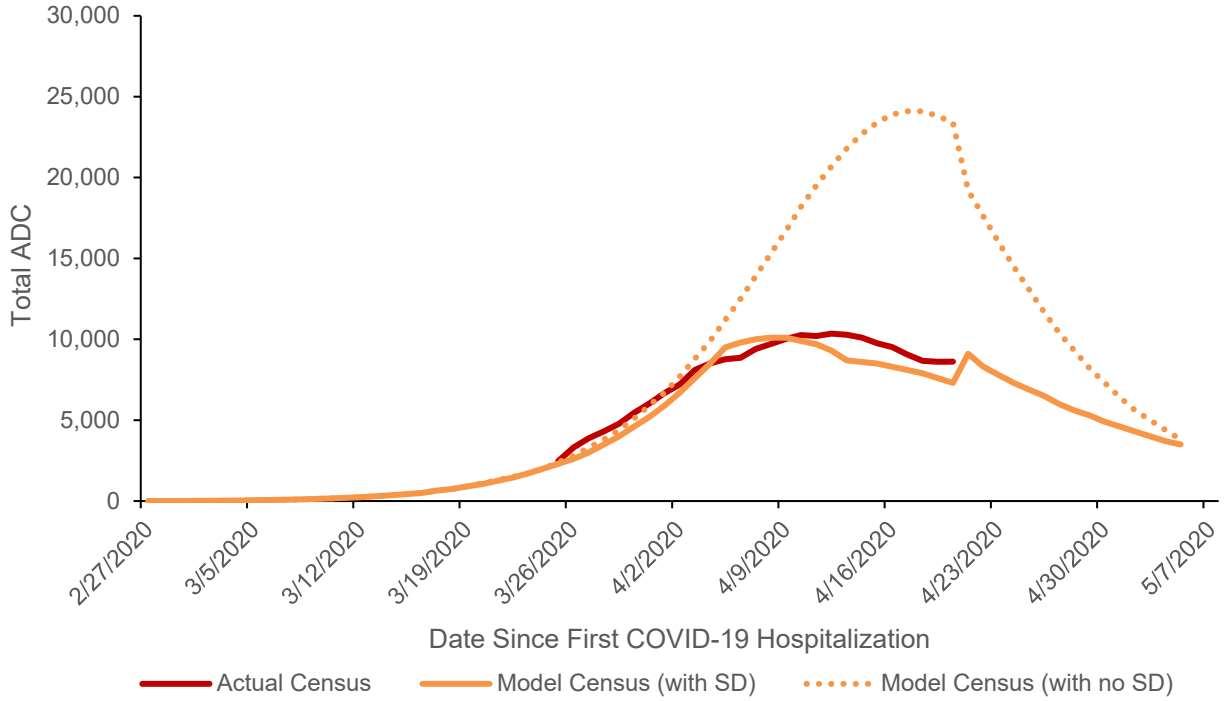
IHME = Institute for Health Metrics and Evaluation. **Sources**: Sg2 COVID-19 Surge Demand Calculator, 2020; NYC Health. COVIID-19: Data; New York State. Pressroom: Official News From the Office of the Governor. All websites accessed April 2020.

Improving the model. The newest update to Sg2's model reflects prolonged peaks that are being observed in actual data throughout the US and builds in the impact of lifting social distancing measures. A demonstration of the newly released v4.1 outputs for the New York City market is shown on page 8.

NEW YORK CITY, NY (V3.2)

The Sg2 model was able to accurately predict the actual ADC peak magnitude and timing experienced by New York City

ADC Surge Scenario Impact for COVID-19 Cases



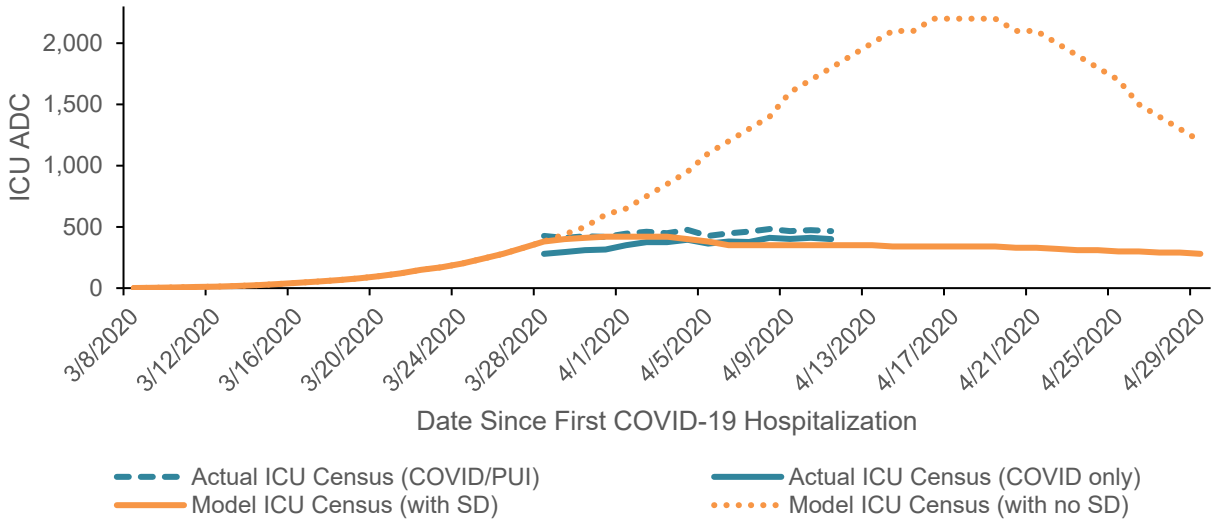
ADC = average daily census; SD = social distancing. **Source:** NYC Health. COVIID-19: Data; New York State. Pressroom: Official News From the Office of the Governor. All websites accessed April 2020.

	PEAK SIZE	PEAK TIMING
Model	10,100 ADC (biggest day)	April 8–9, 2020
Actual	10,351 ADC (biggest day)	April 12, 2020
Difference	Minor difference between model outputs and actual hospitalization of 2%.	The model was slightly early (difference of 8%) but landed within the same week.
Notes	The model was able to closely predict hospitalization.	The model predicted that the peak would occur approximately 3 days earlier than it did.

CHICAGO, IL (V3.2)

The Sg2 model predicted peak ICU ADC with accuracy and the timing of the actual peak was about a week later than expected.

ICU ADC Surge Scenario Impact for COVID-19 (Confirmed and PUI) Cases



ICU = intensive care unit; PUI = person under investigation; vent = ventilator.
Source: City of Chicago. Latest Data. Accessed April 2020.

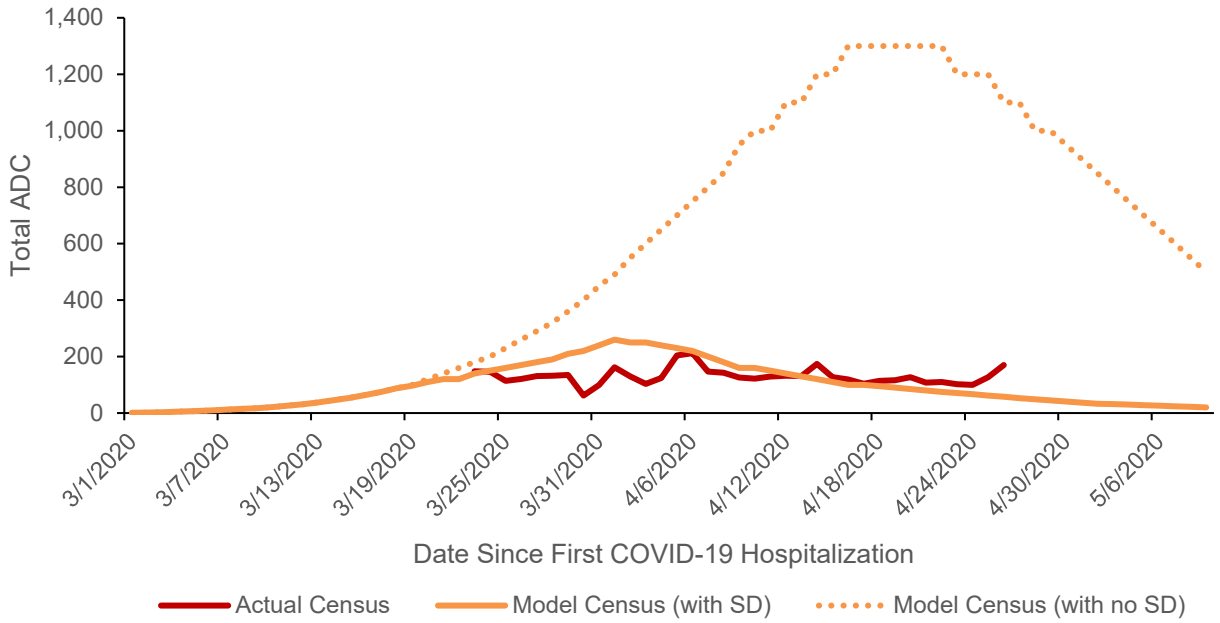
	PEAK SIZE	PEAK TIMING
Model	• ICU ADC: 420 • Vent ADC: 380	• ICU peak: April 7–April 10, 2020 • Vent peak: April 8–April 9, 2020
Actual	• ICU ADC: 410 • Vent ADC: 296 • Vent ADC for COVID-19/PUI: 331	• ICU peak: April 15, 2020 • Vent peak: April 16, 2020 • Vent peak for COVID-19/PUI: April 16, 2020
Difference	• ICU ADC: 2% • Vent ADC: 22% • Vent ADC for COVID-19/PUI: 13%	• ICU: 20% • Vent: 23%
Notes	The model was able to more closely predict the ventilator ADC for COVID-19/PUI patients than COVID-19 patients alone. However, the peak occurred on the same day for both data points.	• It is currently unclear whether Chicago has reached its peak, given that the peak ICU and ventilator ADC occurred recently. • The model predicted that the peak would occur approximately a week earlier than it actually occurred. • From a weekly perspective, the model predicted that the peak would occur between weeks 5 and 6 (April 5–April 12) after the first COVID-19 hospitalization. However, current data suggests that the peak was observed between weeks 6 and 7 (April 12–April 19).

Chicago, unfortunately, has incomplete hospitalization data. The City of Chicago offers ICU and ventilator information, starting from April 4, 2020, which was used to compare against the model's outputs.

SAN FRANCISCO, CA (V3.2)

The magnitude of COVID-19 ADC in San Francisco was predicted with sufficient accuracy, but the city's mitigation efforts prevented the expected surge or peak.

ADC Surge Scenario Impact for COVID+ and PUI Cases



COVID+ = COVID-19 positive. **Source:** DataSF. COVID-19 Data and Reports. Accessed April 2020.

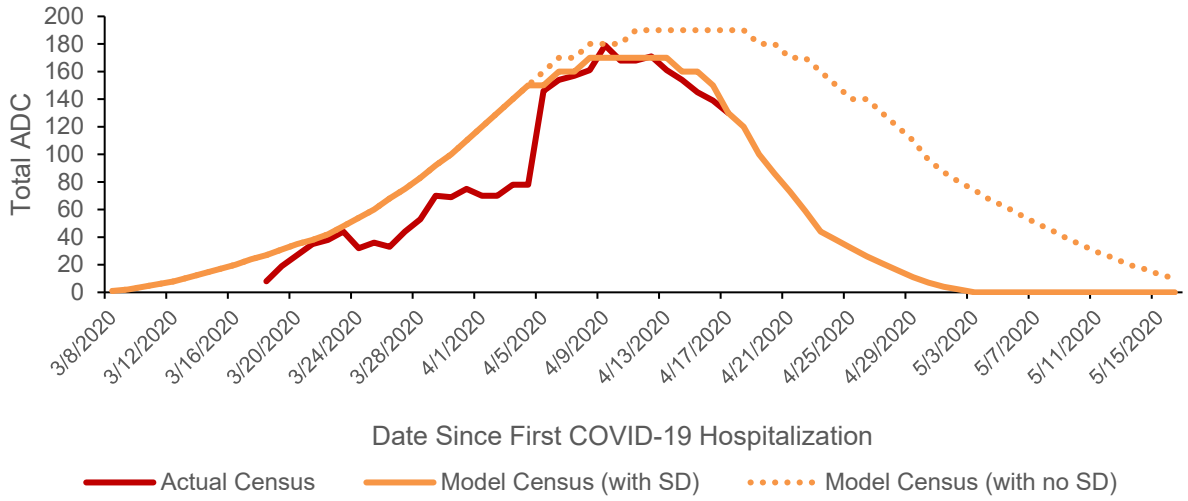
	PEAK SIZE	PEAK TIMING
Model	260 ADC (biggest day)	April 1, 2020 (modest peak)
Actual	212 ADC (biggest day)	April 6, 2020 (sharp spike, 1 of many, but the spike on April 6 was the highest)
Difference	The model overestimated the peak size by 18%.	The model was early, but the peak occurred within the same week.
Notes	Although actual ADC has shown signs of decrease, recent data suggest the potential of ADC rising again. However, it is unlikely that the ADC will reach the peak that occurred on April 6, 2020.	Although the actual peak (biggest spike) occurred on April 6, 2020, there appears to be multiple, although smaller, peaks. While the peak size was accurate, the sustained and prolonged peak timing may have implications for capacity, workforce and finances that were unforeseen.

San Francisco hospitalization data picks up on March 23, 2020, with an ADC of 148. No data are available before that date, but the census of 148 is a very high number for it to be the first true day of hospitalization. Therefore, hospitalization data before March 23 is likely missing, which is why the beginning Actual Census line is hovering on the graph.

ALBANY, GA (V3.2)

The Sg2 model was able to predict the peak size and timing with accuracy.

Daily COVID-19 Census



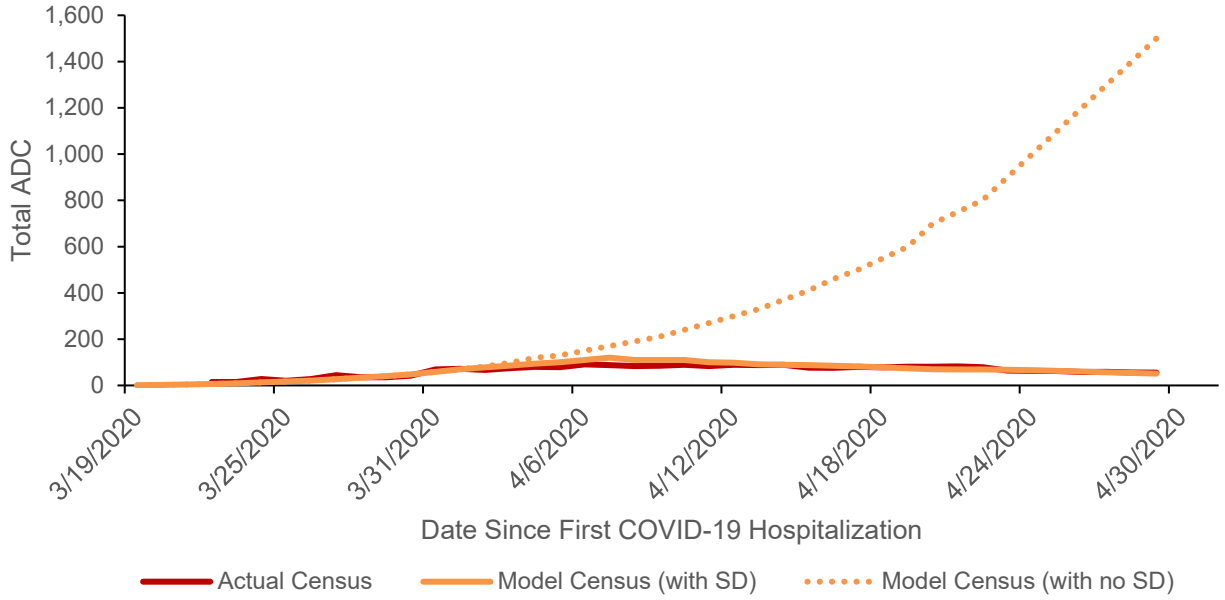
Note: Reflects daily reports from Phoebe Putney and includes their 3 hospitals: Memorial Hospital, Sumter Medical Center and Worth Medical Center. **Source:** Phoebe Health. Coronavirus Updates. Accessed April 2020.

	PEAK SIZE	PEAK TIMING
Model	170 ADC (biggest day)	April 8, 2020 – April 13, 2020
Actual	179 ADC (biggest day)	April 9, 2020 (sharper peak)
Difference	The model slightly underestimated the peak size by 5%.	The model was able to predict peak timing with accuracy, as the peak occurred within the same week as the model anticipated.
Notes	With ADC declining for several days, it is safe to assume that the peak has passed.	

SAN ANTONIO, TX (V3.2)

The Sg2 model accurately fits the actual surge trajectory for San Antonio, with regards to both magnitude and timing.

Daily COVID-19 Census



Source: University of Texas Health Science Center at San Antonio. Accessed April 2020.

	PEAK SIZE	PEAK TIMING
Model	120 ADC (biggest day)	April 7, 2020 (sharper peak)
Actual	91 ADC (biggest day)	April 6–April 14, 2020
Difference	The model overestimated the peak size by 24%.	Model peak timing occurred within the actual peak observed.
Notes		The model was able to predict the timing of the peak and descent with accuracy.

LESSONS LEARNED

- Sg2's COVID-19 Surge Demand Calculator originally recommended a hospitalization rate of 1.2%. However, validation of actual data observed across the nation prompted our experts to decrease the hospitalization rate to a range between 0.5% and 1.2%. In contrast, other models recommended higher hospitalization rates, ranging from 5% to 20%, resulting in an overestimation of their outputs.

- The reproductive rates in rural and warmer climates were observed to be lower than originally estimated.

Sg2 COVID-19 Surge Demand Calculator Overview and Methodologies

Table 1. Sg2 COVID-19 Surge Demand Calculator Starting Infection Rate (Reproduction Rate, R_0) for Local Community Viral Spread: Reproduction Rates and Suggested Uses

R_0	2.6	2.5	2.4	2.3	2.2	2.1	2.0	1.9	1.8	1.7
Total Infection Rate (%)	91%	90%	89%	87%	85%	83%	80%	77%	73%	70%
Relative Population Density	High urban density			Moderate urban density (urban/suburban mix)				Low urban density (rural)		
Relative Use of Public Transportation	High reliance on public transportation			Increased reliance on automobile transportation				No real public transportation use		

Note: R = reproduction number, a mathematical term that indicates how contagious an infectious disease is (R_0 or R naught).

- The impact of social distancing measures were profound, as even modest measures were observed to blunt the curve.

- Hospital trends lag positive test case trends by 5 days.

- The percentage of hospitalizations that resulted in an ICU stay varied significantly from market to market. Published rates across the US suggest an ICU rate of 25%. Data from Seattle, WA and New York City, NY, support this ratio. However, in other markets, ICU rates of up to 50% were observed. The variation in ICU rates can be explained by 3 main factors:
  - ICU bed availability varies widely from surge markets to non-surge markets. Organizations with fewer available ICU beds will be more stringent on using the beds solely for intubated patients.
  - Burden of chronic disease and elderly populations varies by markets: markets with a higher prevalence of chronic disease will have a higher likelihood of ICU and ventilator demand.
  - Variation in pattern practices between academic medical centers (AMCs) and community hospitals: AMCs may be staffed and experienced in managing critically ill non-intubated patients on non-ICU units. On the flip side, AMCs and tertiary care hospitals may have higher acuity case mix due to transfers.

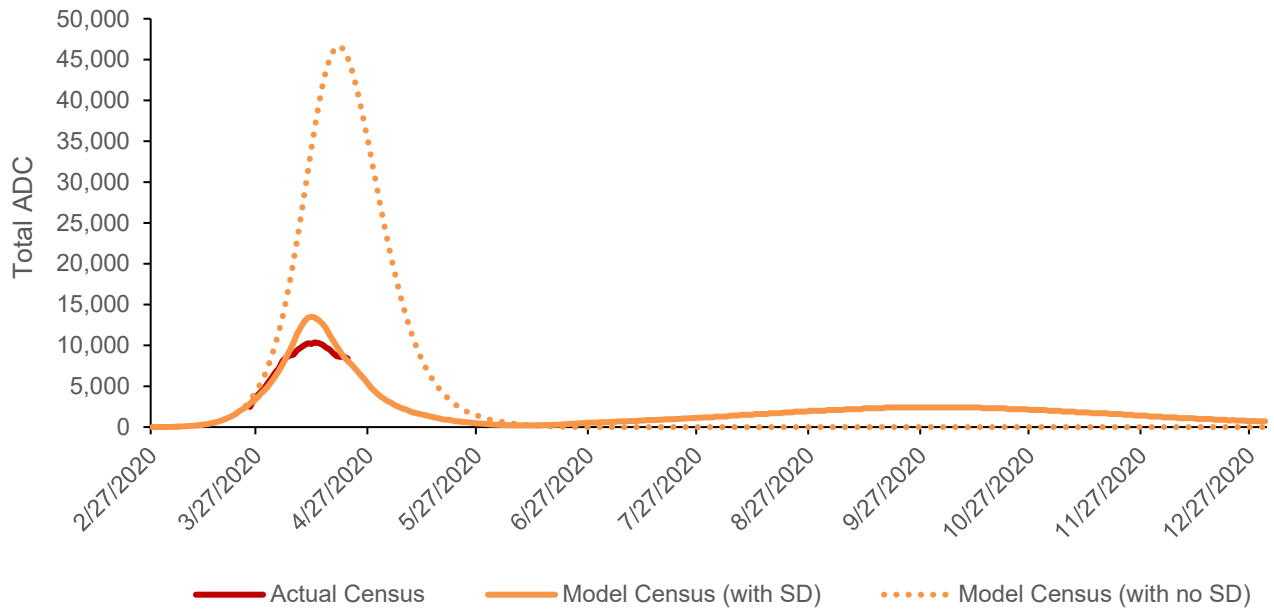
VERSION 4.1: A MORE ACCURATE CURVE FOR NEW YORK CITY

Prominent Updates

- More realistic portrayals of social distancing impacts, including an effect that is additive and more gradual due to a constantly changing reproductive rate over time
  - The more realistic feathering in changes in R_0 allows for a longer plateau (slower decline) in peak ADC, which has been observed in US markets.
- New inputs that allow a resurgence of COVID-19 caused by the relaxing of social distancing measures
- Improved input guidance and output visualizations

New York City, NY v4.1 vs Actual Census Data

Daily COVID-19 Census



Source: NYC Health. COVIID-19: Data. Accessed April 2020.

- The first wave of actual hospitalizations fits the model's expected curve, given the social distancing measures in place.
  - Actual peak: April 12, 2020 (10,351 ADC)
  - Model peak: April 11, 2020 (13,500 ADC)
- Given the anticipated relaxation of social distancing, the model expects a second hump in early October, when a high of a 2,400 census of COVID-19 patients is expected.

Sg2 COVID-19 SURGE DEMAND CALCULATOR VALIDATION—APPENDIX

Table 1, Appendix: Population-Based Non-ICU and ICU Hospitalization Rates

Age Group (years)	Symptomatic Cases Requiring Hospitalization	Hospitalized Cases Requiring Critical Care
0 to 9	0.1%	5.0%
10 to 19	0.3%	5.0%
20 to 29	1.2%	5.0%
30 to 39	3.2%	5.0%
40 to 49	4.9%	6.3%
50 to 59	10.2%	12.2%
60 to 69	16.6%	27.4%
70 to 79	24.3%	43.2%
80+	27.3%	70.9%