Guide Your Organization through COVID-19

Using American Hospital Association Data and Epidemiologic Models

American Hospital Association
Advancing Health In America

AHA CENTER FOR HEALTH INNOVATION

Our Presenters

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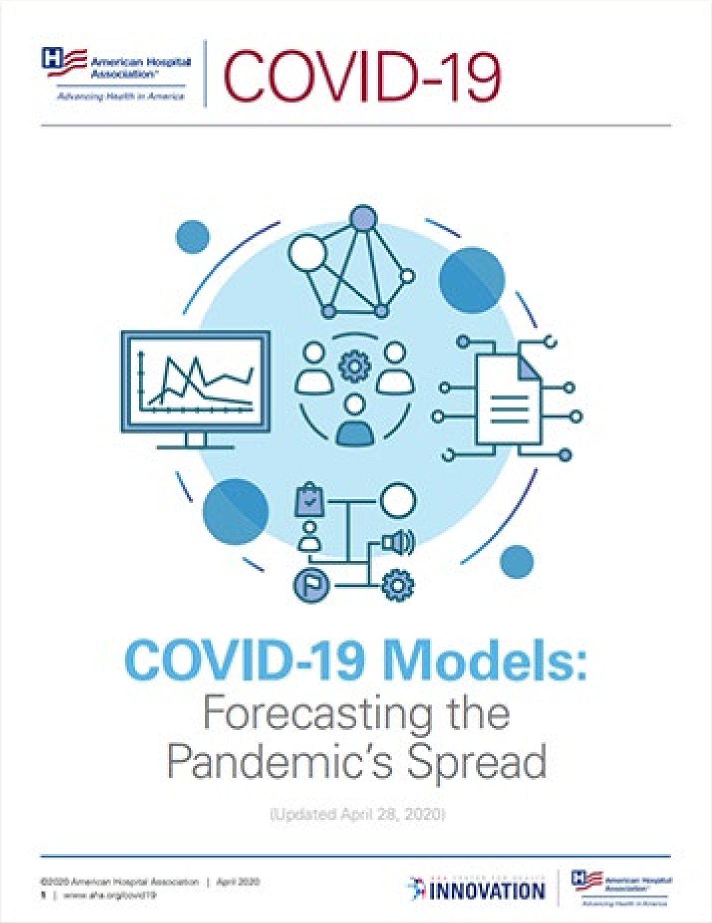
AGENDA

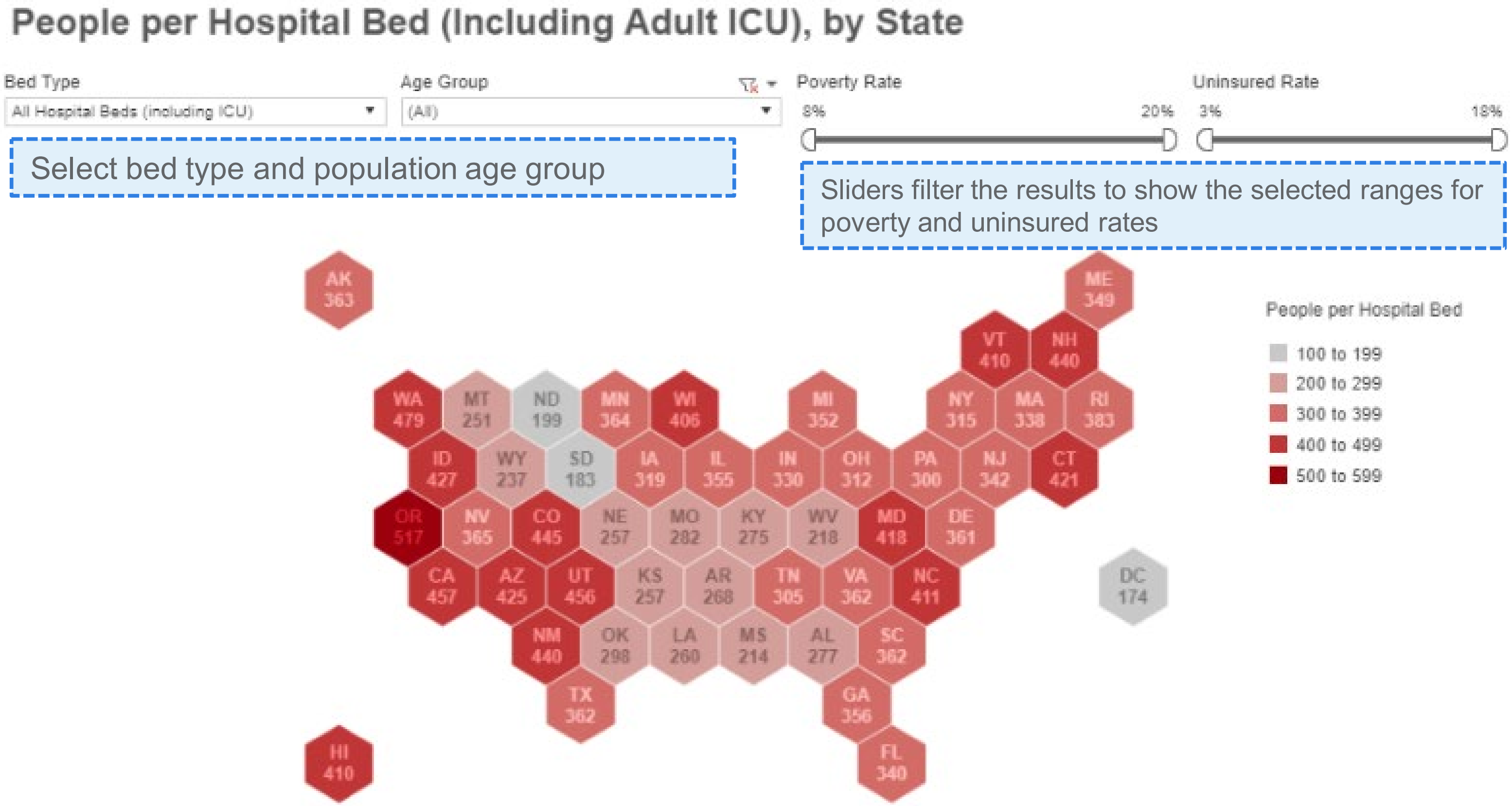
- Introductions
- Interactive poll
- Introduction to AHA’s Compendium of COVID-19 Models
- Demonstration of AHA’s capacity maps
- Description and discussion of two models
- Q & A

AHA Compendium of COVID-19 Models



https://www.aha.org/guidesreports/2020-04-09-compendium-models-predict-spread-covid-19

AHA Bed Capacity Maps



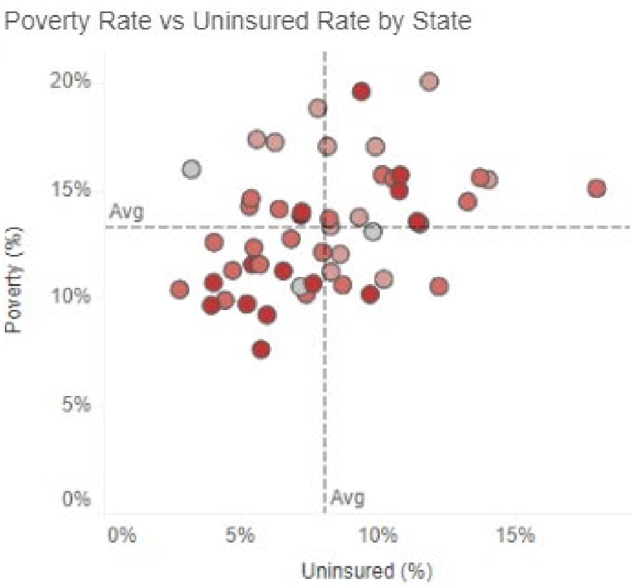
https://metricvu.aha.org/dashboard/covid-bed-shortage-detection-tool

AHA Bed Capacity Maps

Selected bed type, population group, and State(s) are reflected below

Selections are shown compared to uninsured and poverty rates

State	Total Population	Number of Hospital Beds	People per Hospital Bed
Oregon	4,081,943	7,900	517
Washington	7,294,336	15,235	479
California	39,148,760	85,604	457
Utah	3,045,350	6,683	456
Colorado	5,531,141	12,438	445
New Hampshire	1,343,622	3,052	440
New Mexico	2,092,434	4,756	440
Idaho	1,687,809	3,951	427
Arizona	6,946,685	16,342	425
Connecticut	3,581,504	8,501	421
Maryland	6,003,435	14,350	418
North Carolina	10,155,624	24,713	411
Hawaii	1,422,029	3,467	410

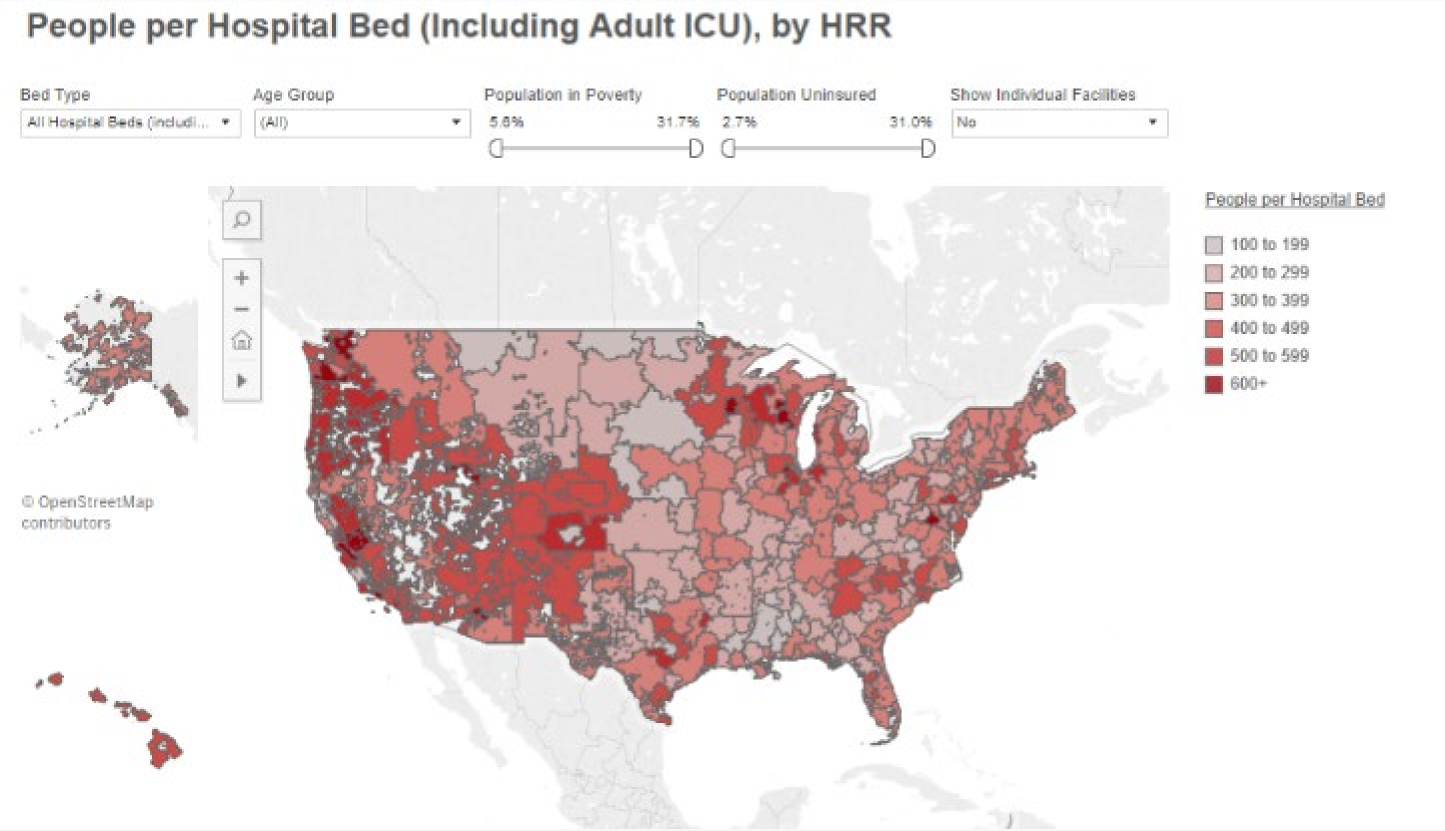


AHA Bed Capacity Maps

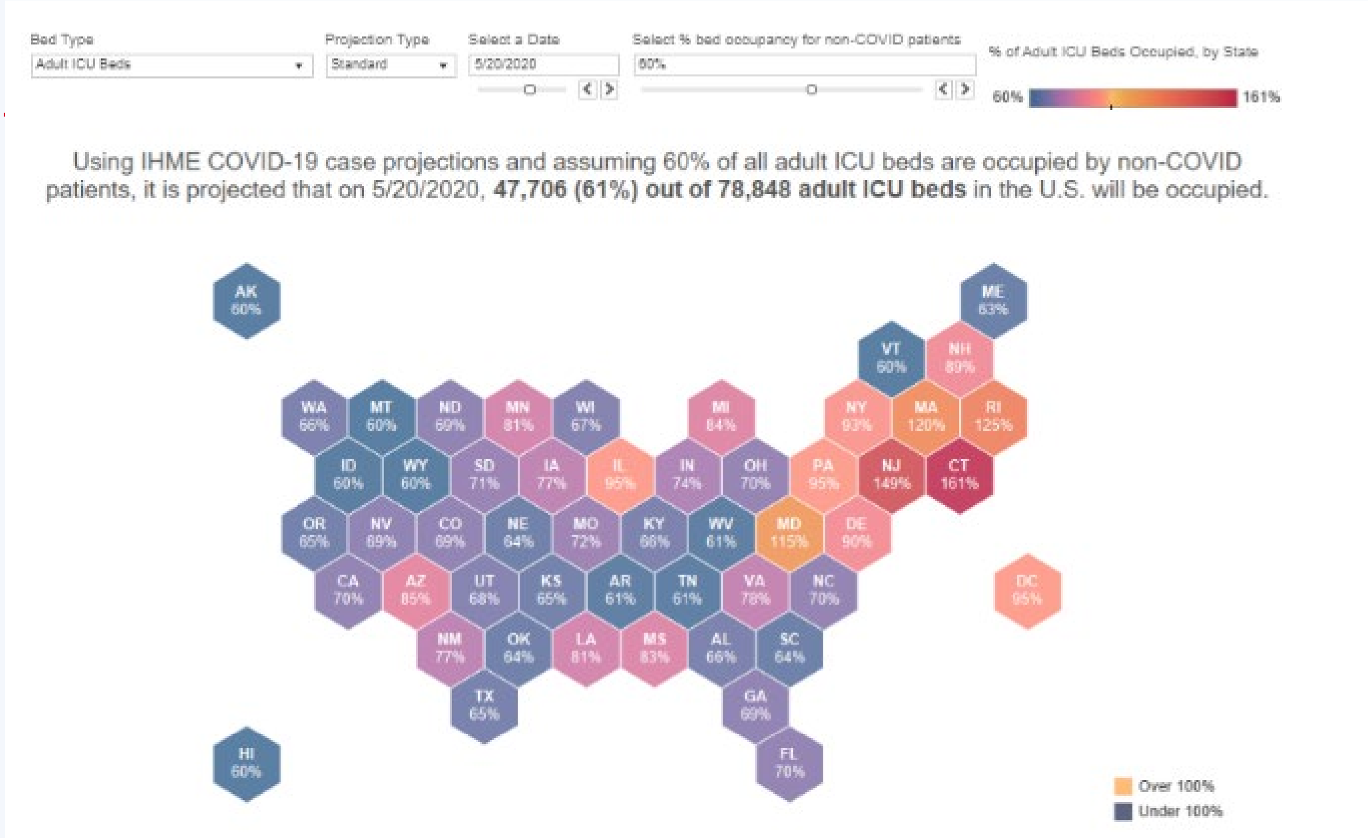
Hospital service areas (HSAs) are local health care markets for hospital care. An HSA is a collection of ZIP codes whose residents receive most of their hospitalizations from the hospitals in that area. HSAs are defined by assigning ZIP codes to the hospital area where the greatest proportion of their Medicare residents were hospitalized. Minor adjustments are made to ensure geographic contiguity. Most HSAs contain only one hospital. The process results in 3,436 HSAs.

Hospital referral regions (HRRs) represent regional health care markets for tertiary medical care. Each HRR contains at least one hospital that performs major cardiovascular procedures and neurosurgery. HRRs are defined by assigning HSAs to the region where the greatest proportion of major cardiovascular procedures were performed, with minor modifications to achieve geographic contiguity, a minimum population size of 120,000, and a high localization index. The process results in 306 hospital referral regions.

AHA Bed Capacity Maps

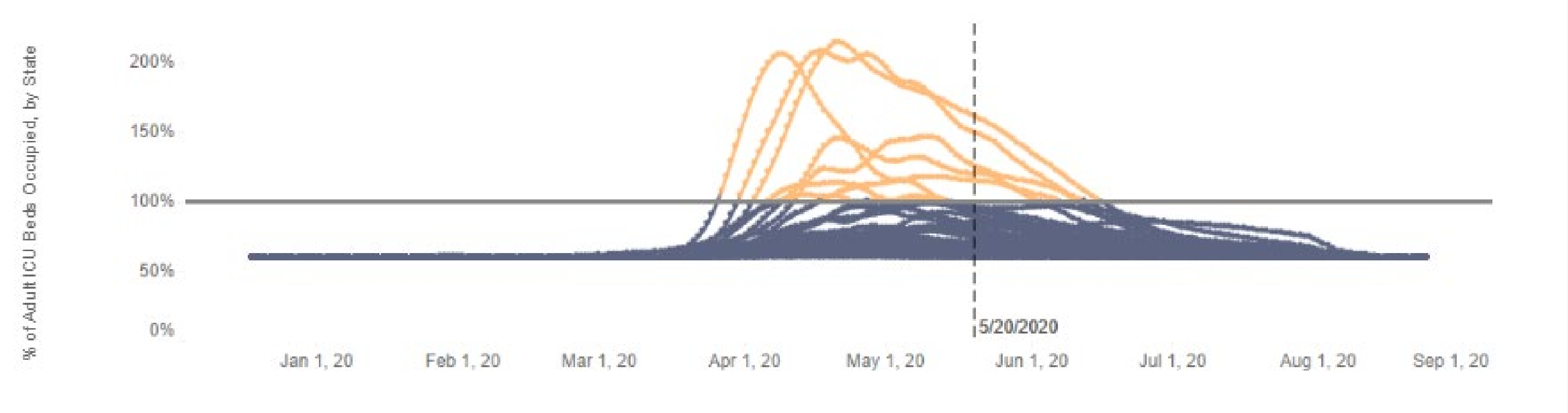


AHA COVID-19 Bed Occupancy Projection Tool



Select bed type, projection scenario, projected date, and percentage of beds committed for non-COVID care.

AHA COVID-19 Bed Occupancy Projection Tool

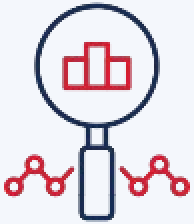


Selections on bed type, scenario and occupancy are reflected in the curve below

A ~~Walk~~Run-through of Two COVID-19 Models

Disclaimers

This presentation is an illustration of the use of two models, not about the theory behind the models



The models cited in this presentation are not necessarily a representative sample of existing COVID-19 models

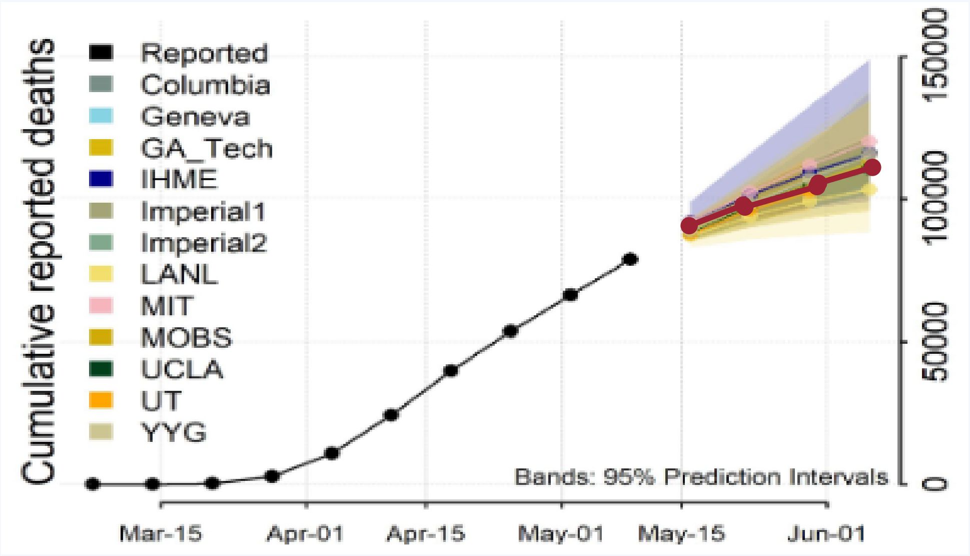
I am a statistician, not an epidemiologist

The COVID-19 Pandemic

There are so (too?) many COVID-19 models

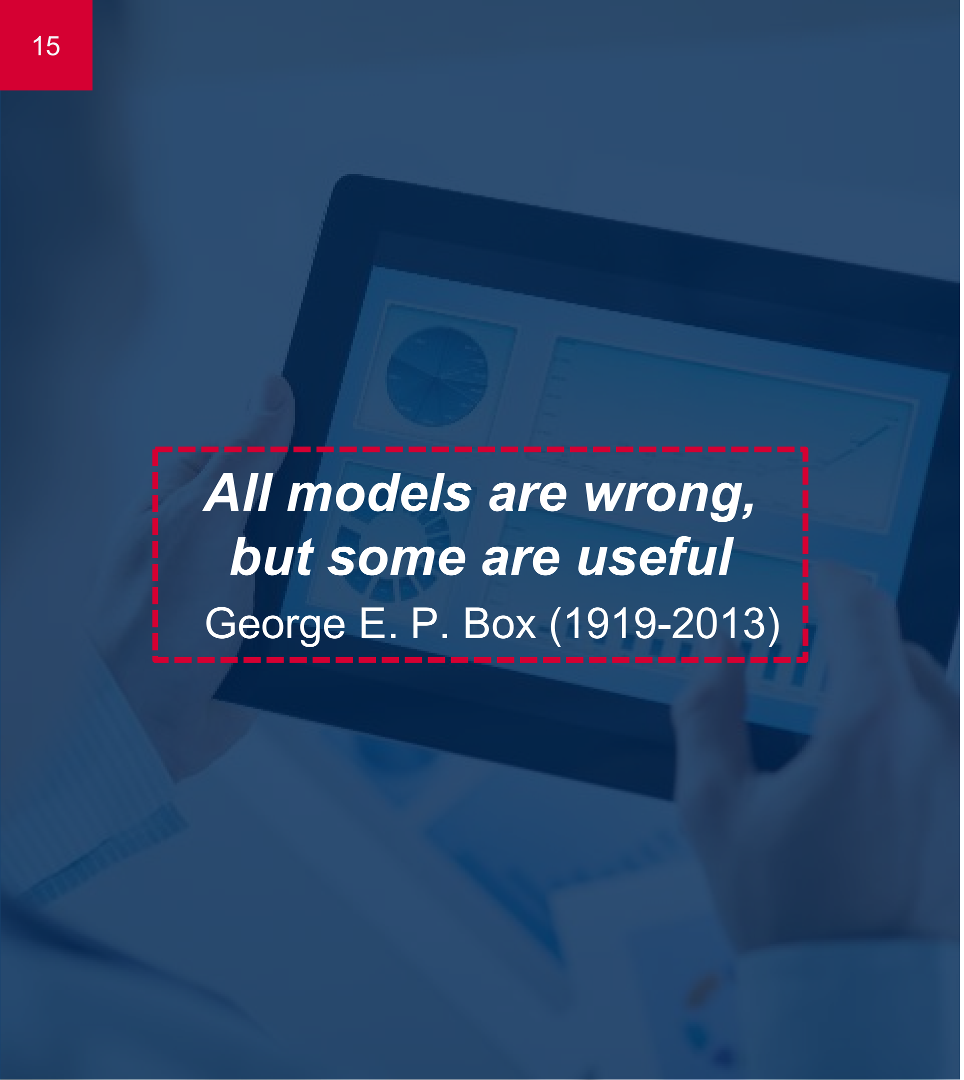
- There is even an **"ensemble model"** that combines predictions from different models by using averages
- Currently, includes predictions for only the **cumulative number of deaths** at the national and state levels

National Forecast (as of May 12)
Over 100K Deaths by June 1st
Actual Deaths as of May 16: 87, 315



Ensemble model

Sources:
- https://reichlab.io/covid19-forecast-hub/
- https://www.cdc.gov/coronavirus/2019-ncov/covid-data/forecasting-us.html



All models are wrong, but some are useful

George E. P. Box (1919-2013)

Which model(s) to use?

A model's predictions:

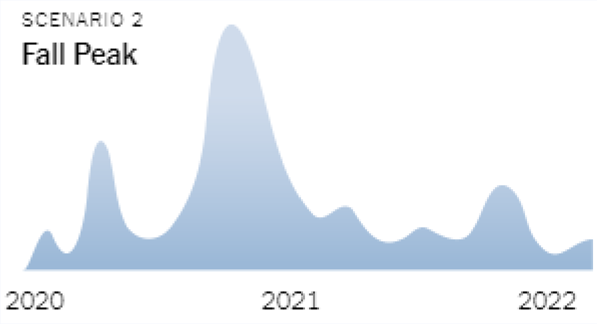
- Are simply educated guesses, not snapshots of the future
- Are only as good as the assumptions they are based on
- Are only as good as the input data
- Tend to be the less reliable (have greater uncertainty) the further out they are into the future

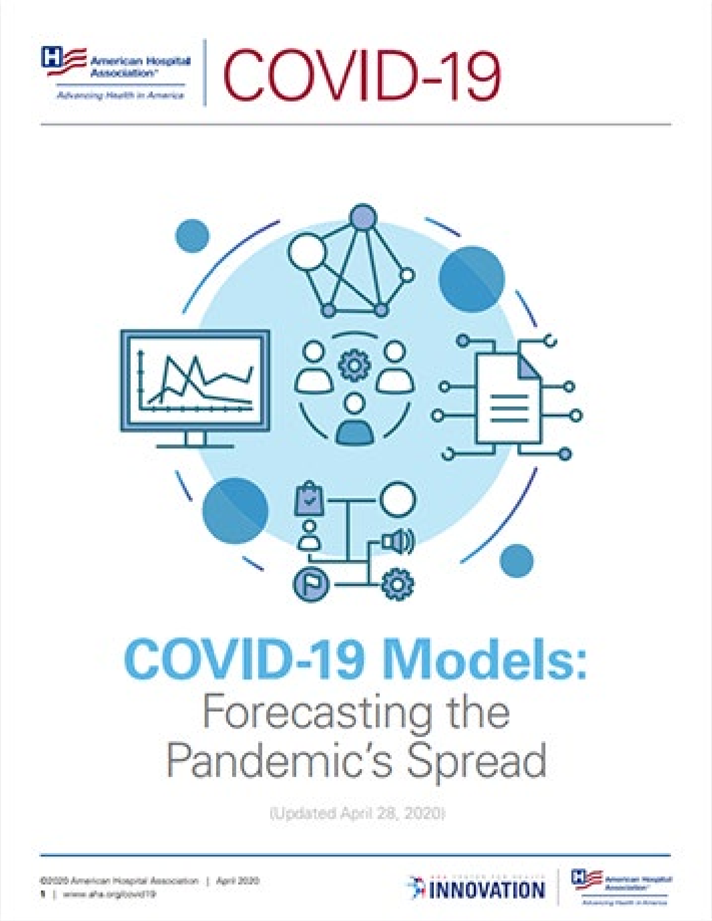
Which models are useful?
Some considerations

- Goals (Output):
  - What do you want to predict?
  - Number of cases, deaths, resource use (e.g., beds, ventilators)
  - At which level?
  - Country, state, hospital referral region (HRR), county, specific hospital(s)
- Personal preference:
  - Simplicity
  - Input parameters
  - Ability to change scenarios
- Model:
  - What factors does it take into account?
  - Is it evolving/learning over time?

AHA Compendium of COVID-19 Models

- Focuses on nine (external) **case mapping and projection tools** that predict and compare resource demands to capacity
- These tools are not necessarily better than other models but are **useful for planning hospital resources**





https://www.nytimes.com/2020/05/08/health/coronavirus-pandemic-curve-scenarios.html

https://www.aha.org/guidesreports/2020-04-09-compendium-models-predict-spread-covid-19

The AHA Compendium of Models: A Summary

Case Projection And Capacity Planning Models	Model Type	Estimation level	C.I.	Social Distancing	Mobility	Output table
1. UW-IHME — COVID-19 Forecasting Tool	Hybrid*	State	Yes	Yes	Yes	Yes
2. Harvard University — Regional Hospital Capacity Calculator	Formula-based**	HRR	N/A	No	No	Yes
3. Qventus — Localized COVID-19 Model and Scenario Planner	SEIR	HRR; System; Hospital	No	Yes	No	Yes
4. Penn Medicine — CHIME:COVID-19 Hospital Impact Model for Epidemics	SIR	State; System; Hospital	No	Yes	No	Yes
6. Health Catalyst — Capacity Planning Tool	SIR	County, Hospital	No	Yes	No	Yes
7. Cleveland Clinic — Hospital Impact Modeling	SEIR	Hospital	No	Yes	No	Yes
5. Rush University — Hospital Resource Calculator for COVID-19	5 models including SEIR	Hospital	No	Yes	No	Yes
8. Stanford Medicine — COVID-19 ICU and Floor Projections	Formula-based**	Hospital	N/A	No	No	Yes
9. RAND Corporation — Critical Care Surge Response Tools	Formula-based**	Hospital	N/A	No	No	Yes

*A combination of disease transmission model and statistical (curve-fitting) models

**Outputs are calculated using formulas instead of mechanistic/statistical models.

Two Illustrative Models

IHME Model

- By the *Institute of Health Metrics and Evaluation (IHME)* at U of Washington
- Dubbed as the "White House model"
- Has been widely cited, and also criticized because it didn't model epidemiological factors such as disease transmission and incubation period
- Has since been modified to address these criticisms

Qventus Model

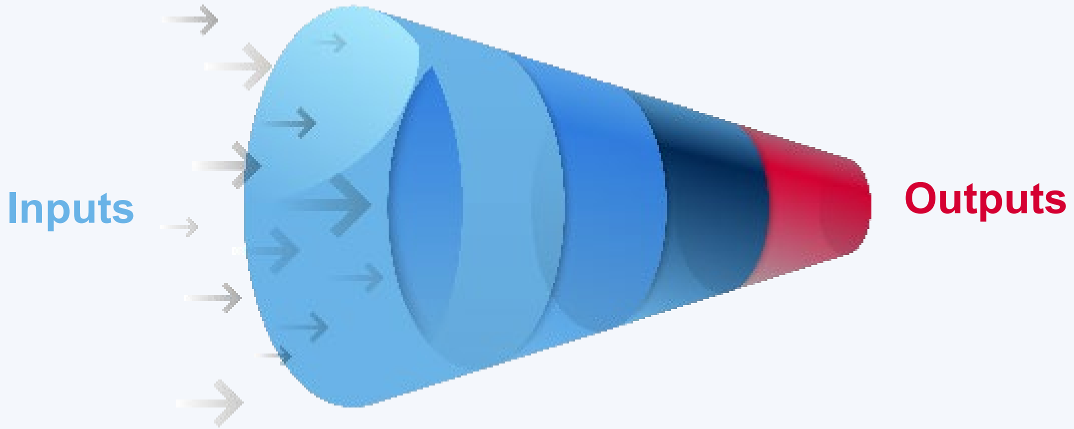
- Developed by *Qventus* (https://qventus.com) – provides a platform that "incorporates artificial intelligence, behavioral science, and data science to deliver a close-loop system for automating patient flow"

Two Illustrative Models

IHME Model	Qventus Model
○ State level	○ Hospital(s) level
○ Simple to use	○ Needs more user input

IHME Model

IHME Model



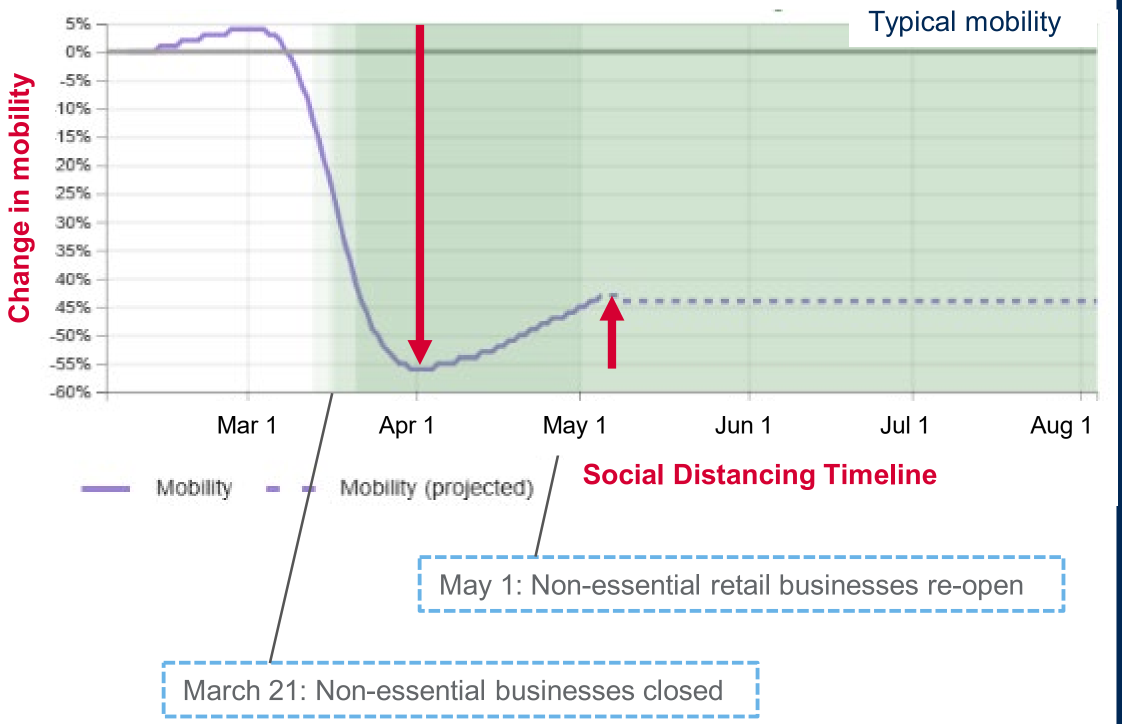
Only requires selecting the country or state from a drop-down menu for country or state

Country or state level:

- Percent change in mobility as a function of when social distancing was implemented and/or lifted
- Daily infection and testing
- Daily deaths
- Cumulative deaths
- Daily resource use: all beds, ICU beds, ventilators

IHME Model Output 1:
Illinois Predicted Change in Mobility*

- Mobility **decreases** with social distancing
- A 55% drop in mobility on Apr 1st
- A 10% increase in mobility following easing of stay-at-home restrictions

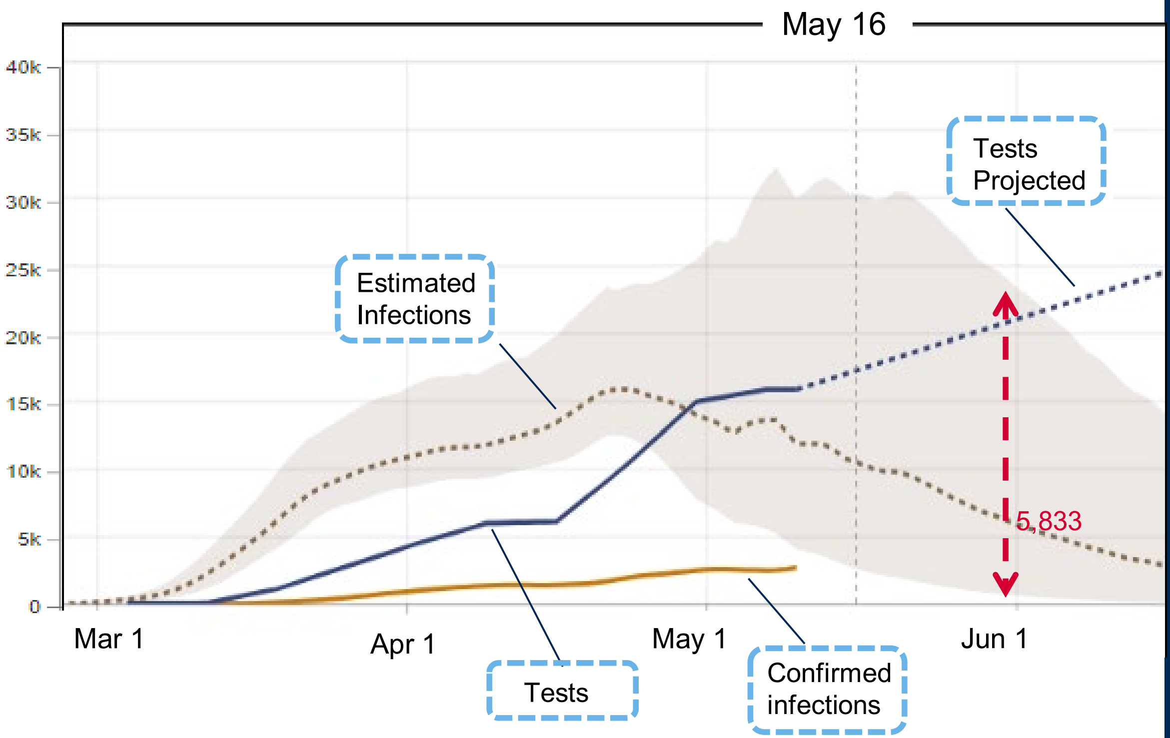


*As of May 16, 2020
Source: https://covid19.healthdata.org/united-states-of-america/illinois

IHME Model Output 2:
Illinois Predicted Daily Infections and Testing*

Graph shows

- Predicted infections:
  - Are much higher than the confirmed infections up to May 10
  - Have wide confidence intervals (shaded region)
  - Ex.: Predicted infections on June 1st is between 623 and 23,325!
- Daily tests:
  - Predicted to go up to 25K by mid-June

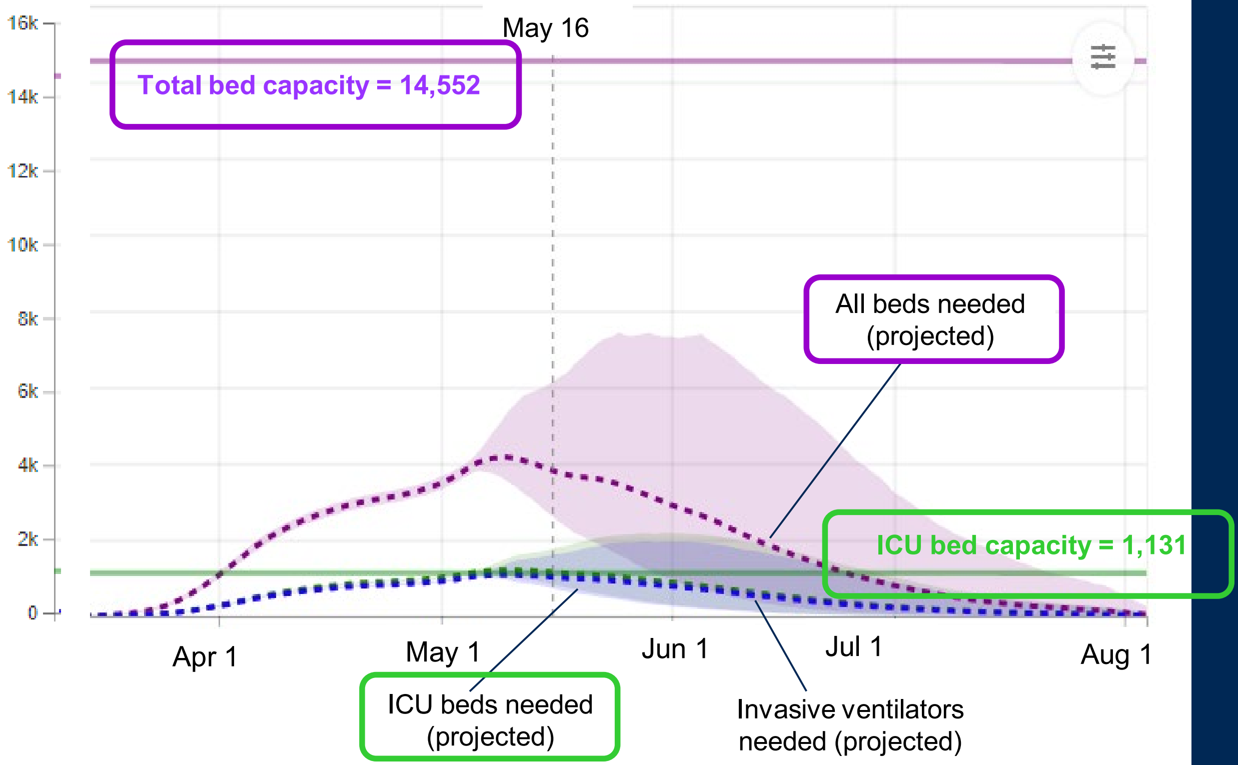


*As of May 16
Source: https://covid19.healthdata.org/united-states-of-america/illinois

IHME Model Output 3:
Illinois Predicted Resource Demand*

Output #5:

- Total beds:
  - Predicted demand is below bed capacity (~15K) throughout the whole period
- ICU beds:
  - Predicted demand will not exceed total ICU bed capacity (~1.1K beds)

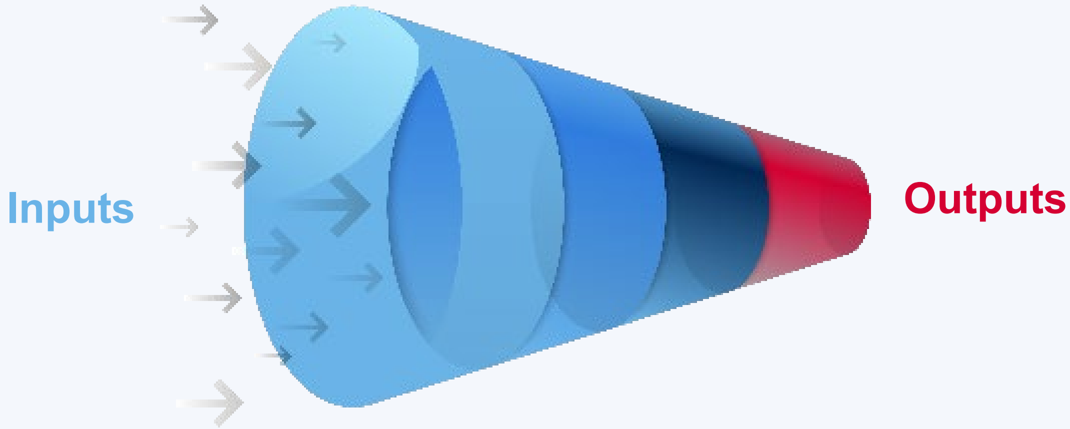


*As of May 16

Source: https://covid19.healthdata.org/united-states-of-america/illinois

Qventus Model

Qventus Model



- Select hospital
- Enter:
  - PANDEMIC RESPONSE & SOCIAL DISTANCING
  - MARKET
  - HOSPITAL ASSUMPTIONS
  - COVID-19 ASSUMPTIONS

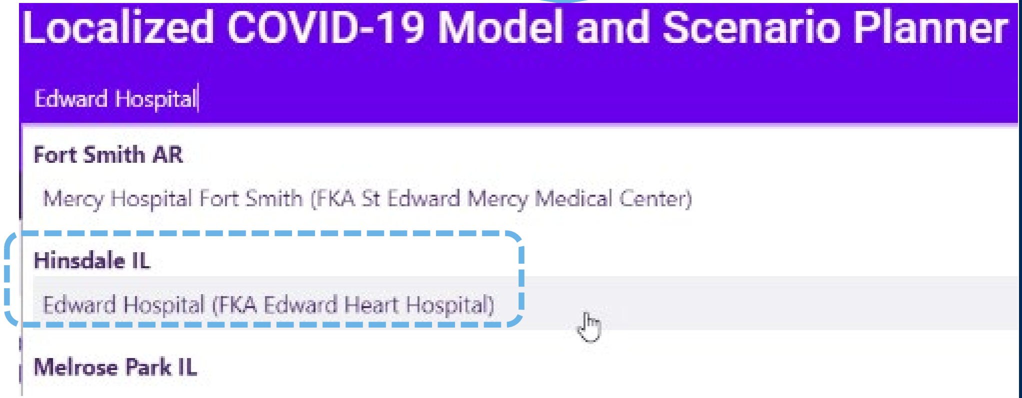
Hospital(s) or HRR level:

- Total new COVID-19 admits in the next 7 days (Med-Surg, ICU, ICU+Ventilator)
- Days remaining until capacity is reached (Med-Surg, ICU, ICU+Ventilator)
- Total deaths over the next 45 days
- Daily resource use: Med-Surg, ICU, ventilator:
- Daily PPE and PPE nursing shifts

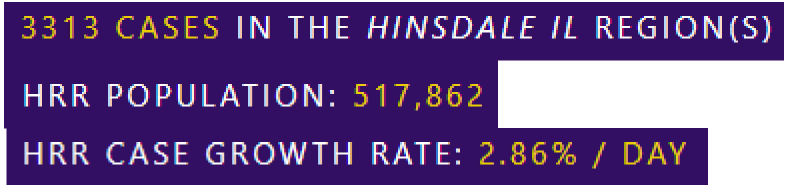
Qventus Model: Selecting Hospital

Hospital drop-down menu

- **Select hospital** from the drop-down menu:
  - Edward Hospital in Naperville, IL
  - HRR #133: Hinsdale, IL



- Model pre-populates the **HRR parameters:**
  - Number of cases: 3,247
  - Population size: 517,862
  - Case growth rate: 2.92% per day

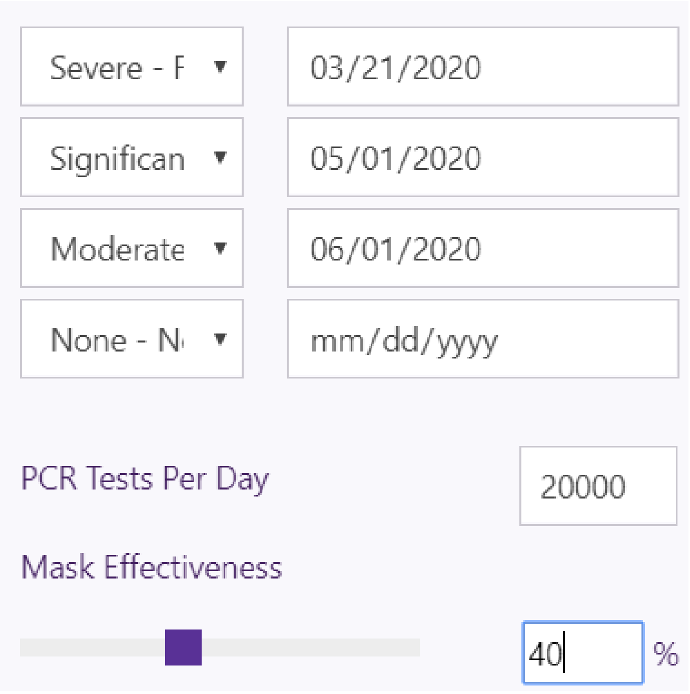


Source: https://covid19.qventus.com/modeling/hospitals

Qventus Model: Social Distancing, PCR Testing & Mask Inputs
Edward Hospital, HRR 133

Enter:

a. **Social distancing dates**
b. PCR tests per day
c. Mask effectiveness



Note: Based on Illinois data (not data specific to HRR)

Sources:
Illinois Department of Public Health
https://www.dph.illinois.gov/covid19/covid19-statistics
Illinois Policy Organization
https://www.illinoispolicy.org/what-you-need-to-know-about-coronavirus-in-illinois/

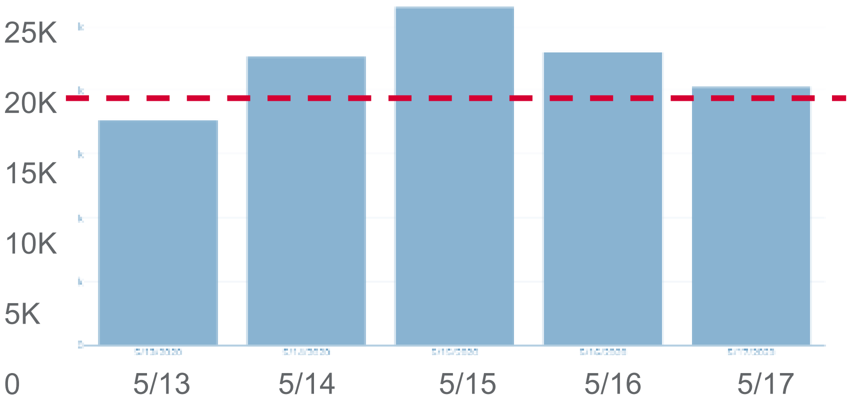
Qventus Model: Testing Input
Edward Hospital, HRR 133

Source for PCR testing data

Illinois Department of Public Health
https://www.dph.illinois.gov/covid19/covid19-statistics

Note: Based on Illinois data (not data specific to HRR)

Daily tests over the past five days (as of 5/17)



PCR Tests Per Day 20,000

Qventus Model: Mask Input Edward Hospital, HRR 133
Calculating Mask Effectiveness

Starting May 1, Illinois residents were ordered to wear masks when in public

Mask Effectiveness =

(% of the population wearing masks) X

(% reduction in the likelihood of an infected person infecting others because of the mask)

= 50% X 80%

= 40%

Source:
Illinois Policy Organization https://www.illinoispolicy.org/what-you-need-to-know-about-coronavirus-in-illino

Qventus Model: Market Inputs
Edward Hospital, HRR 133

Enter:

a. HRR known cases
b. HRR population
c. Market share (%) = $\dfrac{\mathit{Hospital\ bed\ capacity}}{\mathit{HRR\ bed\ capacity}}$

Note: Pre-populated for the selected HRR

⊕ MARKET

Known Cases	3247
Population	517862
Market share (%)	36.6

Qventus Model: Hospital Inputs
Edward Hospital, HRR 133

Enter: Hospital assumptions for Med-Surg, adult ICU, Vents*

a. Beds available
b. Additional surge capacity (optional)
c. Non-COVID occupancy
d. Current COVID patients (optional)

Bed Capacity and Current Patients

	Med-Surg	Adult ICU	Vents
Beds Available	273	25	25
Add'l Surge Capacity	0	0	0
Non-COVID Occ %	81.6	89.6	60
Current COVID Patients			

Note: Pre-populated for the selected hospital using data from Definitive Healthcare

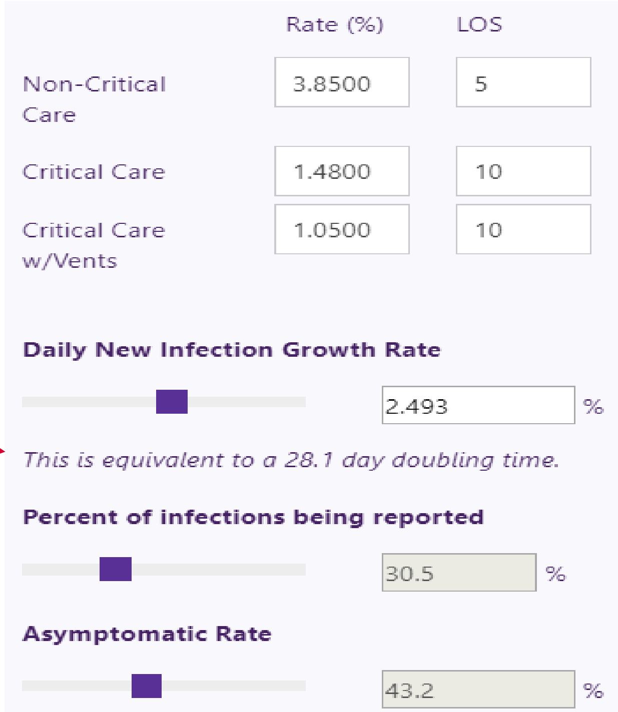
Qventus Model: COVID-19 Inputs
Edward Hospital, HRR 133

Enter: Level of Care and LOS*

a. Non-critical care (%)
b. Critical care (%)
c. Critical care with vents (%)
d. Daily new infection growth rate
e. Percent of infections being reported
f. Asymptomatic rate

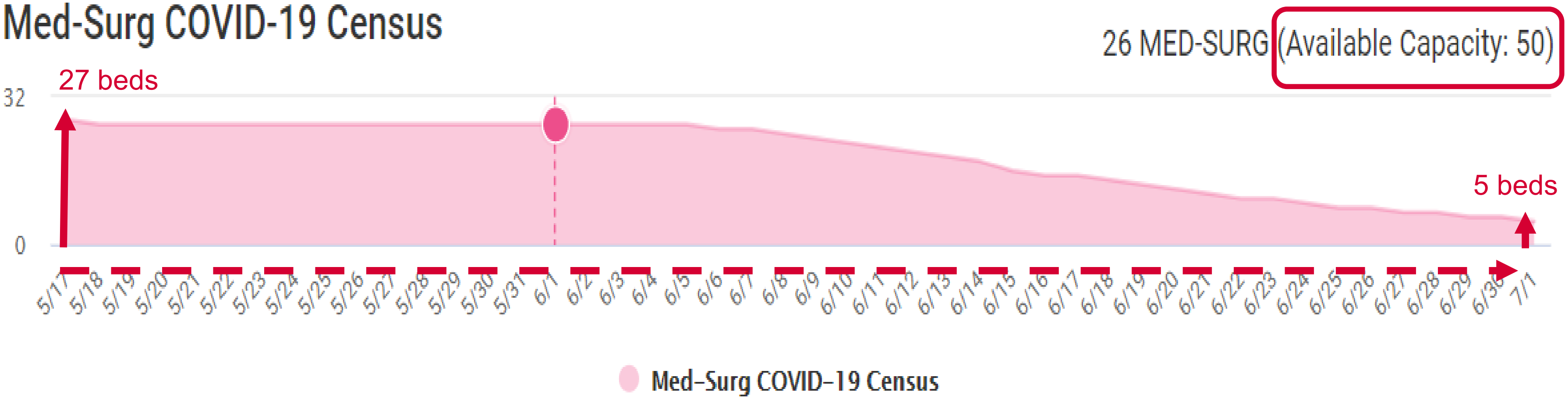
$$\text{Doubling Time} = \frac{\ln(2)}{\ln(1 + growth\, rate)} = \frac{\ln(2)}{\ln(1.02493)} = 28.1$$

***Note:** Pre-populated based on local age demographics, state reports, HCUP, recent literature, etc.



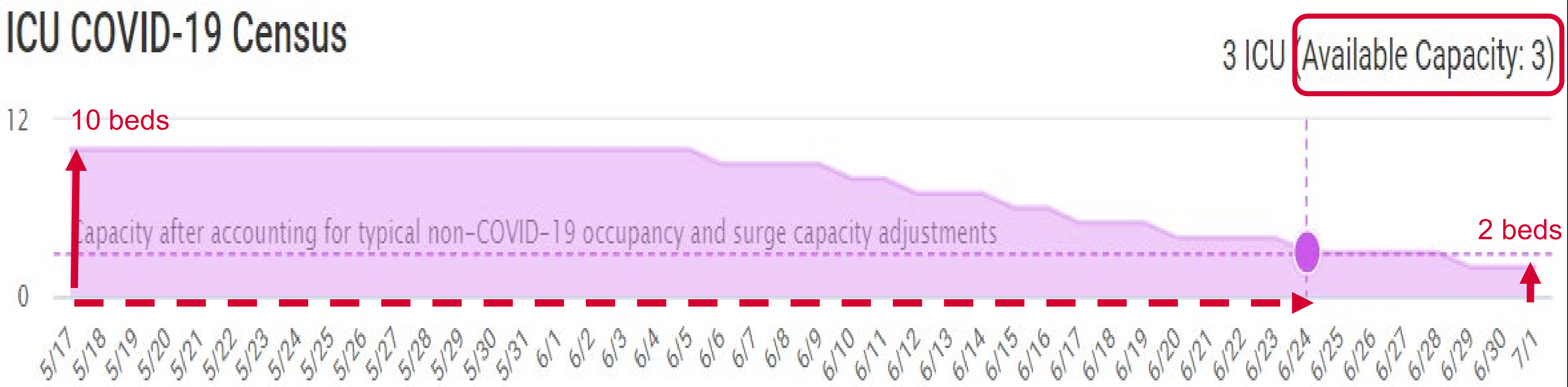
Qventus Model Output 1:
Predicted Med-Surg Beds (Edward Hospital, HRR 133)

- Edward's daily Med-Surg bed demand are predicted to decrease within the next 45 days (from 27 beds on 5/17 to 5 beds on 7/1).
- The demand throughout the period is below the 50 beds available for COVID-19 patients at Edward Hospital



Qventus Model Output 2:
Predicted ICU Beds (Edward Hospital, HRR 133)

- Edward's daily ICU bed demand are predicted to decrease within the next 45 days (from 10 beds on 5/17 to 2 beds on 7/1)
- But with only 3 ICU beds available for non-COVID patients, Edward Hospital is predicted to be short of ICU beds from 5/17 up to 6/24.



Concluding Thoughts

Some models are useful but…

- Be clear about your goals
- Simplicity is convenient, but context matters
- Models, data and assumptions are changing over time
- Predictions (whether presented as such or not) are not merely points. They are intervals.
- Be humble. Nobody really knows what is going to happen!

Thank you!

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Questions?