Using UPenn COVID-19 Hospital Impact Model for Epidemics (C.H.I.M.E.)

Source: https://penn-chime.phl.io/

UPenn C.H.I.M.E. MODEL v1.1.3

What is it? Penn Medicine developed and released an open-source tool to help hospitals plan for patient increases and intake during the COVID-19 spread

How does it work? The tool, called CHIME, or COVID-19 Hospital Impact Model for Epidemics, uses S-I-R (Susceptible-Infected-Recovered) modeling, which computes the theoretical number of people infected with a contagious illness in a closed population over time to project outcomes. It's currently set up to help Penn's and other health systems' operations leaders with projects of how many patients will need hospitalization, ICU beds and mechanical ventilation. The epidemic proceeds via a growth and decline process. This is the core model of infectious disease spread and has been in use in epidemiology for many years.

Rationale for Use: CHIME allows hospitals to enter information about their population and modify assumptions around the spread and behavior of COVID-19. It then runs a standard SIR model to project the number of new hospital admissions each day, along with the daily hospital census. These projections can then be used to create best- and worst-case scenarios to assist with capacity planning.

Default parameters in the model can be customized not only for the at-risk population in question, but also can be adjusted for "real world vs. model" ranges including current hospitalized patients and assumptions around doubling time, social distancing mitigation, hospitalization %, ICU %, ventilation %. The tool may be used to help inform readiness responses and mitigation strategies.

Updates are rolled out by Penn Medicine and community as U.S. spread progresses.

Key outputs for Capacity Planning
- Projected number of new admissions for COVID-19 per day, including new patients requiring hospitalization, new patients requiring intensive care, and new patients requiring ventilation
- Census of COVID-19 Patients, including hospital census, ICU census, and Ventilator census accounting for length of stay and recovery time

COVID-19 Hospital Impact Model for Epidemics (CHIME)

Documentation | Github | Slack

This tool was developed by the Predictive Healthcare team at Penn Medicine to assist hospitals and public health officials with hospital capacity planning.

Notice: *There is a high degree of uncertainty about the details of COVID-19 infection, transmission, and the effectiveness of social distancing measures. Long-term projections made using this simplified model of outbreak progression should be treated with extreme caution.*

The estimated number of currently infected individuals is **20128**. This is based on current inputs for Hospitalizations (**69**), Hospitalization rate (**2%**), Region size (**3600000**), and Hospital market share (**15%**).

An initial doubling time of **4.0** days and a recovery time of **14** days imply an R_0 of **3.65** and daily growth rate of **18.92%**.

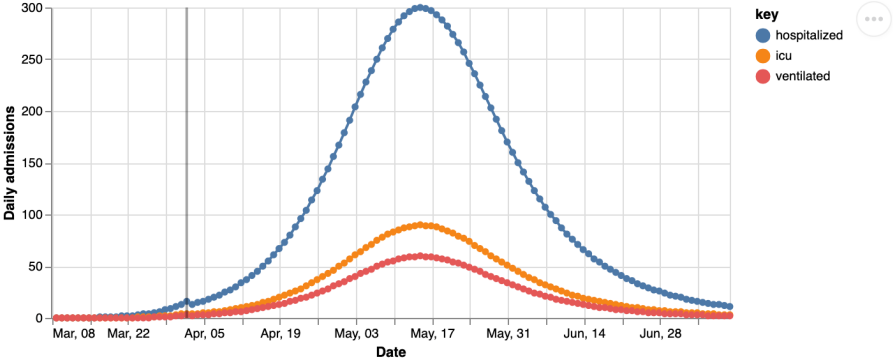**Mitigation**: A **30%** reduction in social contact after the onset of the outbreak **reduces the doubling time to 6.6** days, implying an effective R_t of 2.55 and daily growth rate of **11.10%**.

☐ Show more info about this tool

New Admissions

Projected number of **daily** COVID-19 admissions.

NOTE: Now including estimates of prior admissions for comparison.

UPenn COVID-19 Hospital Impact Model for Epidemics (C.H.I.M.E.) v1.1.3
Projected Daily Inpatient Load (Census)
Projected census of COVID-19 inpatients, accounting for arrivals and discharges

Actuals as of: **14 Apr 2020**
CHIME Projections Report Date: **15 Apr 2020**

Anywhere

Initial Doubling Time between successive generations

6.0 days — Low Hypothetical Rate

Social Distancing at 40%	
R0	2.71
Rt	1.63
Effective Doubling Rate (Days)	15.78

Social Distancing at 50%	
R0	2.71
Rt	1.36
Effective Doubling Rate (Days)	27.51

Social Distancing at 60%	
R0	2.71
Rt	1.09
Effective Doubling Rate (Days)	113.46

MedSurg Peak: 698 on 13-Sep
ICU Peak: 358 on 14-Sep
Ventilated Peak: 358 on 14-Sep

Currently Hospitalized COVID-19 Patients	Inpatient Precautionary Patients	Inpatient Positive
5	1	4

Social Contact Reduction	Days to Peak	Days to MedSurg Capacity	Days to ICU Capacity
40%	151	-13 (02-Apr)	-13 (02-Apr)
50%	-	-13 (02-Apr)	-13 (02-Apr)
60%	-	-13 (02-Apr)	-13 (02-Apr)

Legend:
- MedSurg (40% reduction in social contact)
- ICU (40% reduction in social contact)
- Ventilated (40% reduction in social contact)
- MedSurg (50% reduction in social contact)
- ICU (50% reduction in social contact)
- Ventilated (50% reduction in social contact)
- MedSurg (60% reduction in social contact)
- ICU (60% reduction in social contact)
- Ventilated (60% reduction in social contact)

Initial Doubling Time between successive generations

3.0 days — High Hypothetical Rate

Social Distancing at 40%	
R0	4.64
Rt	2.78
Effective Doubling Rate (Days)	5.78

Social Distancing at 50%	
R0	4.64
Rt	2.32
Effective Doubling Rate (Days)	7.70

Social Distancing at 60%	
R0	4.64
Rt	1.86
Effective Doubling Rate (Days)	11.69

MedSurg Peak: 2,707 on 20-Jun
MedSurg Peak: 1,882 on 07-Jul
ICU Peak: 1,379 on 21-Jun
Ventilated Peak: 1,372 on 21-Jun
ICU Peak: 962 on 08-Jul
Ventilated Peak: 959 on 09-Jul
MedSurg Peak: 1,073 on 12-Aug
ICU Peak: 550 on 14-Aug
Ventilated Peak: 550 on 14-Aug

Currently Hospitalized COVID-19 Patients	Inpatient Precautionary Patients	Inpatient Positive
5	1	4

Social Contact Reduction	Days to Peak	Days to MedSurg Capacity	Days to ICU Capacity
40%	66	-12 (03-Apr)	-11 (04-Apr)
50%	83	-13 (02-Apr)	-13 (02-Apr)
60%	119	-13 (02-Apr)	-13 (02-Apr)

Legend:
- MedSurg (40% reduction in social contact)
- ICU (40% reduction in social contact)
- Ventilated (40% reduction in social contact)
- MedSurg (50% reduction in social contact)
- ICU (50% reduction in social contact)
- Ventilated (50% reduction in social contact)
- MedSurg (60% reduction in social contact)
- ICU (60% reduction in social contact)
- Ventilated (60% reduction in social contact)

Parameter	Value	Parameter	Value	Parameter	Value
Scenario ID	here	Currently Hospitalized COVID-19 Patients (>= 0)	4	Currently Precautionary Hospitalized Patients (>= 0)	1
Doubling Time (low)	6.0000	Doubling Time (observed)	4.2100	Doubling Time (high)	3.0000
Infectious days	14.0000	Market Share	1.0000	Social Distancing Reduction Rate: 0.0 - 1.0	0.4000
Social Distancing Reduction Rate (0): 0.0 - 1.0	0.5000	Social Distancing Reduction Rate (1): 0.0 - 1.0	0.6000	Population	300,000
Hospitalized Rate: 0.00001 - 1.0	0.0500	Average Hospital Length of Stay (days)	7	ICU Rate: 0.0 - 1.0	0.0200
Average Days in ICU	9	Ventilated Rate: 0.0 - 1.0	0.0180	Average Days on Ventilator	10
Date of First Hospitalization	13-Mar	Mitigation Start Date	30-Mar	Location Code	Anywhere
Start day for model output	None	MedSurg Capacity	0	ICU Capacity	0
Ventilator Capacity	0	Days to Project	200	Report Generated	04/15/2020 13:20:01
Actuals as of	04/14/2020	Data Key	Test		