

COVID-19 Modeling Toolbox

Version 5 - Updated 5/11/2020

Summary

The COVID-19 Modeling toolbox provides tools for ArcGIS Pro 2.3 or later to assist hospitals, cities and regions with intervention and resource planning during the COVID-19 pandemic. These tools provide estimates of daily new admissions, current inpatient hospitalizations (census), ICU admissions, and patients requiring ventilation. To estimate the outcomes of different COVID-19 scenarios and interventions, an analyst may explore using different parameters from a single tool or compare the outputs from the two tools. The [Capacity Analysis](#) configurable app can also be used to facilitate the comparison of the chosen scenarios.

CHIME Model v1.1.5

Version 4 - Updated 5/11/20

The CHIME Model tool is an implementation of Penn Medicine's [COVID-19 Hospital Impact Model for Epidemics](#) (CHIME). This uses a Susceptible, Infected, Recovered (SIR) epidemiological model. This model is driven by the number of hospitalized COVID-19 patients, a doubling time, and a social distancing metric along with other parameters. Unlike previous versions of the CHIME Model tool where the social distancing began on the start date, CHIME Model v1.1.5 provides the ability to specify the date when social distancing measures started to impact new cases of COVID-19.

COVID-19Surge (CDC)

Version 1 - Released 5/4/2020

The COVID-19Surge tool is an implementation of the Centers for Disease Control and Prevention's [COVID-19Surge](#) tool. This uses a compartmental Susceptible, Infected, Infectious, Convalescing, Recovered (or dead) (SIIRC) epidemiological model. This model is driven by the total number of COVID-19 cases on the start date of the model and 14 days earlier, the new infections per case (R_0) and one or multiple interventions (such as social distancing, shelter-in-place, lockdown or re-opening), along with other parameters. Multiple intervention strategies with different durations and levels of effectiveness can be provided over the course of the model.

Preparing Equivalent Inputs for the Tools

The CHIME Model and COVID-19Surge tools accept different parameters as input to the epidemiological models and differ in their formulation. In order to compare the outputs from the tools, it is important to ensure the inputs are equivalent. The following points should be considered when preparing data for both tools:

- The CHIME Model tool begins the SIR model using the **Number of Currently Hospitalized COVID-19 Patients**. However, the COVID-19Surge tool begins the SIIRC model with the **Total Number of Cases to Start Date** and the **Cases in the 14 Days Before Start Date**. If one of these pieces of information is missing, or in the case where the total number of cases is unknown due to lack of testing, the hospitalization rate can be used to estimate the number

of cases. For example, if there are 250 currently hospitalized cases, and the hospitalization rate is 5%, then the **Total Number of Cases to Start Date** is 5000.

- The CHIME Model tool parameter **ICU % (Total Infections)** is the percentage of total infections and the COVID-19Surge tool parameter **Average % of Admitted Cases Requiring ICU Care** is the percentage of admitted cases. For example, if the **Average % of Clinical Cases Admitted for Hospital Care** and **Average % of Admitted Cases Requiring ICU Care** are 5.5% and 20% respectively in COVID-19Surge, the equivalent **ICU % (Total Infections)** in CHIME will be 1.1% (5.5 times 20%).
- The CHIME Model tool parameter **Ventilated % (Total Infections)** is the percentage of total infections and the COVID-19Surge tool parameter **Average % of Cases in ICU Requiring Ventilators** is the percentage of ICU cases only. For example, if the **Average % of Clinical Cases Admitted for Hospital Care** and **Average % of Admitted Cases Requiring ICU Care**, and **Average % of Cases in ICU Requiring Ventilators** are 5.5%, 20% and 65% respectively in COVID-19Surge, the equivalent **Ventilated % (Total Infections)** in CHIME will be 0.72% (5.5 times 20% times 65%).
- The COVID-19Surge tool parameter **Average Downtime per Ventilator** allows you to account for durations where ventilators may be out of service either being decontaminated or transferred. The CHIME Model tool does not include ventilator downtime in its definition, so to achieve parity this should be set to 0 in the COVID-19Surge tool.
- The CHIME Model tool parameter **Doubling Time in Days (Up to Today)** impacts the rate of disease spread. In the COVID-19Surge tool, the parameter **New Infections Per Case (R0)** performs a similar role. It is not possible to easily convert between these, so the COVID-19Surge tool reports the median effective doubling time from the model in the **Summary Output Feature Class**, for use in the CHIME Model tool. The **New Infections Per Case (R0)** is now reported in the **Summary Output Feature Class** in CHIME v1.1.5 for use in COVID-19Surge tool.
- The CHIME Model tool parameter **Social Distancing %** is equivalent to the **Effectiveness of Interventions** parameter in the COVID-19Surge tool, assuming the specified social distancing level is 100% successful, and no other types of interventions are taking place throughout the model timespan.
- The CHIME Model tool parameter **Social Distancing % (Reduction in Social Contact Going Forward)** assumes that the intervention starts to impact new cases on the **Date of Social Distancing Measures Effect** provided in the tool and does not change for the entire model span. The **Intervention Policy** of the COVID-19Surge tool allows for multiple interventions to be entered, with varying **Start Date**, **End Date** and **Effectiveness of Interventions** parameters, where the **Start Date** is the date that the population began social distancing. To achieve parity, a single intervention should be applied in the COVID-19Surge tool with an earlier **Start Date** than the intervention **Date of Social Distancing Measures Effect** in CHIME to account for the incubation period.
- The CHIME Model tool parameter **Infectious Days** is equivalent to the **Contagious Period** parameter in the **Advanced Epidemiological Parameters** section in the COVID-19Surge tool. It should be noted that there are significant differences in the defaults for each of these parameters. The other **Advanced Epidemiological Parameters** do not exist in the CHIME Model tool.