State of Missouri regional COVID-19 hospitalized cases model

June 10th, 2020
Multiple data points inform Missouri’s COVID-19 response

- Syndromic surveillance
- Healthcare system capacity (bed, PPE, and staff availability)
- Testing
- COVID-19 cases and deaths
- Economic and social impact
- Insights from U.S. states, nationally, and other countries
- Evidence from scientific literature
- Mathematical disease modelling
Our model estimates possible outcomes based on currently available information

<table>
<thead>
<tr>
<th>What does the model tell us</th>
<th>What does it not tell us</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of plausible outcomes based on our current knowledge of COVID-19 in Missouri</td>
<td>What will happen in the future</td>
</tr>
<tr>
<td>Approximate date and magnitude of peak/s based on current understanding of policy interventions and human behavior and assumptions about future interventions</td>
<td>Date and magnitude of peak/s if there are major changes in planned policy interventions and human behavior</td>
</tr>
<tr>
<td>Approximate estimate of effective transmission rate across a region</td>
<td>Exact transmission rate in all parts of a region – there may be areas of higher and lower transmission within the region</td>
</tr>
<tr>
<td>Projected hospitalizations for regions in MO with sufficient data, i.e. Kansas City Area, Central, St. Louis Area, Southeast and Southwest</td>
<td>Projected hospitalizations in regions where daily COVID-19 hospitalizations are fewer than 15 because insufficient cases</td>
</tr>
</tbody>
</table>

The ability to forecast depends on the quality and availability of data. For a new disease such as COVID-19, much remains uncertain.
Projections are made for each Emergency Response region with sufficient data

- Low levels of daily COVID-19 hospitalizations in the Northeast and Northwest regions limit the ability to generate projections for these regions
  - Northeast: Average of 4 daily confirmed or suspected COVID hospitalizations from 3/26 to 6/1
  - Northwest: Average of 17 daily confirmed or suspected COVID hospitalizations from 3/26 to 6/1
- Projections are available for all other regions
Greater Kansas City area (Region A)

Overview
Population: 1,395,314
COVID-19 cases: 3,283
COVID-19 deaths: 71
ICU Bed Availability*: 241
Medical / Surgical Bed Availability*: 1,051

Reproductive rate
Pre-intervention: 2.77 ± 0.14
Today: 1.03 ± 0.12
Change from last week: ↑0.04

Projected COVID-19 hospitalizations

(*) Daily average during week of 5/26 – 6/1
Source: State of MO, MHA, WUSTL analysis; USA Facts; US Census Bureau
Greater St. Louis area (Region C)

Overview
Population: 2,229,518
COVID-19 cases: 8,590
COVID-19 deaths: 694
ICU Bed Availability*: 212
Medical / Surgical Bed Availability*: 1,062

Reproductive rate
Pre-intervention: 3.38 ± 0.15
Today: 0.87 ± 0.11
Change from last week: ↑0.09

Projected COVID-19 hospitalizations

Source: State of MO, MHA, WUSTL analysis; USA Facts; US Census Bureau

(*) Daily average during week of 5/26 – 6/1
Southwest / Springfield (Regions D,G, I)

Overview
Population: 1,221,847
COVID-19 cases: 513
COVID-19 deaths: 13
ICU Bed Availability*: 113
Medical / Surgical Bed Availability*: 430

Reproductive rate
Pre-intervention: \(2.33 \pm 0.17\)
Today: \(1.15 \pm 0.09\)
Change from last week: \(\downarrow0.01\)

(*) Daily average during week of 5/26 – 6/1
Note: Due to low levels of hospitalized COVID-19 cases, modelling projections are highly sensitive to slight shifts in observed data and must be interpreted with extra caution.
Source: State of MO, MHA, WUSTL analysis; USA Facts; US Census Bureau
Southeast / Cape Girardeau (Region E)

Overview
Population: 363,478
COVID-19 cases: 689
COVID-19 deaths: 27
ICU Bed Availability*: 48
Medical / Surgical Bed Availability*: 252

Reproductive rate
Pre-intervention: $2.61 \pm 0.15$
Today: $1.35 \pm 0.05$
Change from last week: ↑0.54

Projected COVID-19 hospitalizations

(*) Daily average during week of 5/26 – 6/1
Note: Due to low levels of hospitalized COVID-19 cases, modelling projections are highly sensitive to slight shifts in observed data and must be interpreted with extra caution.

Source: State of MO, MHA, WUSTL analysis; USA Facts; US Census Bureau
Central (Region F)

Overview
Population: 736,847
COVID-19 cases: 1,455
COVID-19 deaths: 12
ICU Bed Availability*: 74
Medical / Surgical Bed Availability*: 252

Reproductive rate
Pre-intervention: 2.26 ± 0.08
Today: 0.89 ± 0.12
Change from last week: ↑0.07

(*) Daily average during week of 5/26 – 6/1
Note: Due to low levels of hospitalized COVID-19 cases, modelling projections are highly sensitive to slight shifts in observed data and must be interpreted with extra caution.
Source: State of MO, MHA, WUSTL analysis
See FAQs for additional details


**DISEASE MODEL**

**Missouri’s Regional COVID-19 Hospitalized Cases Model:** Overview and Frequently Asked Questions

**Model Overview**

One of the many data analyses that inform Missouri’s COVID-19 response is a regional model of hospitalized COVID-19 cases that the State of Missouri developed in partnership with the Washington University in St. Louis and various hospital associations.

Missouri’s model uses a standard SIR (susceptible, exposed, infectious, recovered) compartmental structure that is based upon a tool called LEVIMA (Local Epidemiological ( Modeling for Management & Action), which was developed by experts from UMass Amherst, UC Berkeley, UCSF, and WUSTL. The model focuses on COVID-19 hospitalized cases to directly address the questions of hospital capacity and provide a more accurate picture of COVID-19’s impact on the healthcare system.

![Diagram of SIR model](https://health.mo.gov/living/healthcondiseases/communicable/novel-coronavirus/pdf/modeling-faqs060320.pdf)

To help inform decisions at the regional and local level, each region is modeled separately using the same local data, including COVID-19 confirmed and suspected hospitalizations, population, policy interventions, and average hospital length of stay.

**General FAQs**

**Why are regional models of COVID-19 important?**

When new diseases such as COVID-19 emerge, there is much uncertainty about how best to control the epidemic. Decision makers must make the best possible decisions with the available information at hand.

Mathematical models are commonly used to make projections of how infectious diseases might impact key outcomes such as hospitalized cases or deaths. Today, there are many sophisticated models of COVID-19 that make causal or natural projections (e.g., Imperial College, Harvard, ITH). However, these generally do not incorporate key local or regional inputs, such as variations in local population demographics, healthcare systems, and local hospital capacity.

Low levels of daily COVID-19 hospitalizations in the Northeast and Northwest regions limit the ability to generate projections for these regions. In particular, the numbers of hospitalized cases have been so low that
Appendix
Regional COVID-19 transmission models help inform local policy, public health, and business decisions

- Mathematical models are commonly used to make projections of infectious disease epidemics (e.g., tuberculosis, HIV)
- Many sophisticated models on COVID-19 make global or national projections (e.g., Imperial College, Harvard, IHME)
- However, these generally do not incorporate critical local or regional inputs, such as:
  - Variations in local population size and age structure
  - Date and nature of social distancing and other policies
- Regional projections are important because:
  - Regional epidemics may differ markedly from the national average
  - Policy response occurs at state, county, and municipal levels
State of MO, WUSTL, and MHA have developed a regional model of hospitalized COVID-19 cases

- **Standard SEIR model** that combines universal characteristics of COVID-19 infection (e.g., transmission parameters) with local inputs to support regional decision making
  - Mathematical model developed by experts from UMass Amherst, UC Berkeley, UCSF, and WUSTL
  - Uses a statistical approach that adjusts underlying parameters as new data are observed

- **Customized using the latest local data** from Missouri’s emergency response regions, including:
  - COVID-19 positives and PUIs
  - Population and age structure
  - Policy interventions
  - Avg. hospital length of stay

- **Projects COVID-19 hospitalized cases** to directly address the question of hospital capacity and provide a more accurate picture on COVID-19’s impact on the healthcare system

**Model Structure (SEIR)**

- Susceptible
- Exposed
- Infectious
- Removed
- Hospitalized
  - Floor
  - ICU
  - Vent