State of Missouri COVID-19 analytics update

June 3rd, 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
Syndromic surveillance: Total emergency department visits

Daily Total Emergency Department (ED) visits in Missouri ESSENCE, February 1, 2020 – May 28, 2020

Source: Missouri Department of Health and Senior Services
Syndromic surveillance: ILI as a percentage of Total emergency department visits

Missouri Percentage of Emergency Department (ED) Visits for Influenza-Like Illness (ILI) in ESSENCE Participating Hospitals (02/01/2020 – 05/28/2020)

ILI (% of ED visits)

Note: ILI is queried in ESSENCE using Influenza or (FeverPlus and (Cough or SoreThroat) and not NonILIFevers)

Source: Missouri Department of Health and Senior Services
Syndromic surveillance: COVID-like illness as a percentage of Total emergency department visits

Missouri Percentage of Emergency Department (ED) Visits for COVID-like Illness in ESSENCE Participating Hospitals (02/01/2020 – 05/28/2020)

COVID-like illness (% of ED visits)

Note: COVID-like illness is queried in ESSENCE using ^fever^, and, (^cough^, or, ^shortness of breath^, or, ^difficulty breathing^)

Source: Missouri Department of Health and Senior Services
Healthcare system data is analyzed by region

- Based on Missouri’s Highway Patrol Troop and Healthcare Coalition boundaries, historically used for healthcare preparedness and response planning

- Regions D, G, and I are combined into one Southwest region to reflect patient referral and EMS patterns, and their engagement with the Southwest Healthcare Coalition

- While Perry County and Ste. Genevieve County reside in Highway Patrol Troop C, their data is reported through the Southeast Region due to their engagement with the Southeast Healthcare Coalition
COVID-19 positive and PUI hospitalized cases by region

Note: # of hospitals reporting varies from day-to-day and may alter data on COVID-19 hospitalizations. Data from the most recent 72 hours are excluded because of variability in reporting from hospitals. Percentage decrease is calculated from the peak of 1,242 hospitalizations on April 7 through May 29. Data does not include COVID-19 hospitalizations on the KS side of the Kansas City metro.

Source: Missouri Hospital Association, National Healthcare Safety Network, WUSTL analysis
Medical and surgical bed availability by region

Note: # of hospitals reporting varies from day-to-day and may alter data on bed availability. Data does not include hospitals on the KS side of the Kansas City metro.

Source: Missouri Hospital Association
ICU bed availability by region

Note: # of hospitals reporting varies from day-to-day and may alter data on bed availability. Data includes all types of ICU beds (adult, pediatric, NICU, negative airflow). Data does not include hospitals on the KS side of the Kansas City metro.

Source: Missouri Hospital Association
A **PCR** test is a diagnostic test that looks for the viral RNA in the nose, throat, or other areas in the respiratory tract to determine if there is an active infection with SARS-CoV-2, the virus that causes COVID-19. A positive PCR test means that the person has an active COVID-19 infection.

A **Serology** test looks for antibodies against SARS-CoV-2 in the blood to determine if there has been an infection in the past. Antibodies are formed by the body to fight off infections. A positive antibody test means that the person was infected with COVID-19 in the past or recently, and that their immune system developed antibodies to try to fight it off.

Note: Antigen testing has recently been approved by the FDA. More details will follow when antigen testing becomes more widespread.

Source: Missouri Department of Health & Senior Services
COVID-19 testing: PCR testing volume and results, 7-day rolling average

# of tests conducted and results (rolling 7-day average)

Note: Due to reporting lags from some labs and for negative results, total testing volumes from the most recent 3-5 days often are underreported

Source: Missouri Department of Health and Senior Services
COVID-19 testing: PCR positivity rate

Average 7-day PCR testing results (% negative, % positive, % unknown)

Cumulative % positive: 6.76%

Source: Missouri Department of Health and Senior Services
COVID-19 testing: PCR test volume and % positivity by county

PCR tests conducted / 100k population: 3,885 tests

Positive tests (% of total): 6.76%

Source: Missouri Department of Health and Senior Services

Note: County of provider or county of lab is used for tests where the county of patient is not available, as per CDC recommendations.
COVID-19 testing: Weekly lab PCR testing volume

PCR Tests by Lab, by Week

Note: Data for the first week of June is incomplete
Source: Missouri Department of Health and Senior Services
COVID-19 testing: Age distribution of PCR test results and volume

Cumulative PCR testing volume and results by age group

Source: Missouri Department of Health and Senior Services
COVID-19 cases: Overview

COVID-19 cases in Missouri

Source: USA Facts database
COVID-19 cases: Missouri compared to other states (cases / 100k population)

COVID-19 cases by State -- days since 20th case (per 100k population)

Note: X-axis denotes days since 20th case in each State, so each State line may vary in length
Source: USA Facts database
COVID-19 cases: Cumulative by county

Total cases: 13,327

- 109 counties have 1 or more cases of COVID-19
- Total cases concentrated in St. Louis and Kansas City area
- Highest case count / 100k in Saline county (1,171), followed by Sullivan county (964), Buchanan county (800), and St. Louis City (604)

Source: USA Facts, State of Missouri analysis
COVID-19 cases: New case growth

Counties by 7-day % increase in COVID-19 cases

Counties by 7-day "rate of change" in COVID-19 cases

Note: This table reflects only Counties that have at least five confirmed COVID-19 cases

Note: This table reflects only Counties that have at least five confirmed COVID-19 cases

Note: The "7-day rate of change" reflects number of new cases in past 7 days relative to prior 7 days (8-14 days ago)

Source: USA Facts, State of Missouri analysis
COVID-19 deaths: Overview

COVID-19 deaths in Missouri

Source: USA Facts database
COVID-19 deaths: Missouri compared to other states (deaths / 100k population)

Note: X-axis denotes days since 10th confirmed COVID-19 death in each State, so each State line may vary in length

Source: USA Facts database
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.
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
Projections were 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 were made for all other regions
Greater Kansas City area (Region A)

**Overview**
Population: 1,395,314  
# of COVID-19 cases: 2,721  
# of COVID-19 deaths: 65  
ICU Bed Availability*: 241  
Medical / Surgical Bed Availability*: 1,051

**Reproductive rate**
Pre-intervention: 2.77 ± 0.14  
Today: 0.99 ± 0.13

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

**Overview**
Population: 2,229,518
# of COVID-19 cases: 8,117
# of COVID-19 deaths: 660
ICU Bed Availability*: 212
Medical / Surgical Bed Availability*: 1,062

**Reproductive rate**
Pre-intervention: $3.38 \pm 0.15$
Today: $0.78 \pm 0.10$

(*) Daily average during week of 5/26 – 6/1
Source: State of MO, MHA, WUSTL analysis
Southwest / Springfield (Regions D,G, I)

Overview
Population: 1,221,847
# of COVID-19 cases: 409
# of COVID-19 deaths: 13
ICU Bed Availability*: 113
Medical / Surgical Bed Availability*: 430

Reproductive rate
Pre-intervention: 2.33 ± 0.17
Today: 1.16 ± 0.10

(*) 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
Southeast / Cape Girardeau (Region E)

Overview
Population: 363,478
# of COVID-19 cases: 602
# of COVID-19 deaths: 24
ICU Bed Availability*: 48
Medical / Surgical Bed Availability*: 252

Reproductive rate
Pre-intervention: 2.61 ± 0.15
Today: 0.81 ± 0.03

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
Central (Region F)

**Overview**
Population: 736,847
# of COVID-19 cases: 453
# of COVID-19 deaths: 5
ICU Bed Availability*: 74
Medical / Surgical Bed Availability*: 252

**Reproductive rate**
Pre-intervention: $2.26 \pm 0.08$
Today: $0.81 \pm 0.11$

(*) 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
COVID-19 Regional Hospitalized Cases Model FAQs on DHSS website has further details

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 Missouri Hospital Association.

Missouri’s model uses a standard SIR (susceptible, exposed, infectious, recovered) compartmental structure that is based upon a tool called LEMMA (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 question of hospital capacity and provide a more accurate picture of COVID-19’s impact on the healthcare system.

To help inform decisions at the regional and local levels, each region is modeled separately using the latest 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 about how infectious diseases might impact key outcomes such as hospitalizations or deaths. Today, there are many sophisticated models of COVID-19 that make global or national projections (e.g., Imperial College, Harvard, IHME). However, these generally do not incorporate key local or regional inputs, such as variations in local population demographics, healthcare system capacity, or patient outcomes. In contrast, regional models can take into account local nuances such as individual hospital and facility capacities and local population demographics to more accurately project impacts at a smaller scale.
Guidance on interpreting analyses – Syndromic surveillance

Chart: Daily total emergency department visits
What it tells you: Daily emergency department visits for all conditions across the state over time
Why it’s important: Shows day to day surges in emergency department visits (driven by acute and cyclical demand) as well as larger trends in demand over time

Chart: Missouri Percentage of Emergency Department (ED) Visits for Influenza-like Illness
What it tells you: Daily emergency department visits for Influenza-like illnesses as a percent of total daily emergency department visits across the state over time (symptoms include “fever”, “cough”, or “sore throat”). COVID-19 infected patients may report such symptoms
Why it’s important: Shows how much of state-wide emergency department demand is being driven by Influenza-like illnesses

Chart: Missouri Percentage of Emergency Department (ED) Visits for COVID-like Illness
What it tells you: Daily emergency department visits for COVID-like illnesses as a percent of total daily emergency department visits across the state over time (symptoms include: “fever” and “cough” or “shortness of breath” or “difficulty breathing”)
Why it’s important: Shows how much of state-wide emergency department demand is being driven by COVID-19
Guidance on interpreting analyses – Healthcare system capacity

**Chart: COVID-19 positive and PUI hospitalized cases by region**
What it tells you: Shows daily confirmed and suspected COVID-19 hospitalizations over time; broken out by hospital region. Due to reporting lags, data from the most recent 24-48 hours often are underreported.
Why it’s important: Shows the demand placed on the hospital network by COVID-19 over time.

**Chart: Medical and surgical bed availability by region**
What it tells you: Shows medical and surgical bed availability across the state over seven day periods; broken out by hospital region.
Why it’s important: Gives insight into localized hospital resources across the state and how they have changed over time.

**Chart: ICU bed availability by region**
What it tells you: Shows ICU bed availability across the state over seven day periods; broken out by hospital region.
Why it’s important: Gives insight into localized hospital resources across the state and how they have changed over time.
Guidance on interpreting analyses – Testing (1/2)

Chart: Cumulative test volume and results by test type
What it tells you: Shows overall testing volume and results by test type. Reports separately volumes for antigen testing, PCR testing, and serological testing
Why it’s important: Shows volume of each of the primary types of COVID-19 testing in Missouri

Chart: PCR testing volume and results, 7-day rolling average
What it tells you: Shows daily testing volume and results, smoothed over a 7-day period; each point on the curve represents the average volume of tests conducted over the previous seven days. Broken out into four curves (total tests in blue, negative tests in green, positive tests in yellow, unknown results in red). The 7-day rolling average is used to smooth out day-to-day variations in testing results. Due to reporting lags from some labs and for negative results, total testing volumes from the most recent 3-5 days often are underreported
Why it’s important: Shows volume and results of tests over time normalized for weekend volume drops

Chart: PCR positivity rate, 7-day rolling average
What it tells you: Shows breakdown of testing results over 7-day periods over time (% negative in blue, % positive in red, % unknown in yellow). Cumulative percent positive represented as a black line. The 7-day rolling average is used to smooth out day-to-day variations in testing positivity results
Why it’s important: Gives indication of how testing results change over time; lower positivity rates suggest lower presence of COVID-19
Guidance on interpreting analyses – Testing (2/2)

Chart: PCR tests by county per 100k population
What it tells you: Heat-map of cumulative tests conducted by county; normalized for population
Why it’s important: Shows concentration of where more and less testing is being conducted across the state relative to the population density of counties

Chart: Positive test rate by county
What it tells you: Heat-map of PCR testing positivity rate by county
Why it’s important: Shows concentration of where more and less PCR tests are returning positive results by county

Chart: Weekly lab PCR testing volume
What it tells you: Shows testing volume conducted in bars over seven day periods; bars broken out by labs where tests are conducted. Due to reporting lags, total testing volumes from the most recent week are often underreported
Why it’s important: Provides testing volume conducted by lab through time

Chart: Test volume and results by age
What it tells you: Shows Missouri’s cumulative testing breakdown by age with colored results (blue bars are negative results, green bars are positive results, yellow bars are indeterminate results); mapped against left y-axis. Also shows percent positivity for each age demographic (red triangles); mapped against right y-axis. Default states are CA, NY, TN, KS, MO, but states can be adjusted
Why it’s important: Shows concentration of testing and positive results by age group
Guidance on interpreting analyses – Cases (1/2)

Chart: COVID-19 Cases in Missouri
What it tells you: Shows the daily new case count (green bars) over time; also shows the cumulative number of cases (blue line) over time. Note – cumulative cases will be much higher than current cases as individuals recover from infection over time. Both data sets shown on a logarithmic scale
Why it’s important: Shows how the pandemic has grown over time at a state-wide level

Chart: COVID-19 Cases by State -- days since 20th case (per 100k population)
What it tells you: Shows the cumulative number of cases over time since reaching ‘critical-mass’ of various states on a logarithmic scale, normalized for population; Missouri shown as red line. Other states shown are CA, IL, KS, NY, TN
Why it’s important: Shows how Missouri’s COVID-19 case growth compares with other states on a relative basis

Chart: Positive COVID-19 Cases by County
What it tells you: Cumulative case heat-map. Darker counties have a higher cumulative case count
Why it’s important: Shows where the volume of cases has been highest over the course of the pandemic

Chart: Positive COVID-19 Cases by County (per 100k population)
What it tells you: Cumulative case heat-map; normalized for population. Darker counties have a higher cumulative case count
Why it’s important: Shows where the volume of cases relative to the population of local residents has been highest over the course of the pandemic
Guidance on interpreting analyses – Cases (2/2)

Chart: Counties by 7-day % increase in COVID-19 cases
What it tells you: Heat-map of seven day growth in cases by county compared to the previous week’s cumulative case count; filtered to show only counties with at least 5 cases and at least 1% growth in cases. Minimum case count filter can be adjusted
Why it’s important: Gives mid-term indication of potential outbreaks and hot-spot sustainment

Chart: Counties by 7-day “rate of change” in COVID-19 cases
What it tells you: Heat-map of seven day ‘rate of change’ in cases by county, where ‘rate of change’ refers to the number of new cases in the past 7 days relative to prior 7 days (8-14 days ago); Negative numbers indicate slowing rates of growth; filtered to show only counties with at least 5 cases. Minimum case count filter can be adjusted.
Why it’s important: Shows where case growth is growing and declining on a relative (to each county) basis over time
Guidance on interpreting analyses – Deaths

Chart: COVID-19 Deaths in Missouri

What it tells you: Shows the daily new death count (red bars) over time; also shows the cumulative number of deaths (orange line) over time. Both data sets shown on a logarithmic scale
Why it’s important: Shows fatality impact on Missouri over time

Chart: COVID-19 Deaths by State -- days since 10th death (per 100k population)

What it tells you: Shows the cumulative number of deaths over time since reaching ‘critical-mass’ of various states on a logarithmic scale, normalized for population; Missouri shown as red line. Default states are CA, IL, NY, TN, KS, MO, but states can be adjusted in the parameters box (upper left hand corner)
Why it’s important: Shows how Missouri’s COVID-19 death count compares with other states on a relative basis