COVID-19 in Colorado, 11/03/2021

Prepared by the Colorado COVID-19 Modeling Group

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Key Messages

- SARS-CoV-2 infections and hospitalizations in Colorado have increased for 2.5 months. Over the last two weeks, the epidemic curve has continued its sharp rise with the effective reproductive number at 1.2.
- 1280 Coloradans were hospitalized with confirmed COVID-19 on November 3, still well below the December 2020 peak, which exceeded 1800.
- We estimate approximately 1 in every 48 people in Colorado are currently infectious, equivalent to past prevalence peaks, while 62% of Coloradans are estimated to be immune.
- If Colorado remains on this trajectory, projections show that COVID-19 hospital demand will likely increase through November and could reach over 1500 hospitalized patients by early December. In a limited number of scenarios, hospital demand could exceed the December 2020 peak.
- Immediate efforts to increase non-pharmaceutical interventions and assure access to monoclonal antibody treatment will slow the spread of infections and reduce the occurrence of severe COVID-19 and hospital demand on the short-term. At this time, effective measures could include increasing testing and use of isolation and quarantine, enhancing mask wearing and advancing access to monoclonal antibody treatment.
- On the longer-term, increasing booster uptake and vaccinations in children, age 5 to 11, will prevent thousands of COVID-19 hospitalizations and hundreds of COVID-19 deaths between now and the end of February 2022.
- The growth of infections and hospitalizations is concentrated in regions with low vaccination and older adults (65+). This pattern suggests that both pockets of unvaccinated populations and waning immunity are drivers of the current increase.

Introduction

The purpose of this report is to answer three questions:

1. What is the current state of the SARS-CoV-2 pandemic in Colorado?
2. What might future hospital demand for SARS-CoV-2 look like in Colorado under different scenarios of transmission control and vaccination?
3. Why is the epidemic curve rising in Colorado?

To answer these questions, we use COVID-19 hospital, vaccination, and case data and a mathematical model of the epidemic of the virus tailored to Colorado. We first characterize the current status of the COVID-19 epidemic in Colorado: how rapidly infections are increasing or decreasing, the proportion of the population estimated to be immune, and the proportion of the population estimated to be currently infectious.

We then generate projections of the potential future course of COVID-19 in Colorado under different assumptions. These projections are not predictions of what will happen but, rather, projections of what may happen in the coming months under different scenarios that are relevant to planning and decision-making. In this report, we consider what future hospital demand might look like if we stay on the current trajectory or experience modest changes to transmission control akin to what we have seen in the past few weeks. We consider the potential impacts of monoclonal antibody treatment, which can decrease the severity of SARS-CoV-2 and thus, reduce hospital demand. We also consider the potential impacts of vaccinating children, age 5-11—now a reality — and the impact of providing boosters to adults. Our primary focus is projecting hospital needs for COVID-19 patients in the months ahead, an indicator that reflects the burden on the medical care system. We additionally estimate future COVID-19 mortality, another critical measure of overall impact.

Lastly, we offer perspective on what may be driving the current increase in COVID-19 hospitalizations and infections in Colorado.

About the model. The model is an age-structured SEIRV (susceptible-exposed-infected-recovered-vaccinated) infectious disease transmission model that has been calibrated to Colorado-specific data whenever possible. For example, the length of time that a COVID-19 patient is assumed to spend in the hospital varies by age and over time and is based on data provided by Colorado hospitals. Model details and a listing of recent model updates are provided in the Appendix at the end of this report. Key recent changes to the model include updates to assumptions of immunity from vaccination and incorporating the impact of booster doses.

This report is based on hospitalization data through 11/01/2021 and vaccination data through 10/30/2021.

Question 1. What is the current state of the SARS-CoV-2 epidemic in Colorado?

Colorado is now experiencing the second-highest peak in COVID-19 hospital demand since the start of the pandemic (Figure 1). COVID-19 hospitalization demand has increased dramatically over the month of October in Colorado. COVID-19 hospital demand is now the highest since December 2020.

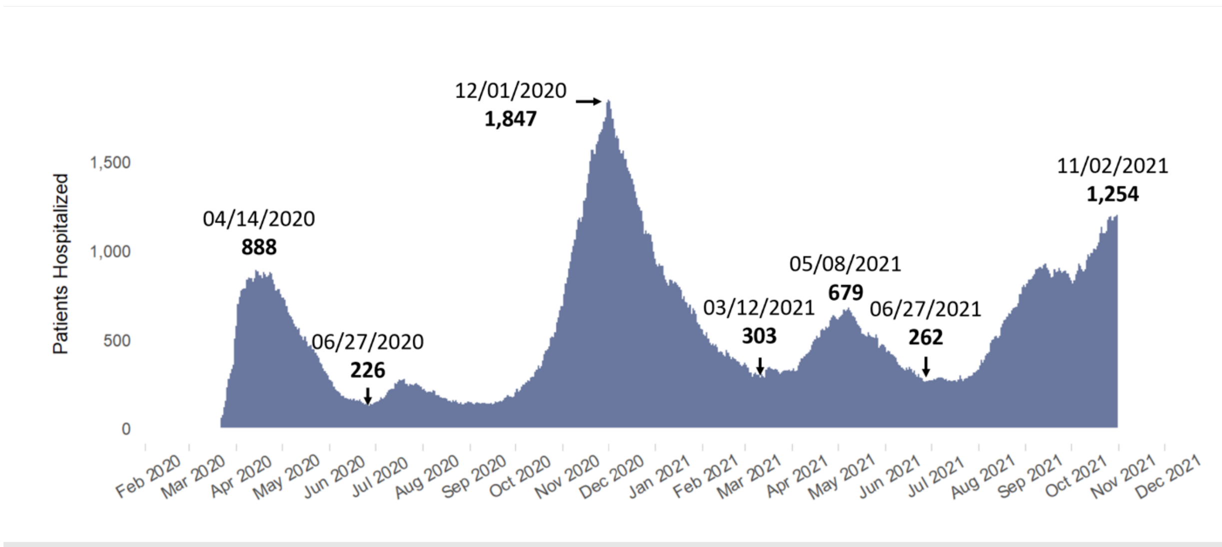


Figure 1. The number of people hospitalized with COVID-19 in Colorado, March 2020 to November 2, 2021.

Colorado now has the 10th highest COVID-19 hospital demand in the United States (Figure 2). It is one of 11 states where COVID-19 hospital demand is rising and has the second-highest rate of increase among the 11. Note that many other states have experienced larger fall waves but most are now declining.

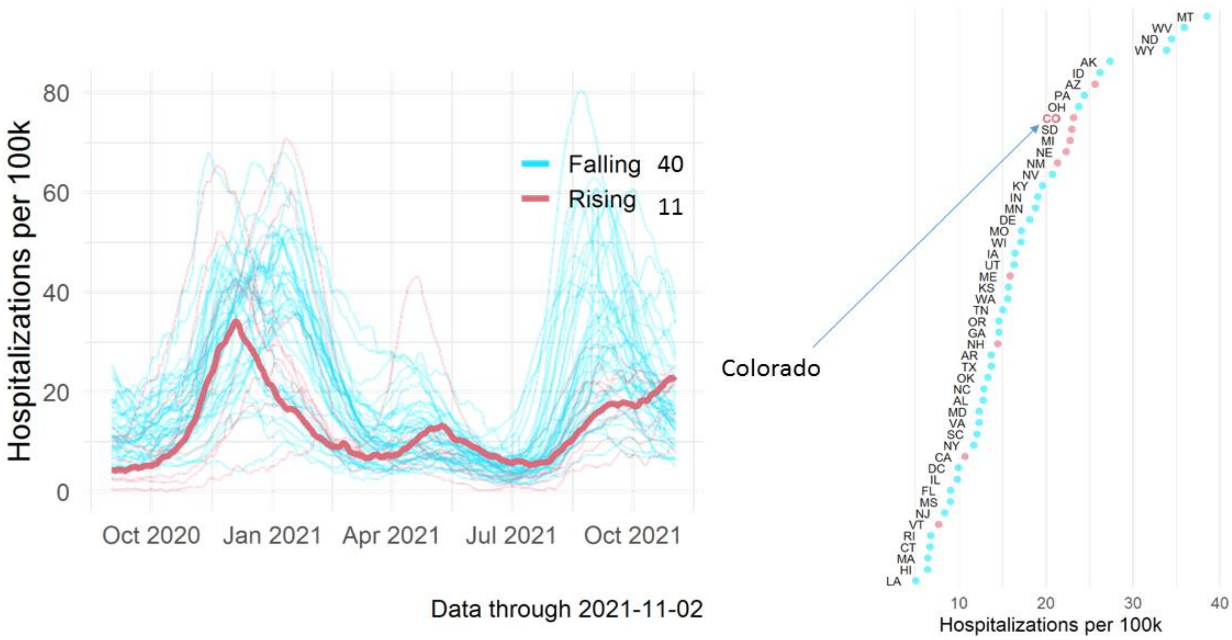


Figure 2. Current and past hospital demand by US state since October 2020. The left panel shows each states time series with Colorado indicated by the thick red line. The right panel shows the current hospitalization rate across states (horizontal axis). States with red lines and dots have experienced increased hospitalization rates over the past two weeks and blue indicate falling rates. Colorado currently has the tenth highest hospitalization rate in the country. Data from US Health and Human Services https://healthdata.gov/Hospital/COVID-19-Reported-Patient-Impact-and-Hospital-Capa/g62h-syeh.

The number of people currently infected is approaching the highest levels of the pandemic (Figure 3). We estimate that approximately 2,061 of every 100,000 Coloradans or 1 in every 48 people are infectious in Colorado as of 11/01. Because many people experience no symptoms or mild symptoms of COVID-19, many infections are not identified by surveillance systems. The estimates we present here are intended to provide an approximation of all infections, including those not detected by the Colorado Electronic Disease Reporting System (CEDRS).

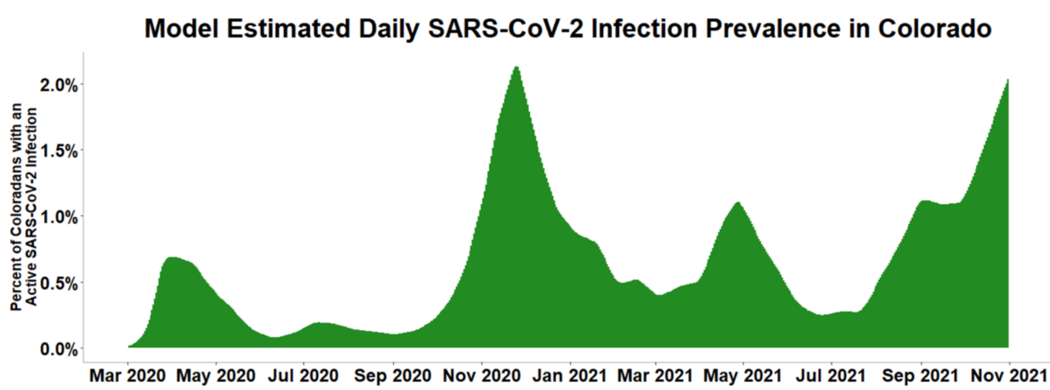


Figure 3. Estimated daily number of people who are infectious and infected with SARS-CoV-2 (point prevalence). The estimate is shown per 100,000 population. The number of infectious individuals is

inferred using the model and is based on hospitalizations. These estimates are sensitive to the model assumptions, including assumptions about the probability an infected individual will be symptomatic and require hospital care, which vary by age, and assumptions about the virulence of variants.

SARS-CoV-2 infections are increasing. Our current estimate of the effective reproductive number (Re) is 1.2 (Figure 4). The effective reproduction number (Re) is a measure of how rapidly infections are spreading. When the effective reproduction number is below 1, the number of infections is decreasing. When the effective reproduction number is above 1, the number of infections is increasing. Due to the lag between infections and hospitalizations, this estimate reflects the spread of infections occurring on approximately 10/19.

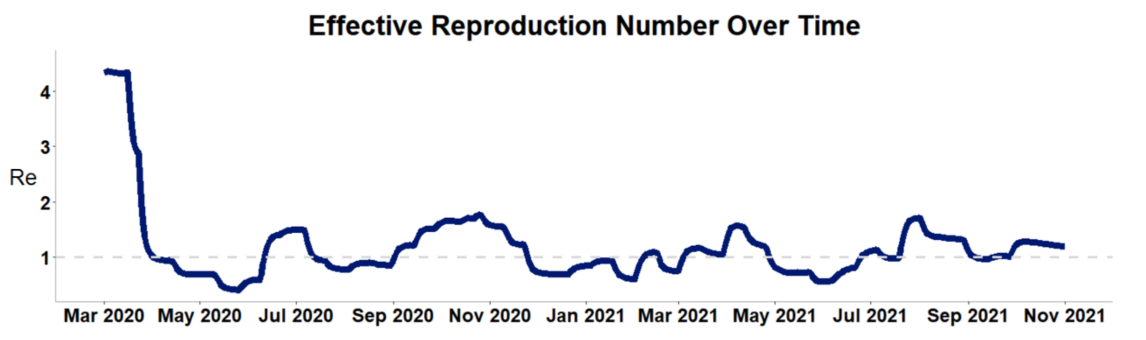


Figure 4. Estimates of the effective reproduction number over time based on data through 11/01/2021.

We expect hospital demand to continue to increase. Figure 5 shows the current estimated trajectory of hospitalizations, based on the most recent model-fit compared to the daily reported number of people hospitalized with COVID-19. For reference, the trajectory estimated two-weeks prior is also shown. The two lines are close, showing that Colorado has been on a consistent trajectory over the past several weeks.

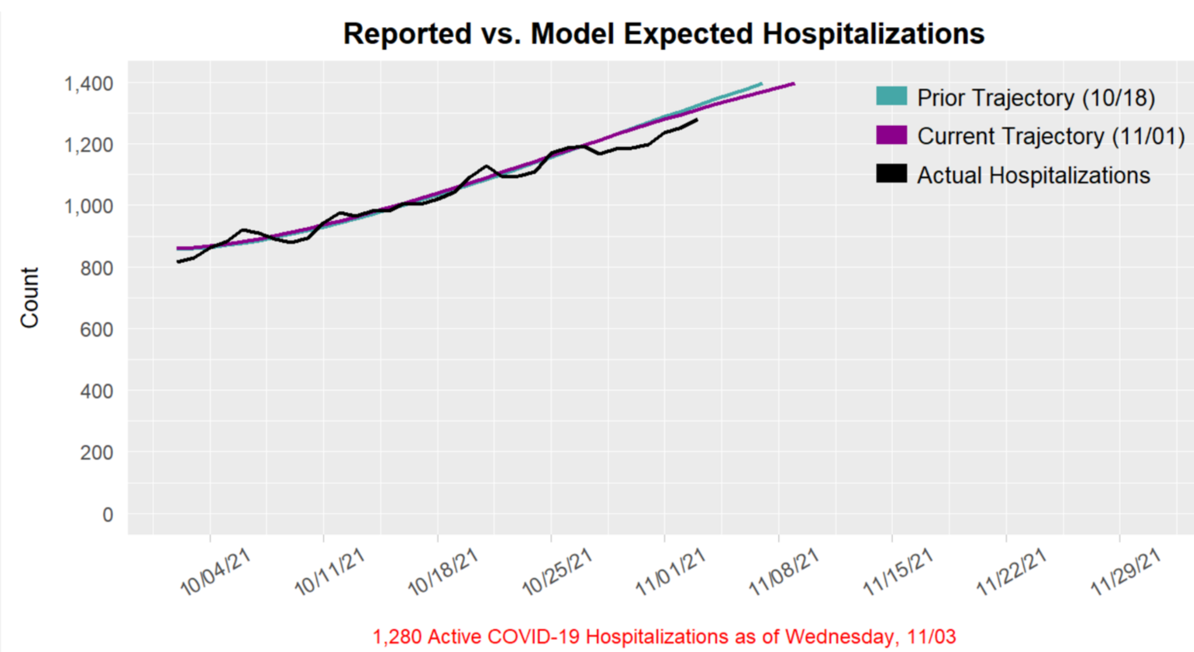


Figure 5. The projected course of COVID-19 hospitalizations if Colorado were to remain on the current estimated trajectory (purple line), the trajectory estimated two-weeks prior (turquoise line). Actual daily number of people hospitalized with COVID-19 in Colorado is shown in black. Trajectories are generated assuming Colorado continues vaccinations consistent with current trends.

Question 2. What will future hospital demand for SARS-CoV-2 look like in Colorado?

We generated projections of future COVID-19 hospital demand and mortality in Colorado using our age-structured SEIRV model to answer the questions outlined, below. These projections highlight three key points

- Immediate increases in transmission control measures such as mask wearing, testing and isolation, and physical distancing can reduce the magnitude of the coming peak.
- Timely access to monoclonal antibody treatment can reduce COVID-19 hospital demand.
- Vaccine boosters and vaccinations in children will prevent COVID-19 hospitalizations and deaths over the next four months and beyond.

How high could hospital demand get and when will hospital demand peak?

Near-term COVID-19 hospital demand is primarily determined by the level of transmission control, as we have reported previously. We take two approaches to estimating the magnitude and timing of the current peak along with the uncertainty of the estimate. First, we construct scenarios informed by past experience with the course of the pandemic in Colorado. Second, we use statistical uncertainty in our transmission control estimate to describe the range of potential outcomes based on the current trajectory.

Using our first approach, we evaluate three transmission control scenarios: 1) transmission control remains on the current trajectory, 2) transmission control increases by 5%, and 3) transmission decreases by 5% (Figure 6). In these scenarios of transmission control increase and decrease, the changes are phased in over the next two weeks. The changes in these scenarios are in line with the magnitude of transmission control changes we have seen on a short-term basis over the course of the pandemic. If transmission control remains at current levels, we estimate hospital demand will peak in early December at around 1400 patients. If transmission control increases, for example, due to increased mask wearing and/or increased identification and isolation of those who are infected, hospital demand could peak in mid-November at approximately 1325 patients. If transmission control declines by another 5%, to levels seen in summer 2021, hospital demand could match the peak in December 2020, reaching around 1750 patients by mid-December 2021.

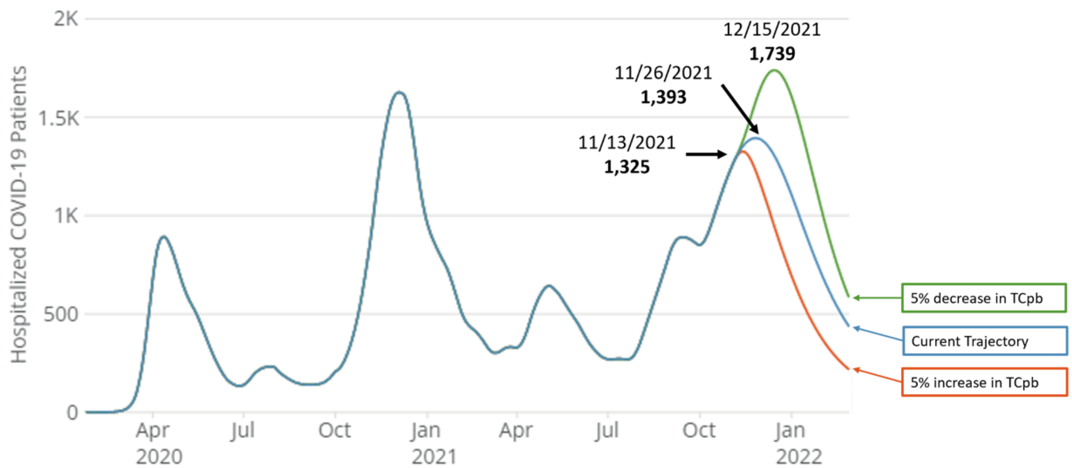
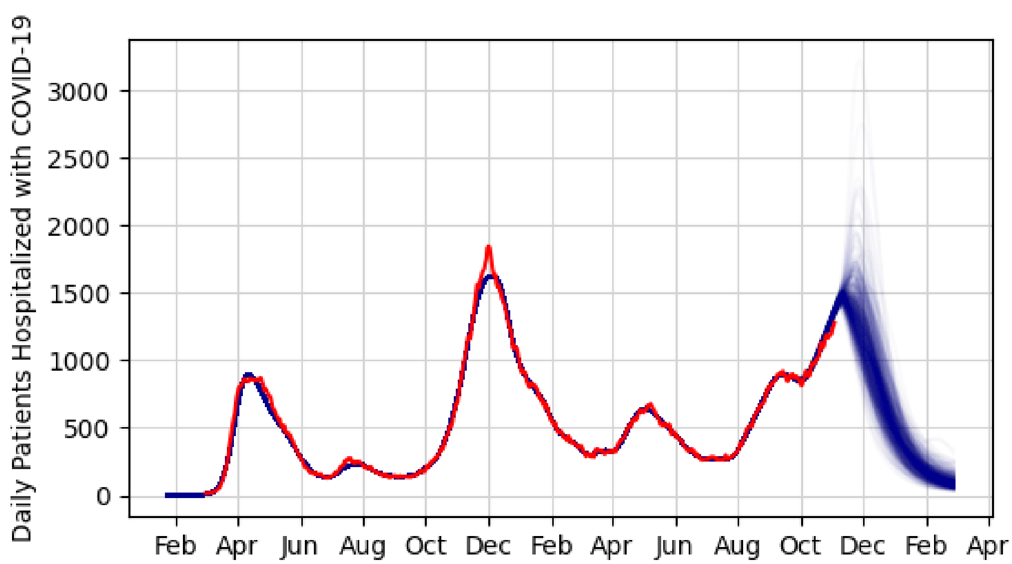
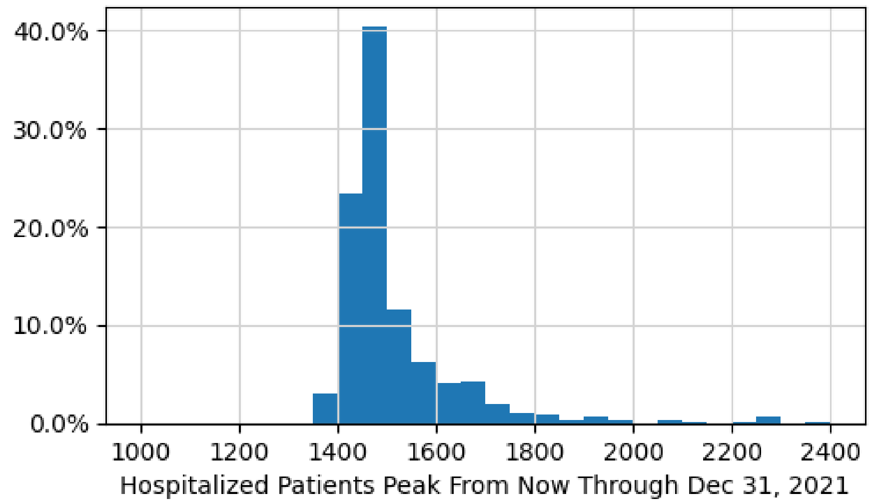


Figure 6. Projected number of hospitalized patients with COVID-19 per day through January 2021 assuming transmission control decreases by 5% (green line), remains on the current trajectory (blue line) or increases by 5% (red line). In these projections we assume booster uptake continues on current trends and pediatric vaccinations begin in early November.

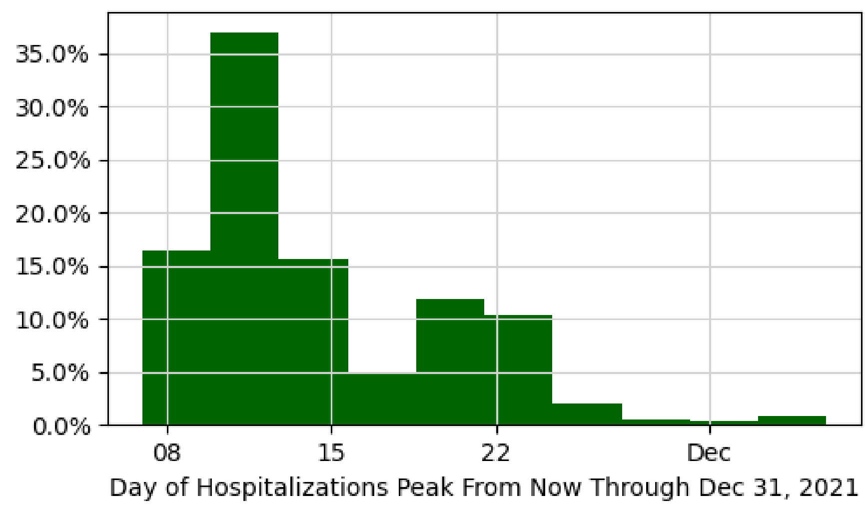
Second, we generated a set of simulations accounting for uncertainty in transmission control (Figure 7). The different values are drawn from a normal distribution defined by estimated transmission control mean and variance from historical data. This approach underscores that there is uncertainty in the exact height and timing of the peak. Most simulations indicate hospital demand peaks in November and demand does not exceed 1600 hospital beds. However, in some simulations hospital demand exceeds 2000 hospital beds and the peak occurs in late December.



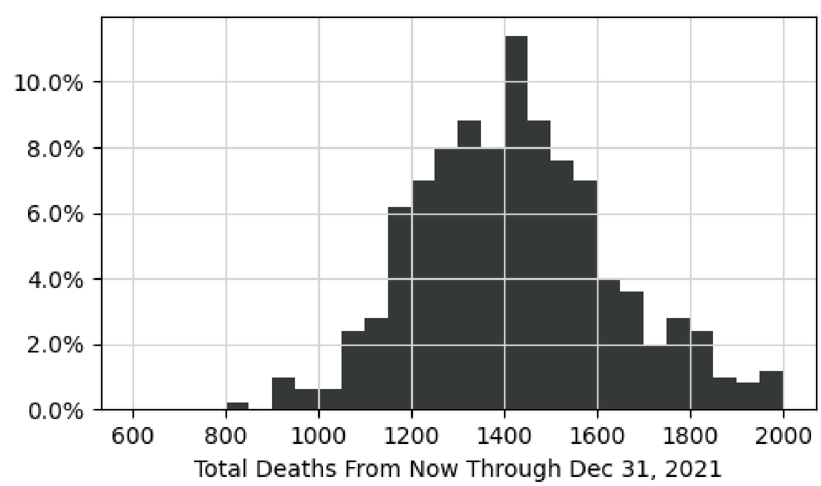
A)


40.0%
30.0%
20.0%
10.0%
0.0%
1000
1200
1400
1600
1800
2000
2200
2400
Hospitalized Patients Peak From Now Through Dec 31, 2021

B)


35.0%
30.0%
25.0%
20.0%
15.0%
10.0%
5.0%
0.0%
08
15
22
Dec
Day of Hospitalizations Peak From Now Through Dec 31, 2021

C)


10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
600
800
1000
1200
1400
1600
1800
2000
Total Deaths From Now Through Dec 31, 2021

D)

Figure 7. Range of projected COVID-19 hospital demand (A), hospital demand peak (B), date of hospitalization peak (C), and deaths (D) , accounting for current uncertainty in our estimate of the current level of transmission control. Panel A: red line shows actual hospital demand, blue lines show simulations where each line represents a projection that accounts for transmission control parameter uncertainty. These projections do not capture uncertainty in how transmission control may vary over the long-term. Panels B, C, and D display histograms with the vertical axis presented as shares of the simulation corresponding to the horizontal axis values.

What is the potential impact of monoclonal antibody treatment on hospital demand?

Timely treatment for COVID-19 can reduce disease severity, lessening hospital demand. The State of Colorado has taken recent steps to enhance access to monoclonal antibody therapy, which has substantial benefit if administered early in the course of the infection, prior to hospitalization. We estimated the potential impact of widespread access to monoclonal antibody treatment on COVID-19 hospital demand.

Monoclonal antibody (mAB) treatment can reduce the probability an individual with SARS-CoV-2 infection will require hospitalization and reduce the length of stay if hospitalization is required (e.g., Brobst and Borger, Verderese et al). Estimates for the impact of mAb treatment vary across different drugs and studies, from 60% to 92% decrease in hospitalization risk. The majority of studies find relative hospitalization risk reduction between 70% and 85%. In addition, a study looking at the impact of mAb treatment in a real-world setting identified a 28% reduction in average length of stay for those who were hospitalized (Verderese et al). Combining the reduction in risk of hospitalization and the reduction of length of stay if admitted suggests that the net impact of mAb treatment on the mean expected hospital-days for a COVID patient is a reduction of 78-89%.

We then estimated what proportion of individuals who are likely to be hospitalized for SARS-CoV-2 might receive mAB treatment, which must be administered early in the course of infection. To be eligible for treatment, an individual must have at least one risk factor such as being over the age of 65 or having a BMI above 25, AND must also have a positive test or prolonged exposure to someone with a positive test before hospitalization. Using demographic data, as well as examining the number of people with positive tests before hospitalization, we estimate that approximately 53% of hospitalized patients would be eligible for treatment. The uptake for mAB among those who are eligible is dependent on a number of factors, including availability, awareness, and other logistical details. Since these factors are not fixed, it's difficult to produce a firm data-driven estimate of what uptake will be in the future. For the purpose of this analysis, we're targeting 30-50% uptake among those who are eligible. With ~52% eligibility among those who would be hospitalized, and 30-50% uptake, we estimate 16%-26% of those who would be hospitalized will receive mAb treatment.

Combining our estimates on efficacy and uptake we estimate that mAB treatment can reduce COVID-19 hospital demand by 12-23% (Table 1).

	<u>Low Efficacy Estimate</u> **70% reduction in hospitalizations, 78% reduction in hospital-days**	**<u>High Efficacy Estimate</u>** **80% reduction in hospitalizations, 89% reduction in hospital-days**
Low Uptake Estimate ***30% of eligible*** **16% of potential hospitalizations**	**12%** reduction in peak hospitalizations	**14%** reduction in peak hospitalizations
High Uptake Estimate ***50% of eligible*** **26% of potential hospitalizations**	**20%** reduction in peak hospitalizations	**23%** reduction in peak hospitalizations

Table 1. The estimated impact of monoclonal antibody therapy on COVID-19 hospital demand in Colorado populations.

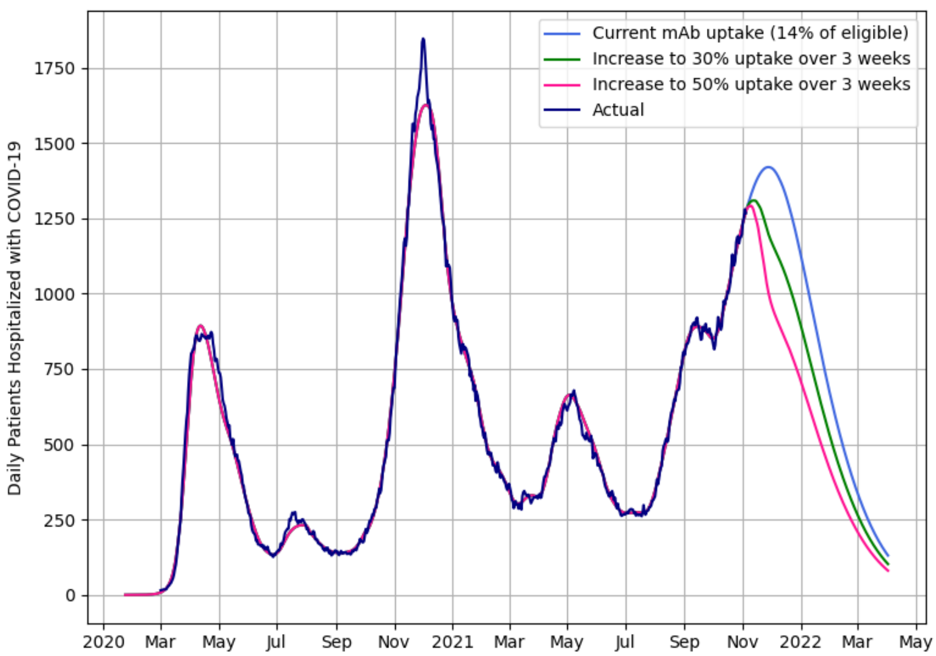


Figure 8. Projected COVID-19 hospital demand if we remain on the current trajectory assuming monoclonal antibody use stays at current levels (14% of eligible population, blue line), increases to 30% over 3 weeks (green line), increases to 50% over 3 weeks (pink line). A person is eligible for monoclonal antibody treatment if they are over 65 and/or have certain risk factors, and tested positive or had a high-risk exposure before hospitalization.

What is the potential impact of boosters and vaccinations in children age 5-11?

Vaccinations, including boosters, act to protect the vaccinated from infection, COVID-19 hospitalization and death and increase the proportion of the population immune to SARS-

CoV-2, slowing the spread of infections. Because it takes days to weeks for vaccines to confer immunity, we examine the impact of boosters and pediatric vaccines on severe COVID-19 outcomes over the next four months, through February 28, 2022.

Boosters. The scientific evidence indicates that immunity to SARS-CoV-2 wanes over time (e.g., Thomas et al NEMJ, Tartof et al Lancet). In our model, we assume that vaccine-induced immunity is waning in the Colorado population. Boosters can counter-act waning immunity, providing a "boost" in immunity that has immediate impact as shown in recent studies (e.g., Bar-On et al NEMJ).

In our projections, we model two booster scenarios:

- Current trajectory. Administration of boosters follows current trends such that 67% of vaccinated adults 65+ and 22% of those 40-64 receive a booster by December 31.
- Booster uptake is doubled such that 83% of vaccinated adults 65+ and 68% of those 40-64 receive a booster by December 31. This scenario roughly translates to providing boosters to 75% of the eligible population.

Vaccines in children. The Pfizer BioNTech vaccine was approved for children, age 5 to 11 on November 2, 2021. In Colorado, this age group comprises 8.3% of the Colorado population. Vaccinating this age group not only protects the health of children, but also increases population-level immunity in Colorado and thereby prevents the spread of infections from children to older people including parents, teachers and grandparents.

In our projections, we model two pediatric vaccination scenarios

- 64% of children age 5 to 11 receive a first dose by January 31, 2022.
- No pediatric vaccine is administered.

Projected impacts. Increased booster uptake and vaccinations in children, age 5-11 can prevent thousands of COVID-19 hospitalizations and hundreds of deaths over the next four months (Figure 9). The benefits of vaccination extend beyond the time-period of these projections.

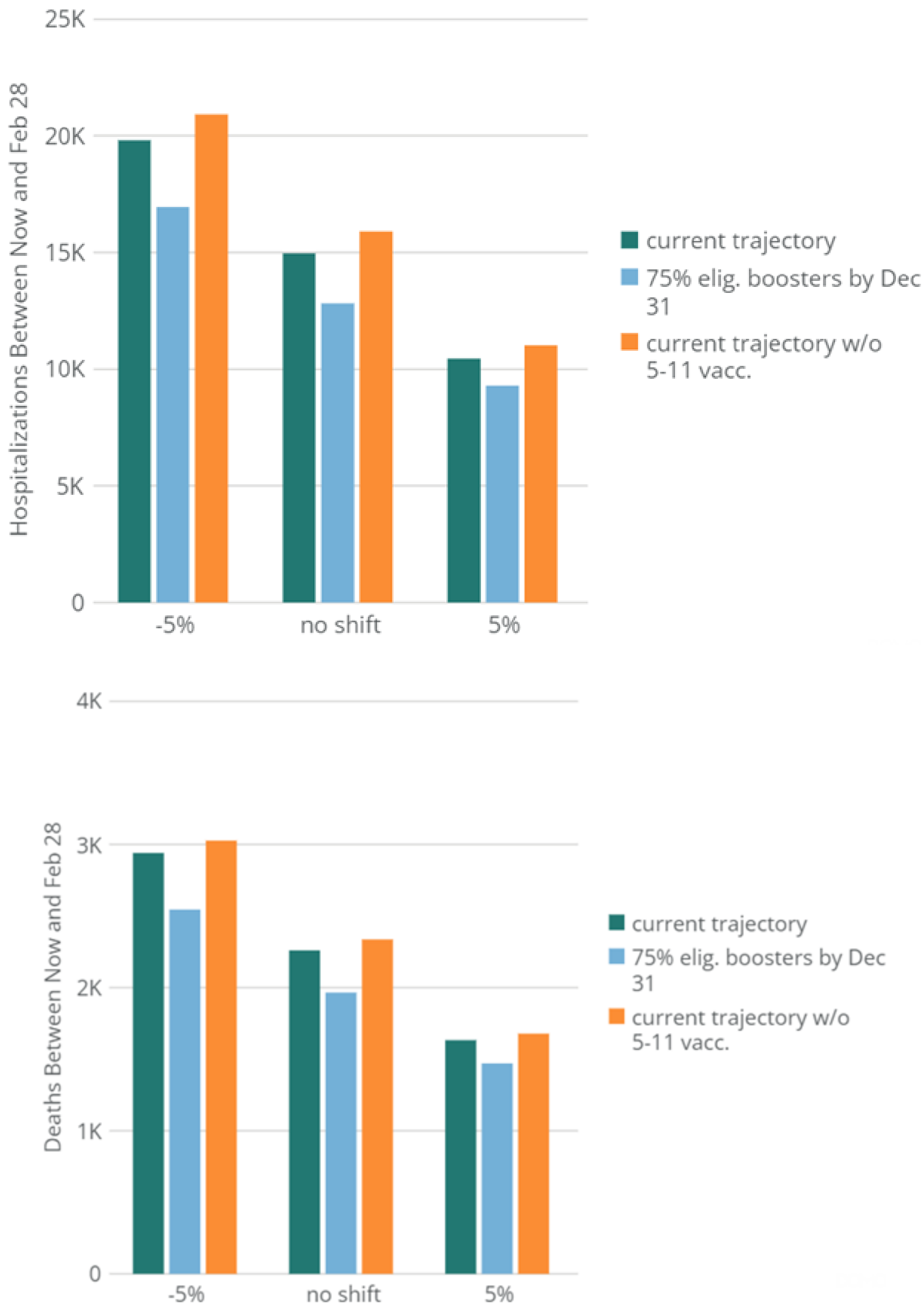


Figure 9. The estimated number of people hospitalized with COVID-19 (top) and deaths (bottom) from now until February 28, 2022 for different booster and pediatric vaccine uptake scenarios. The orange bars show projected COVID-19 hospitalizations (top) and deaths (bottom) if booster uptake continues on the current trajectory and no pediatric vaccines are administered; the teal bars show projected impacts if booster uptake continues on the current trajectory and 64% of children receive the pediatric vaccine before February 2022. The blue bars show projected impacts if booster uptake increases to 75% of the eligible population and 64% of children receive the pediatric vaccine before February 2022. To account for uncertainty in transmission control, projections are generated for transmission control remaining on the current trajectory as well as increasing/decreasing by 5%. In these scenarios, we assume the pediatric vaccine is administered starting November 5, 2021.

Question 3. Why is the epidemic curve rising in Colorado?

Over the last month, Colorado has been among the minority of states with a rising epidemic curve and is having the second steepest rise. Apart from geographic location, there appears to be no unifying factor that explains the surge that each of the 11 increasing states is experiencing. Here, we review the different factors that could contribute to the current picture of the pandemic in Colorado.

Reason 1. Pockets of unvaccinated populations. With 62% percent of the population fully vaccinated, Colorado is above the national average of 58 % percent. However, the percent of the population vaccinated varies widely across the state, from 36% of the population vaccinated in the Southeast LPHA region to 66% of the population vaccinated in the Central Mountains LPHA region. Statewide, approximately 80% of those hospitalized are not vaccinated, reflecting a high burden of severe disease in the unvaccinated.

Geographically, the toll of SARS-CoV-2 is most severe in regions where vaccination rates are low and among unvaccinated populations (Figure 10 & 11). Vaccinated individuals in high-vaccination regions have the lowest hospital and mortality rates in the state. Conversely, unvaccinated individuals in low-vaccination regions have the highest hospital and mortality rates in the state. Notably, unvaccinated individuals in high-vaccination regions have lower hospitalization and mortality rates than unvaccinated individuals in low-vaccination regions, suggesting that vaccination is protecting not only the vaccinated, but reducing transmission risk in regions with high vaccination coverage.

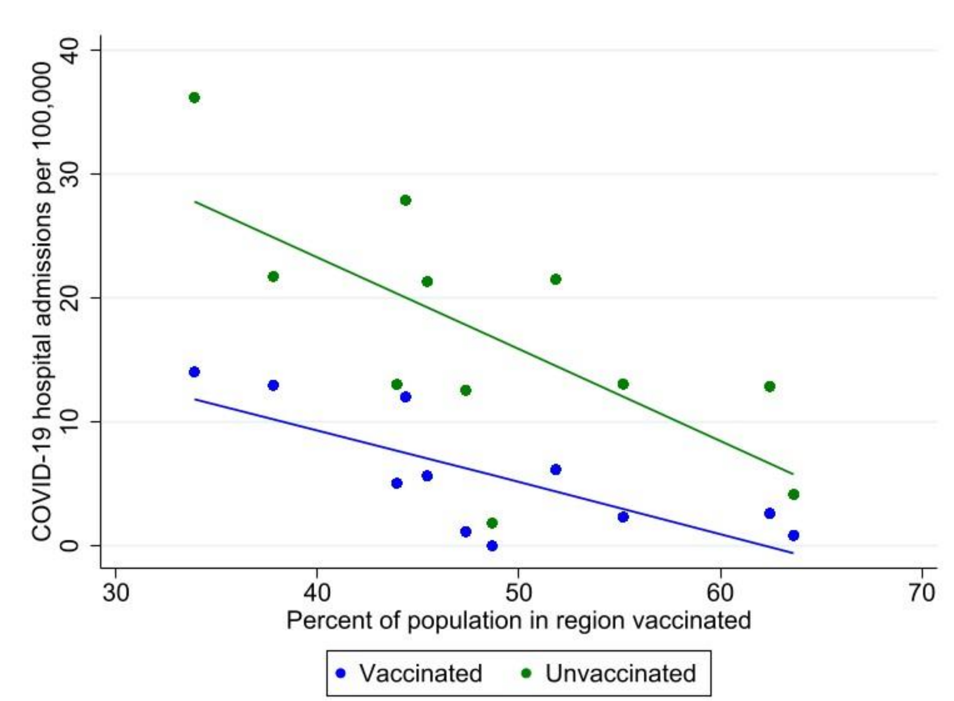


Figure 10. The mean weekly rate of COVID-19 hospitalizations per 100,000 residents for vaccinated (blue dots) and unvaccinated (green dots) individuals by region. The x-axis shows the percent of the total population vaccinated in each of the 11 Colorado LPHA regions. Hospitalization rates are the average weekly rate for the four weeks beginning 9/19/21 to 10/10/21.

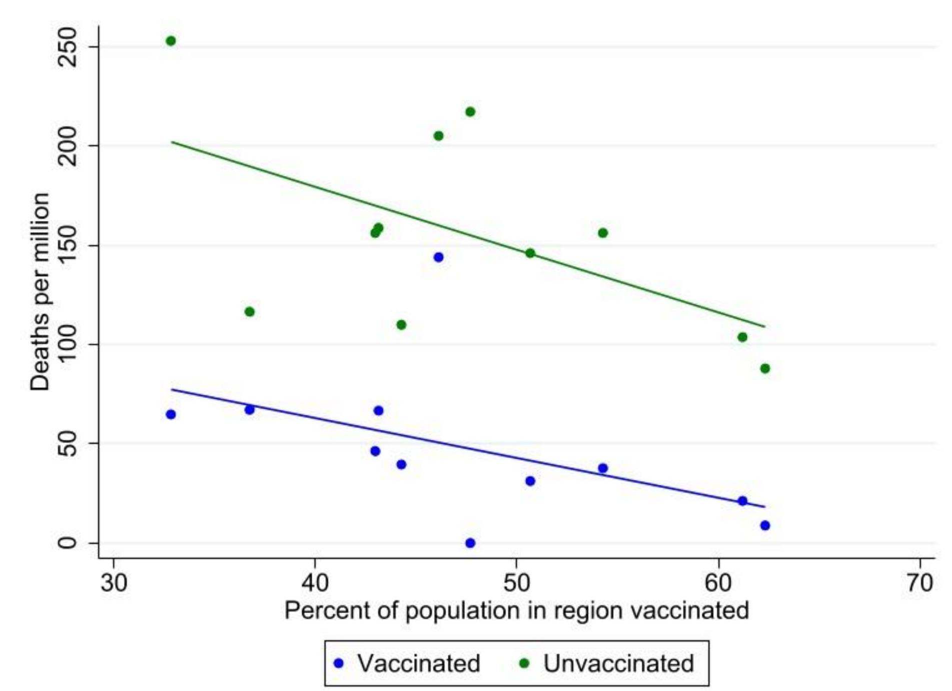


Figure 11. The number of COVID-19 deaths per million residents for vaccinated (blue dots) and unvaccinated (green dots) individuals by Colorado LPHA region, September 2021. The x-axis shows the percent of the total population vaccinated in each of the 11 Colorado LPHA regions.

Reason 2. Immunity due to vaccines is waning. The scientific evidence indicates that immunity to SARS-CoV-2 wanes over time (e.g., Thomas et al NEMJ, Tartof et al Lancet). We estimate approximately 62% of the Colorado population is currently immune to SARS-CoV-2 as of 10/18 (Figure 12). Our model estimates that vaccine-induced immunity has declined in the population. Boosters can rapidly increase population immunity in the weeks and months ahead (Bar-On et al NEMJ).

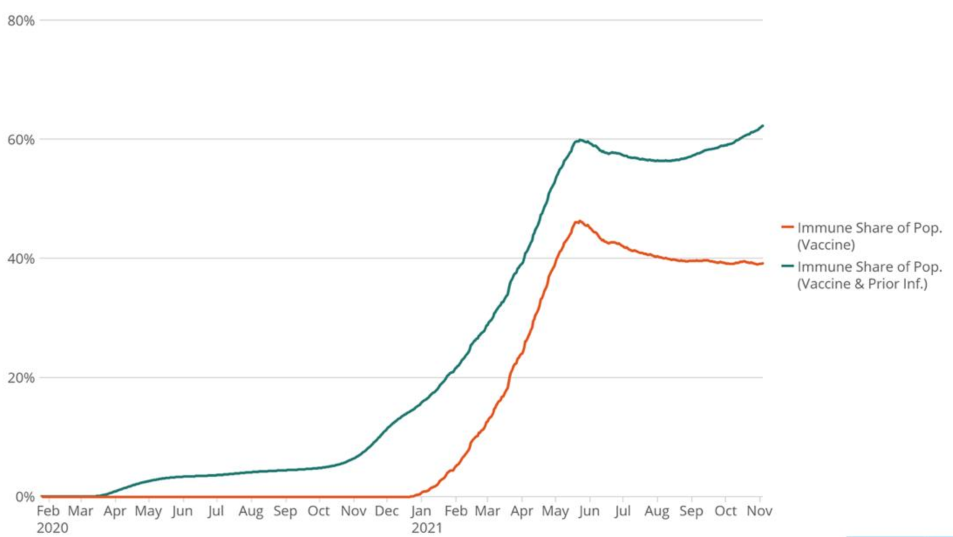


Figure 12. Estimated percent of the population in Colorado assumed to be immune to SARS-CoV-2 due to infection and/or vaccination through 11/03/2021. We estimate the proportion of the

population immune using our age-structured SEIRV model and data on vaccinations in Colorado provided by CDPHE. We assume that not everyone who was previously infected or vaccinated is immune, and that immunity wanes over time based on recent scientific evidence

Reason 3. Population movement is at or beyond pre-pandemic levels. Our primary measure of behavior related to transmission of SARS-CoV-2 is mobility and contact information estimated from mobile phone data. These data indicate a gradual return to the mixing patterns of 2019. Additionally, most schools re-opened with fully in person learning in August. The start of the growth in hospitalizations coincides with school opening, but the return to school, which began about three months ago, does not explain the recent sharp rise in hospitalizations. Additionally, patterns of school re-opening across the country do not align with the current pattern of rising and falling epidemic curves across the states.

Reason 4. Weather. Most respiratory viruses peak in winter months and the scientific literature indicates that cooler, drier conditions may favor the spread of SARS-CoV-2. For, example, as the weather cools, people may be more likely to gather indoors. However, weather driven impacts are thought to be modest relative to interventions to control the spread of infections (e.g., Sera et al). The extent to which weather is driving the current surge is unclear. Temperatures have dropped in many of the states experiencing high COVID-19 hospital demand (Figure 13) but many other states are also experiencing colder weather.

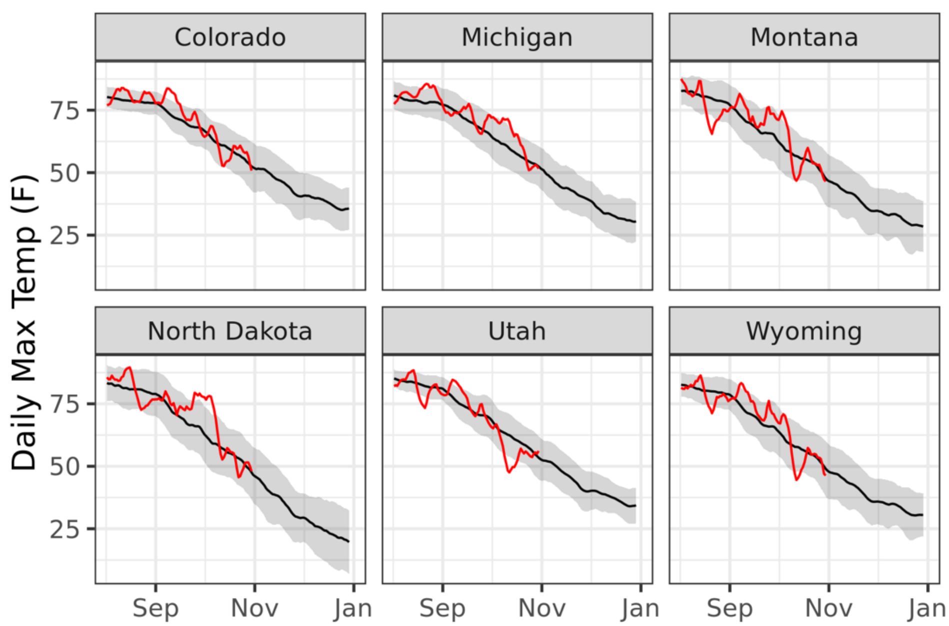


Figure 13. Daily maximum temperature 7-day rolling average. The red line indicates this year and the black line represents a 30-year average ± standard deviation indicated with gray band.

Reason 5. Non-pharmaceutical interventions. In contrast to prior waves, the use of non-pharmaceutical interventions is more limited and we examined whether a decrease in mask wearing could be driving the current wave. We examined mask-wearing patterns using public survey data. Facebook survey data do not show a sharp downtown in reported use of masks coincident with the timing of the surge (Figure 14). In fact, there is a gradual increase in mask wearing, particularly in Boulder and Larimer counties, which recently implemented mask mandates, which may explain why Colorado's increase in SARS-CoV-2 spread has been more gradual than other states. We do not see evidence that a decrease in mask wearing is driving the current surge.

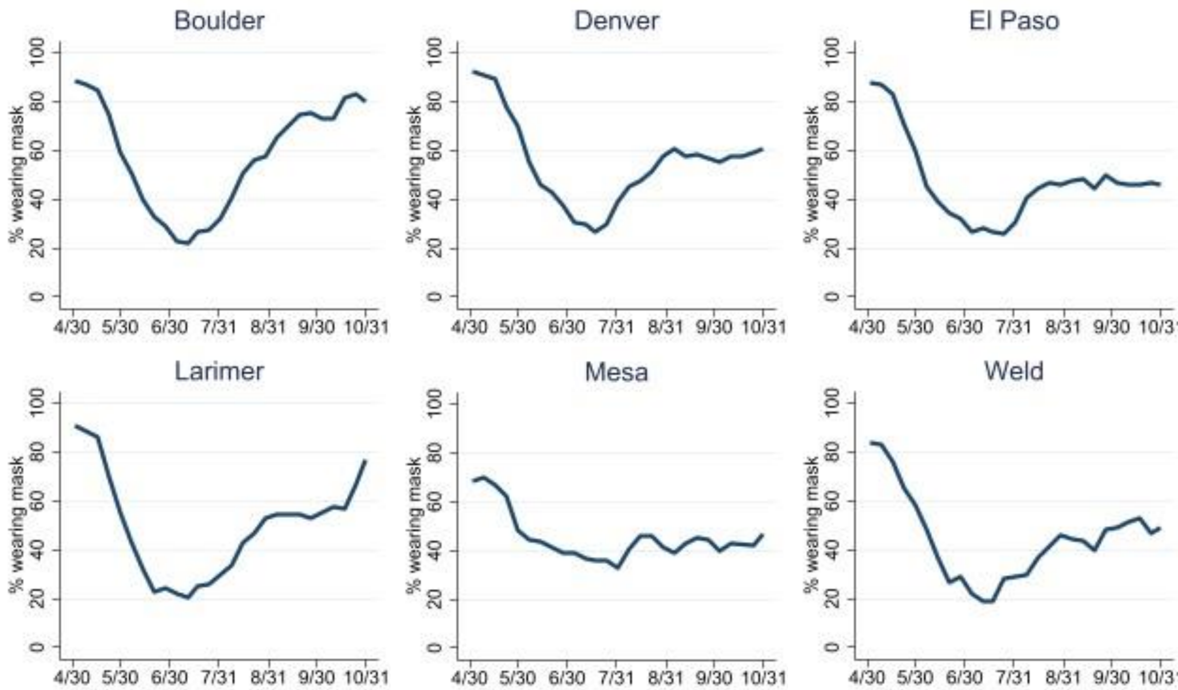


Figure 14. Self-reported percent of people wearing mask in public by week and county based on Facebook survey data.

Conclusions. This review of potential explanations for the timing of the surge does not lead to a single, responsible factor. Rather, we point to unanticipated synergies that have ignited and sustained the pandemic among the unvaccinated. In terms of measures to take to end the surge, this explanation points to ***the need for a two-pronged strategy of strengthening the application of non-pharmaceutical interventions while pushing to vaccinate the unvaccinated, provide booster shots, and vigorously implement vaccination programs for those 5-11 years old.***

Appendix

Model Updates. We updated how we model vaccine immunity to align with recent scientific evidence that suggests vaccine-induced immunity wanes over time and vaccination success varies by age. This new approach also account for boosters. In this new approach, upon vaccination

- 5% of vaccinated population is moved into a vaccine failure compartment, representing individuals who do not have an immune response to the vaccine. 8% comes from the population that is 65 or older, 4% comes from the population under 65. Any hospitalizations and deaths among the vaccinated come from this population
- 95% of vaccinated population is moved into a protected compartment, representing individuals who are protected against infection. Vaccine efficacy against infection changes over time such that
    - vaccine efficacy at 4 months is 87% (non-Delta), 79% (Delta)
    - Vaccine efficacy at 8 months is 70% (non-Delta), 55% (Delta)

  In this population, efficacy against hospitalization and death remains at 100%.

- Individuals who receive a booster dose removes the decaying efficacy since second dose of a mRNA vaccine. 50% of individuals who were initially in the vaccine failure compartment are moved into the protected compartment following booster dose.

Model fit. We assess model fit by comparing the model-estimated number of hospitalizations to actual hospitalizations. Figure A1 showing model-estimated and actual hospitalizations since the beginning of the pandemic.

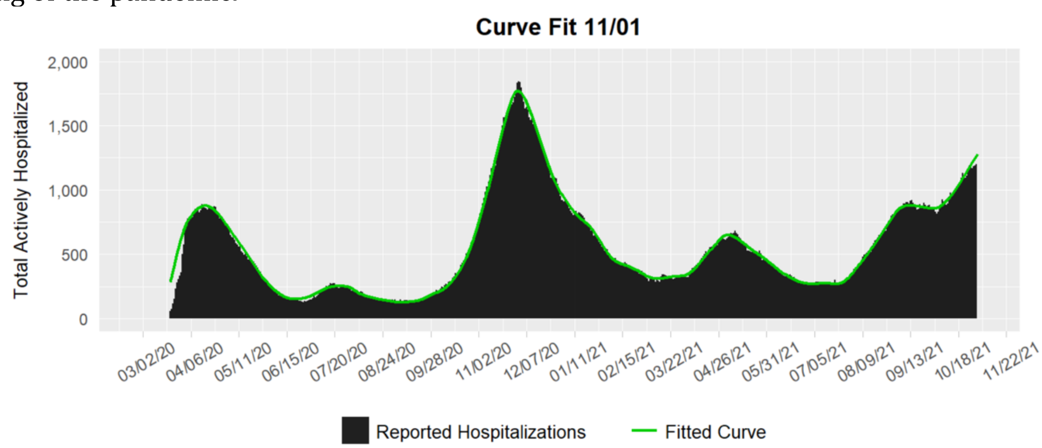


Figure A1. Current model fit (green line) to the count of hospitalized COVID-19 cases (black lines) through 11/01 using the age-structured SEIR model. Hospitalized COVID-19 cases are from CDPHE reported COVID-19 hospitalizations and EMResource (EMR) hospital census data provided by CDPHE.

Variants of Concern. We estimate variant prevalence using data from CDPHE and incorporate variant prevalence in our model.

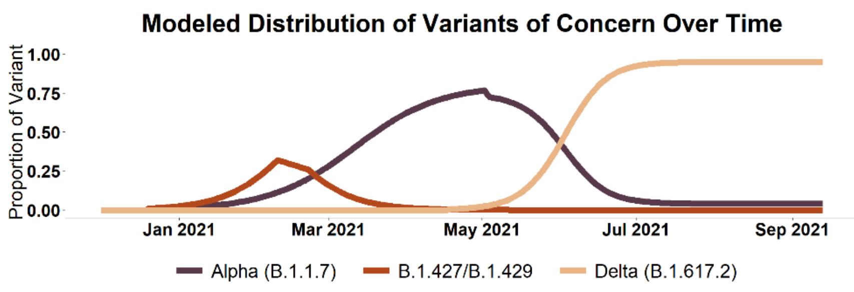


Figure A2. Estimated prevalence of variants of concern: Alpha (purple), B.1.427/B.1.429 (dark orange), Delta (light orange) in Colorado over time used in the SEIR model.

Case detection. We compare model-estimated infections to the number of cases reported in order to estimate the proportion of cases detected over time.

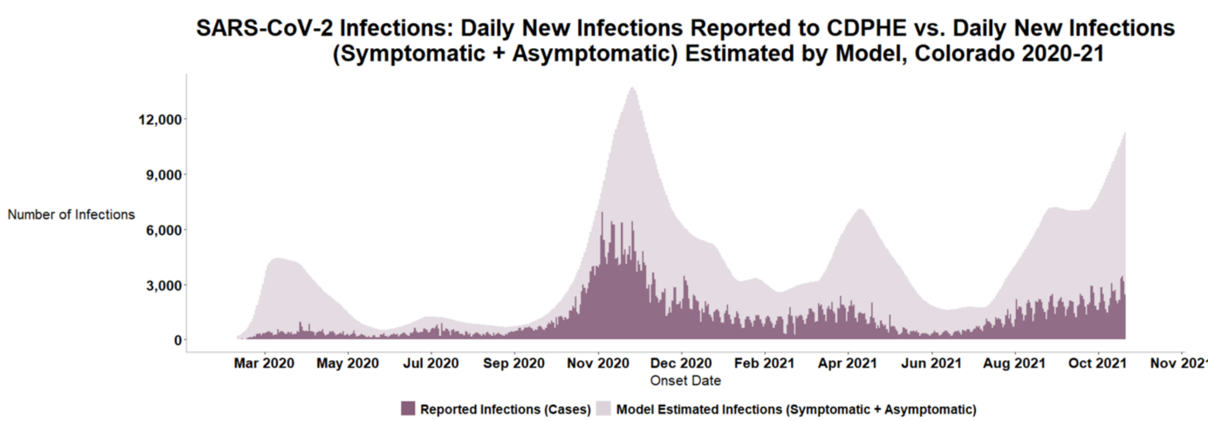


Figure A3. Estimated daily number of new (incident) SARS-CoV-2 infections based on the total estimated by the SEIR model (light purple graph) and reported cases (dark purple graph) over time shown.

Code, Documentation, and Prior Reports

Code for our model is available on GitHub: https://github.com/vanadata/covid-models

Documentation for the model: https://agb85.github.io/covid-19/SEIR%20Documentation.pdf

Prior modeling reports and documentation: https://agb85.github.io/covid-19/

Regional modeling results: https://www.colorado-data.org/regional-epidemic-models

Methods and notes for Question 2.

Variants. In these projections, we assume the Delta variant continues to account for over 90% of SARS-Cov-2 infections in Colorado through the fall and that no new variant of concern emerges.

Transmission control. Throughout the pandemic, there has been uncertainty about future levels of transmission control as it reflects a complex and still incompletely understood combination of behavior, policy, and, perhaps, weather. The modeled range of transmission control is based on recent trends and the changes of transmission control observed over the pandemic in Colorado (Figure A4). Changes in transmission control are modelled as gradual changes implemented from 10/29 to 11/12 such that, by 11/12, transmission control (TC_{pb}) has increased or decreased by 5%. Our projections do not capture uncertainty in how transmission control may vary over time.

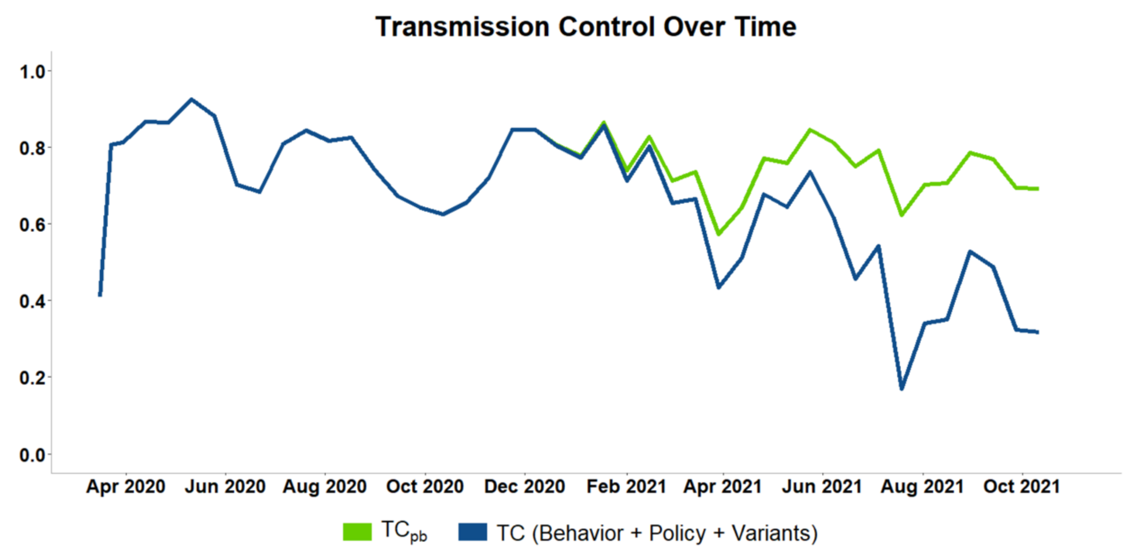


Figure A4. The estimated transmission control value for each two-week period since the beginning of the epidemic due to behavior and policy only (TCpb, green line) and the estimated transmission control accounting for behavior, policy, and variants (TC, blue line). On the graph, the value is shown for the mid-point of each two-week period. Transmission control is estimated using model fitting approaches to align model output with COVID-19 hospitalizations.

COVID-19 Mortality. COVID-19 deaths were higher than expected based on our model during the April 2020 and December 2020 peaks (Figure A5). This discrepancy is consistent with recent literature suggesting hospital mortality increases as hospitals admit high numbers of COVID-19 patients, even below capacity limits. We have seen a recent increase in COVID-19 deaths above our model projections that we will monitor closely in the weeks ahead. If Colorado does approach patient loads similar to December 2020, a similar increase in mortality could occur that is not captured in our projections.

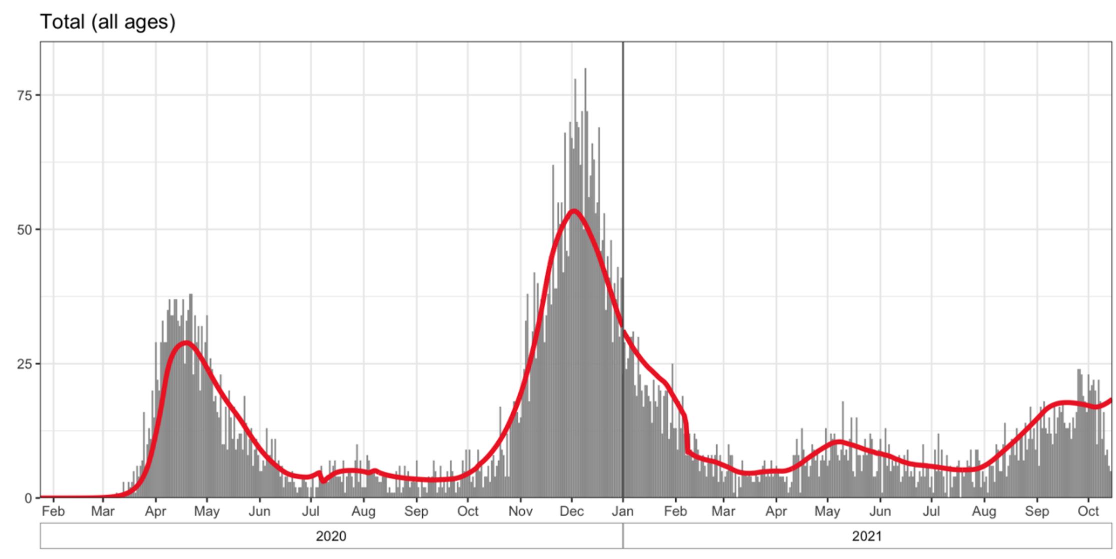


Figure A5. Model estimated COVID-19 deaths (red line) vs. reported COVID-19 deaths in Colorado by date. Due to lags in reporting, reported data in the past month may underestimate the true number of deaths.