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# STATUS UPDATE: COVID-19 EPIDEMIC TRENDS AND SCENARIO PROJECTIONS IN OREGON

*Results as of 4-22-2021, 9:30am*

## PURPOSE OF THIS STATUS UPDATE

This report uses numerous measures to create the most accurate picture of past COVID-19 transmission and incidence of infection over time in Oregon, and it projects possible trends over the next month assuming different scenarios. This report complements the extensive epidemiologic data (e.g., demographic trends in cases, testing patterns) for Oregon available at the [Oregon Health Authority \(OHA\) COVID-19 webpage](#).

## RESULTS UPDATED EVERY THREE WEEKS

Please note that the COVID-19 data used for the modeling are continually being updated. (For daily up-to-date information, visit the [OHA COVID-19 webpage](#).) The results in this brief will be updated every three weeks as more data become available, the science to inform the model assumptions expands, and modeling methods continue to be refined. The model serves as a useful tool for summarizing trends in COVID-19 transmission in Oregon and for understanding the potential impact of different future scenarios. Point estimates should be interpreted with caution, however, due to considerable uncertainty behind COVID-19 model assumptions and limitations to the methods.

## ACKNOWLEDGEMENTS

OHA wishes to thank the Institute for Disease Modeling (IDM) for their support. For this status update, Niket Thakkar at IDM provided the software, programming scripts, and technical assistance. This report is based on aspects of IDM's technical reports ([IDM COVID Reports](#)) and Washington State Department of Health's COVID-19 Situation Reports ([WA Situation Reports](#)), adapted for Oregon.

## METHODS

For this status update, we used the COVID-19 modeling software Rainier. Rainier is software designed by the Institute for Disease Modeling (IDM) to algorithmically estimate the effective reproduction number ( $R_e$ ) over time based on local data and to conduct simple projections. Rainier fits a stochastic SEIR (susceptible – exposed – infectious – recovered) model to testing, hospitalization, and mortality time series. This software has been used to generate regular situation updates for the State of Washington overall and by two regions within Washington ([Example WA Report](#)).

Results are based on COVID-19 data compiled April 21 from the Oregon Pandemic Emergency Response Application ([Opera](#)) on COVID-19 testing, total diagnosed cases,<sup>1</sup> hospitalized cases, and deaths among people living in Oregon. To account for delays in reporting, diagnosed cases with a specimen collection date after April 13 were not used; we used the same cutoff date for hospital admissions and deaths.<sup>2</sup> In the model, cases tested on April 13 reflect exposures that occurred around April 7.

Since the last report, we have made the following methodological updates:

- Our age-specific infection fatality ratio (IFR) assumptions are now consistent with CDC's updated best estimates [here](#).
- We updated the model's age-specific infection hospitalization ratio (IHR) assumptions based on the new IFRs, making each consistent with age-specific ratios of hospitalizations to fatalities from Opera.
- We now assume that COVID-19 reported cases reflect a higher detection rate among symptomatic infections, and that the likelihood of symptoms increases with age. For this, we used estimates of the proportion symptomatic by age from [here](#).

These updates lowered the estimate of cumulative infections (6.9% vs. 9.4% in the last report); hence, our estimate of natural immunity is lower (more conservative) than before. Although there remains considerable uncertainty about these assumptions, these updates reflect the latest science. In Rainier, the IFR assumptions primarily affect the estimated number of infections over time, while IHR assumptions inform the  $R_e$  curve (along with testing data).

Additional information about the methods, including the vaccination update, can be found in Appendix 1.

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<sup>1</sup> Total diagnosed cases include confirmed (positive test) and presumptive cases (symptoms with epidemiologic link).

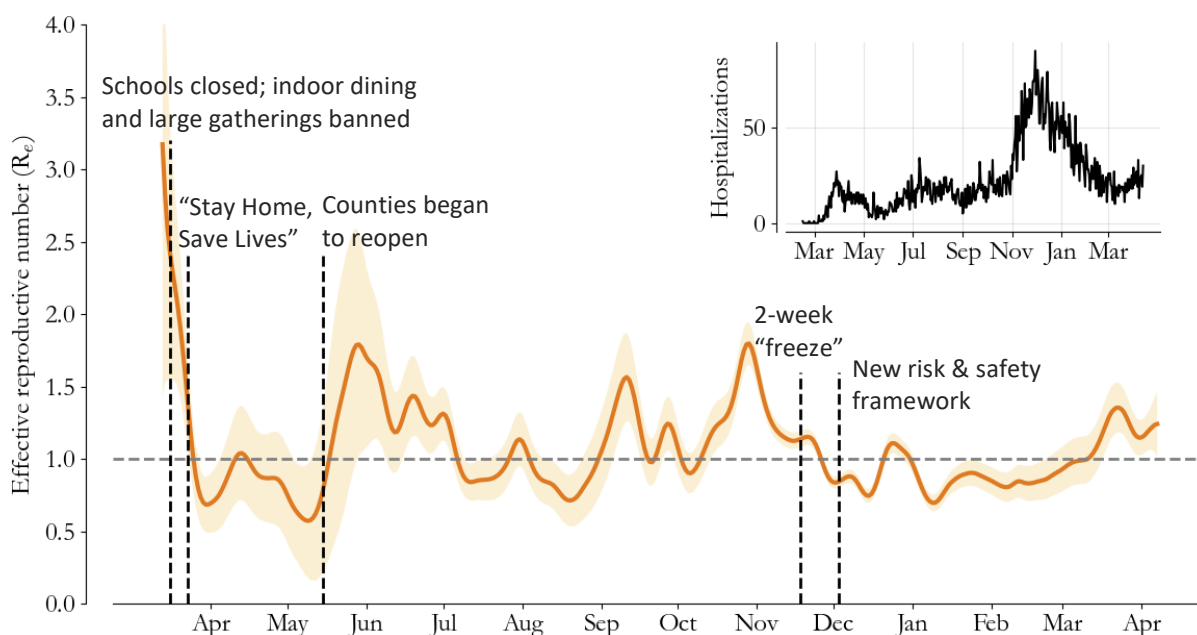
<sup>2</sup> This date reflects the cutoff through when individuals had a test specimen collected, were admitted to a hospital, or died. Any of these events may have been reported to OHA at a later date.

# RESULTS

## Effective reproduction number

From the model results (Figure 1), it is clear the statewide  $R_e$  -- the average number of secondary cases that a single case generates -- has continued to fluctuate up and down over time, with dramatic shifts sometimes happening quickly.

Since mid-March, the  $R_e$  has increased above 1 and continued on a generally upward trend. As of April 7, the statewide  $R_e$  was likely between 1.02 and 1.46, with a best estimate of 1.24. The best-estimate  $R_e$  averaged 1.20 over the week ending on April 7.



**Figure 1:**  $R_e$  estimates over time for Oregon, with shaded 95% confidence interval.<sup>3</sup> Graph insert is the number of new hospitalizations over time in Oregon, a key input for the estimates.  $R_e = 1$  is the threshold for declining transmission.

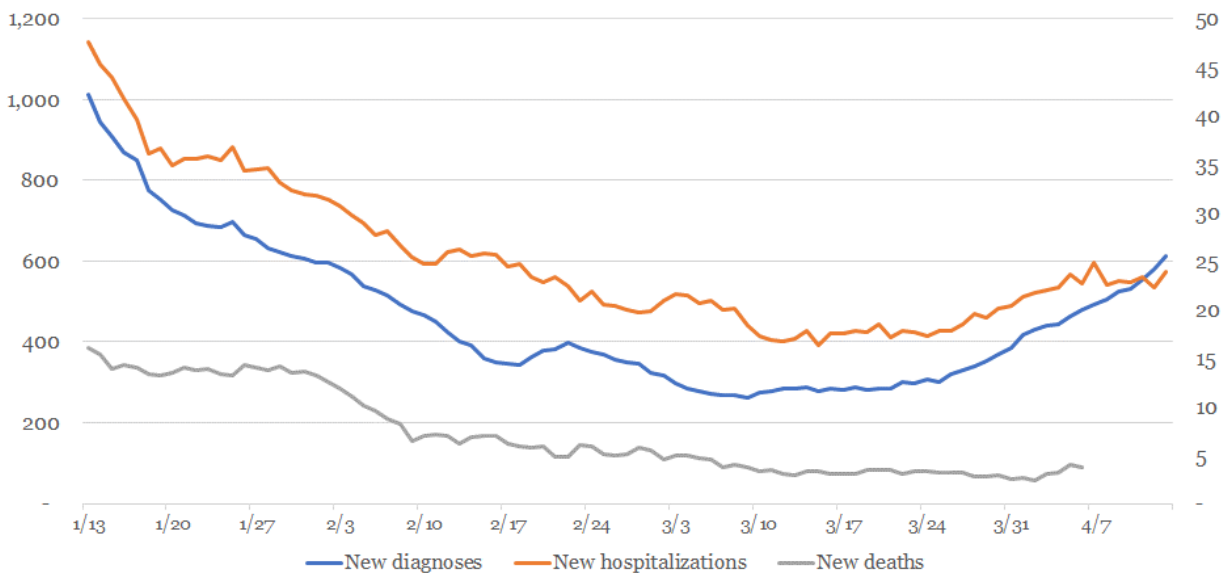
It is important to note that the changes in  $R_e$  over time may be due to some combination of changing behaviors, changes in opportunities for potential exposure as counties' interventions become more or less stringent, viral infectivity, and/or immunity (either from vaccination or recovering from infection). In addition, these  $R_e$  estimates are based on averages statewide, but the growth in cases in Oregon has varied by county ([OHA County Dashboard](#)), race, ethnicity, and age ([COVID-19 Weekly Report](#)).

<sup>3</sup> Our  $R_e$  confidence interval may be narrower at times because of how we estimated specimen collection dates for negative tests (and thus positive test rate for each day), as described in Appendix 1.

Our best estimate of the  $R_e$  for April 7 (1.24) is similar to the estimate for that date<sup>4</sup> from [Harvard, Yale, and Stanford](#) (1.29), but higher than recent estimates from [Covid Act Now](#) (1.16) and Institute for Health Metrics and Evaluation ([IHME](#); 1.03).

### Recent case trends

Our  $R_e$  estimates are based on a model that used data on diagnosed cases, hospitalized cases, and deaths, while taking into account changes in testing volume and practice. Examination of these outcomes (Figure 2) helps explain the recent trends in the estimated  $R_e$ . The 7-day rolling average of diagnosed cases has been increasing since mid-March. New hospitalizations increased between mid-March and early April and then seemed to level off through April 13. The number of deaths had been long-declining, but this trend started to reverse in early April.

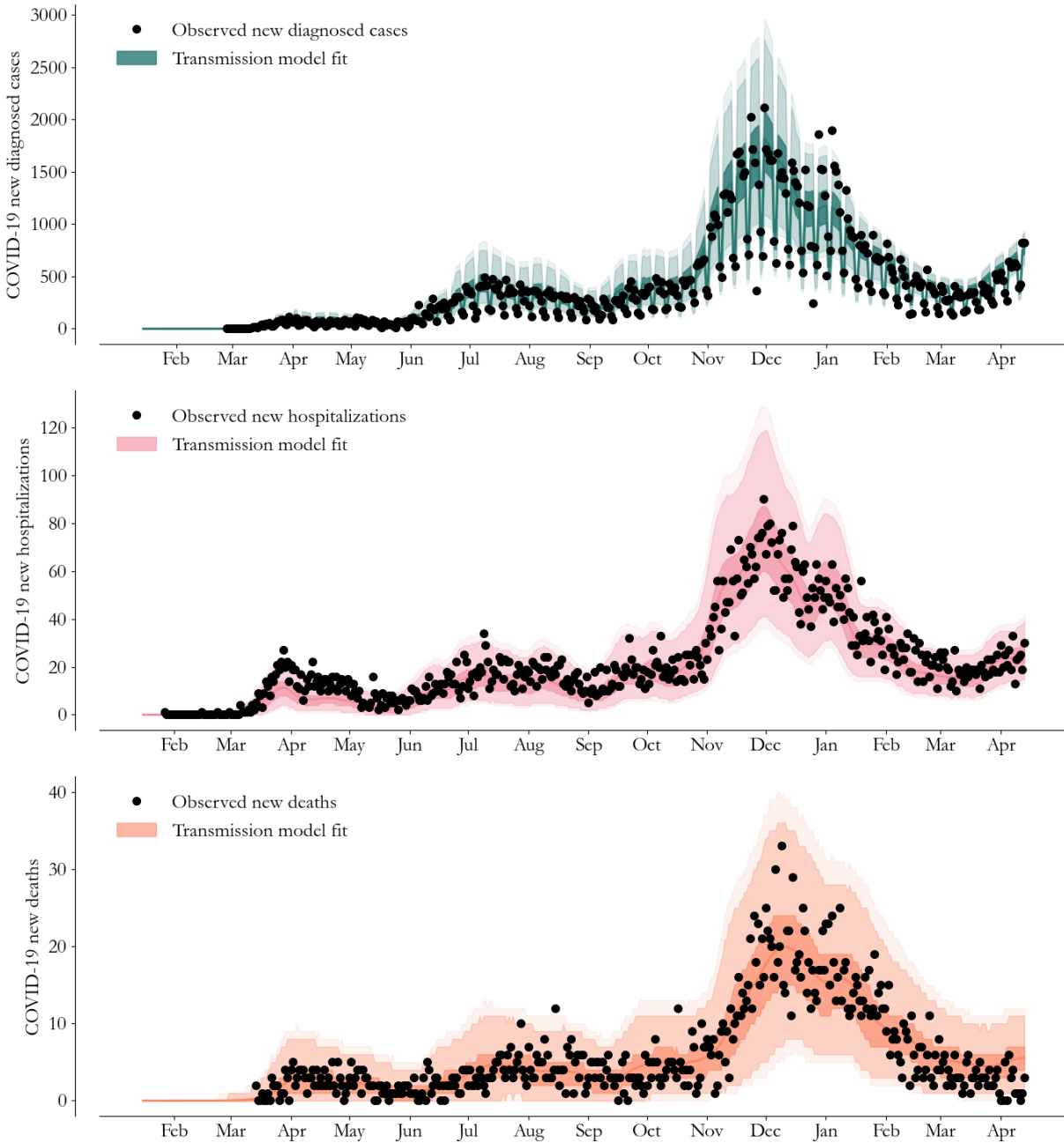


**Figure 2:** Seven-day rolling average numbers of new diagnosed cases (left axis), new hospitalizations (right axis), and new deaths (right axis) due to COVID-19. Dates reflect when individuals had a test specimen collected (diagnosed cases), were admitted to the hospital, or when they died.

### Model fit to Oregon COVID-19 data

Figure 3 shows how the transmission model captures trends in the daily Oregon COVID-19 outcomes over time.

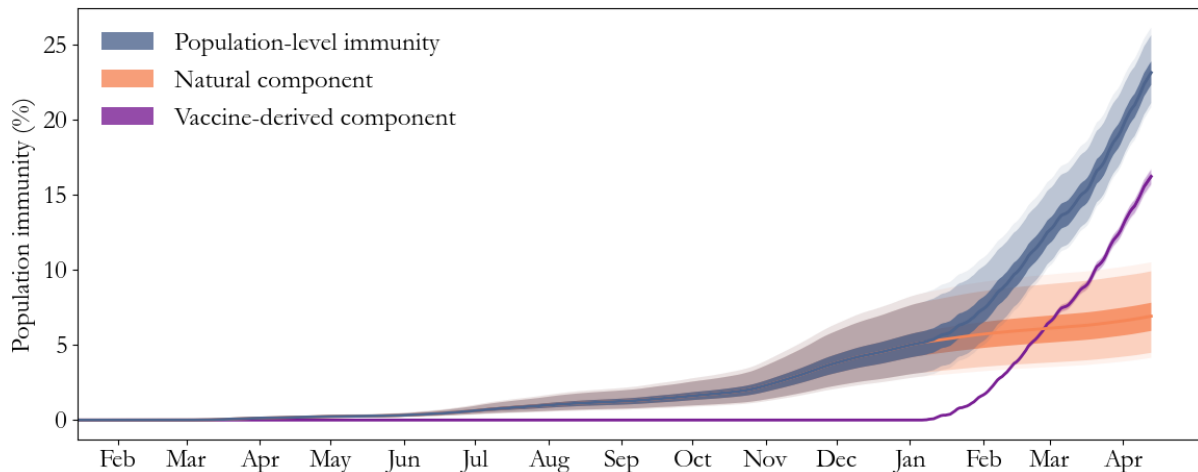
<sup>4</sup> Model  $R_e$  estimates are dated April 7, 2021, except for IHME's, which is dated April 1. All were accessed on April 20, 2021.  $R_e$  estimates from RT Live and covid19-projections.com have been discontinued. The exact point  $R_e$  estimate from [CMMID](#) was not available for April 7, but was approximately 1.1.



**Figure 3:** Fitting the transmission model to Oregon’s COVID-19 data on diagnosed cases, hospitalizations, and deaths. The lines represent the mean of 10,000 runs; the 25th-75th percentiles are given in dark shaded areas, 2.5th-97.5th percentiles in the lighter shade, and 1st-99th percentiles the lightest shade. The black dots are observed data. Top panel: Modeled cases (teal) capture the trend in observed, daily new diagnosed cases based on  $R_e$  estimates and a free number of importations on January 20, 2020 and February 1, 2020. Middle panel: Simultaneously, the model (pink) captures the trend in observed daily new hospitalizations by assuming hospitalizations are independent of testing volume. Bottom panel: With its time-varying infection fatality ratio, the model (orange) captures the observed trend in daily deaths.

## Population-level immunity

Figure 4 shows population-level immunity from SARS-CoV-2 infection over time.



**Figure 4:** Population-level immunity to SARS-CoV-2 infection over time. The “natural component” consists of people who developed and then recovered from COVID-19. The “vaccine-derived component” consists of people who were not previously infected, but who achieved immunity from a vaccination dose administered 21 days prior.

Rainier estimates that as of mid-April, the population-level immunity to SARS-CoV-2 is 23.1% (95% confidence interval: 21.1% - 25.6%). The estimated immunity from vaccination (16.2%) is over double the estimate for natural immunity (6.9%).

## Other indicators of trends in transmission

Since we did not include COVID-19 outcome data occurring after April 13 in our modeling dataset due to reporting delays, we examined other possible indicators to better understand how transmission might be changing.

First, we examined counts of Oregon COVID-19 [hospital occupancy](#) to see if trends have changed more recently. Data from HOSCAP, which is updated daily, indicate that hospital occupancy increased substantially between April 13 and April 22.

Second, recent trends in measures of mask wearing and mobility from other studies suggest that protective health behaviors might be waning in Oregon, further supporting transmission increases and the possibility that cases will continue to increase in the near future. IHME has reported results from the Premise Survey, which suggest current mask wearing in public in Oregon might be lower than February 2021 levels – with only 75% of participants currently reporting always wearing a mask in public when they

expect to be within six feet of another person. The physical distancing composite index from the [University of Maryland COVID-19 Impact Analysis Platform](#) recorded the lowest average level of physical distancing in our state since early March 2020. Likewise, the statewide [Google](#) mobility index recorded the greatest amount of mobility across the state since before the pandemic began

Data on SARS-CoV-2 variants suggest transmission rates will increase in the shorter term even if protective health behaviors do not experience further decline. B117 appears to make up more than half of the variants recently tested in Oregon ([OHA Variant Dashboard](#)) and is estimated to be 50% more infectious than the earlier SARS-CoV-2 strains ([CDC Information on Variants](#)).

## Scenario Projections

With the fitted model, we can explore outcomes under future scenarios. That is, we do short-term projections to compare what *would* happen if we assume different future scenarios, rather than specific forecasting about what *will* happen. More about this distinction is described [here](#). Some forecasts of COVID-19 trends generated by others are summarized in Appendix 2.

For the current report, we modeled what would happen to case and hospitalization trends under two future scenarios having different transmission rates.<sup>5</sup> These scenarios assume recent vaccination levels will continue in the upcoming weeks.

Figures 5 and 6 illustrate what could happen over the next month:

- If the transmission rate as estimated for April 7 persisted.
  - We would see a continued rapid increase in diagnosed cases. For the two-week period between April 28 and May 11, the projected number of new diagnosed cases would rise to 320 per 100,000 people. This rate translates to a daily average of 960 cases.
  - New hospitalizations would increase to 38 per day by May 11.
- If the transmission rate increased by 20% starting on April 8. This scenario is intended to illustrate what might happen over the next month if the transmission rate

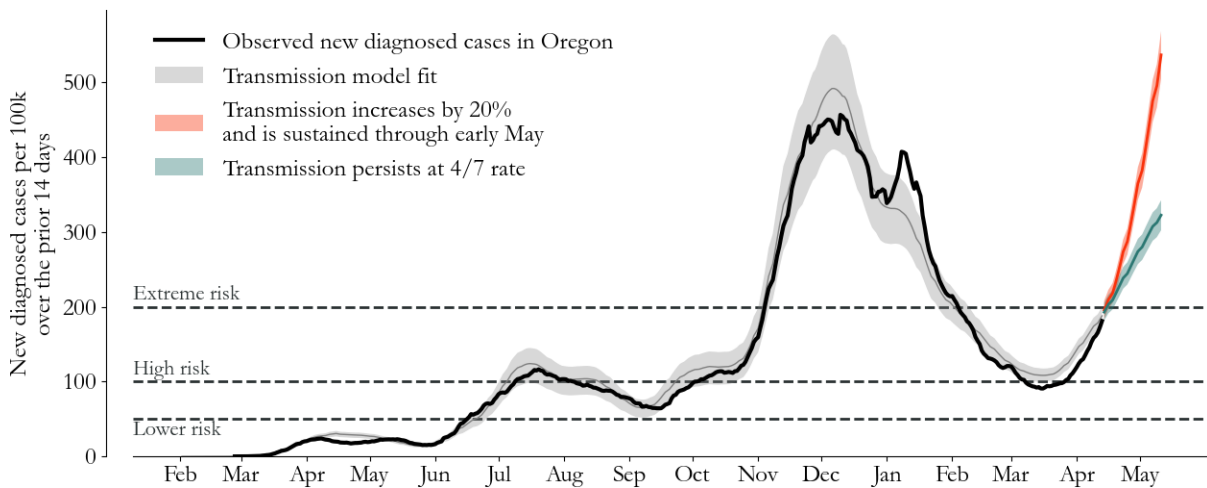
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<sup>5</sup> A given transmission rate will result in slower growth in cases over time (and lower  $R_e$ ) as the population immunity increases because people who are infected becomes less and less likely over time to encounter someone not immune. Hence, as a larger proportion of the population becomes vaccinated, the  $R_e$  for Oregon will begin to decrease even if the transmission rate stays the same. On April 7, the estimated rate of transmission corresponded to a  $R_e$  of 1.24.

were to increase due to continuing spread of more infectious variants, and if increased infectivity was not offset by people adopting more protective behaviors.

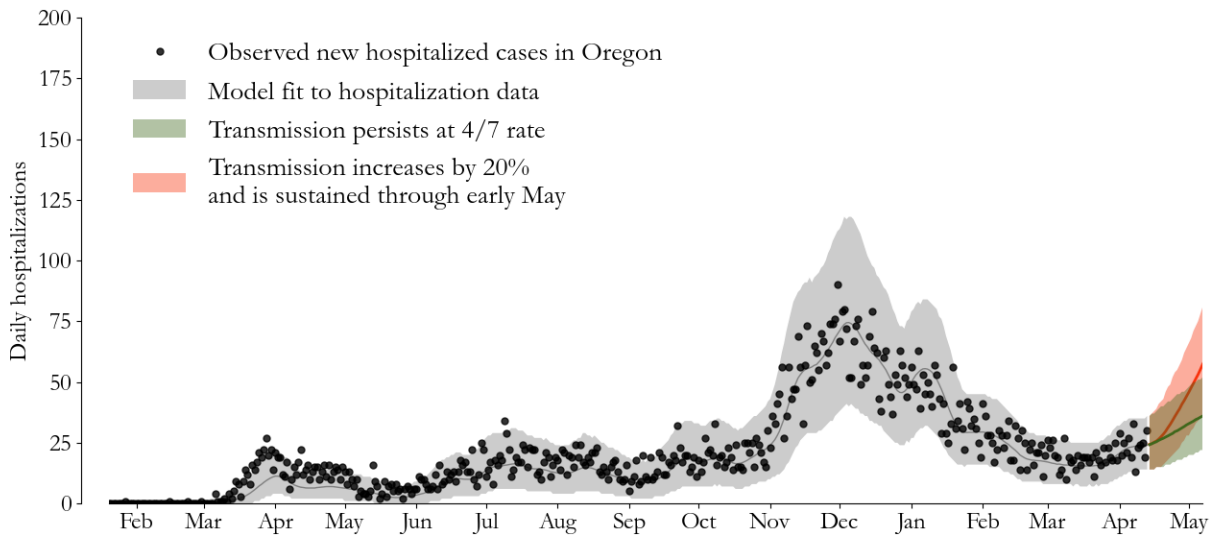
- New diagnosed cases would reach 540 per 100,000 people for the two-week period between April 28 and May 11; this rate translates to a daily average of 1,610 cases.
- New hospitalizations would increase to 66 per day by May 11.

The results for the latter scenario are more consistent with the trends in hospital occupancy over the last week from HOSCAP data than the first scenario.



**Figure 5:** Observed diagnosed cases (per 100k population over the previous 14 days) for Oregon and projected cases under two scenarios. The black line shows observed cases, while the colored lines show diagnosed cases projected if the transmission rate estimated for April 7 persists (blue) or increases by 20% starting April 8 (red). Shaded areas: 25th-75th percentile ranges of the model fit. The risk levels of COVID activity (dashed horizontal lines) are defined by the [Oregon Framework for County Risk Levels](#).





**Figure 6:** Observed hospitalized cases for Oregon and projections under two scenarios. Black dots show observed daily counts, while the grey line shows model fit. The colored lines show hospitalizations projected if the transmission rate estimated for April 7 persists (green) or increases by 20% starting April 8 (red). Shaded areas: 2.5th-97.5th percentile ranges.

Consistent with both of our scenario projections, forecasts from CDC and Oregon Health and Science University (OHSU) suggest COVID-19 hospitalizations will be increasing in the month ahead in Oregon (Appendix 2) rather than flattening. COVID-19 hospitalizations over the coming months will continue to depend on our collective efforts. Although over 1.5 million Oregonians have received at least one [COVID-19 vaccine](#) dose, it takes weeks to develop immunity after vaccination, and millions of Oregonians – including many of those vulnerable to severe illness -- have yet to receive even a single dose. Oregonians need to continue doing their part to stop COVID-19 hospitalizations -- getting vaccinated when they are eligible, wearing a mask, physical distancing, and avoiding indoor gatherings.

## Appendix 1: Additional assumptions and limitations

We used a COVID-specific transmission model fit to Oregon data on testing, confirmed COVID-19 cases, hospitalized cases, and deaths to estimate the effective reproduction number ( $R_e$ ) over time. The key modeling assumption is that individuals can be grouped into one of four disease states: susceptible, exposed (latent) but non-infectious, infectious, and recovered.

- For an in-depth description of our approach to estimating  $R_e$  and its assumptions and limitations, see IDM's [technical report](#) for detailed methods information, as well as the November 23 [WA Situation Report](#) for methodology updates.
- As described [previously](#), estimates of  $R_e$  are based on an adjusted epidemiologic curve that accounts for changing test availability, test-positivity rates, and weekend effects, but all biases may not be accounted for.
- We included only diagnosed cases, hospitalized cases, and deaths occurring at least 8 days before our Opera data file extract to account for delays in reporting. If reporting delays are longer than that, the last few days of our model input data may undercount COVID-19 events.
- In calculating the proportion of the population with natural immunity, Rainier assumes all people infected and recovered have remained immune.
- Estimates of  $R_e$  describe average transmission occurring across Oregon. This report does not separate case clusters associated with known super-spreading events from diffuse community transmission. This report also does not estimate  $R_e$  separately for specific populations, who might have higher risk of exposure because of their occupation, living arrangements, access to health care, etc.
- We assumed free / undefined numbers of importations occurring on 1/20/20 and 2/1/20, and specified changes in testing volumes occurring around 4/1/20, 6/23/20, 9/29/20 11/1/20, 11/28/20, 12/15/20, and 12/27/20.
- In contrast to recent reports for Washington State, we assumed a mean exposure-to-hospitalized time of 12 days.
- Our age-specific infection fatality ratio (IFR) assumptions are based on those referenced by CDC's [Planning Scenarios](#). We used population fatality rate data from Opera to compute IFRs for the age groups used by Rainier.
- Our age-specific infection hospitalization ratio (IHR) assumptions were computed by dividing each age-specific IFR by the corresponding death-to-hospitalization ratio using data from Opera.
- We now assume that COVID-19 reported cases reflect a higher detection rate among symptomatic infections, and that symptomatic infection rate increase with age. We used age-specific % symptomatic assumptions as estimated [here](#) and adjusted our weekly case distribution to reflect these detection assumptions (without affecting the total number of cases detected).

- We compared our estimates of immunity with [CDC's](#) latest commercial laboratory seroprevalence estimate for Oregon, which was for February 2021. Their estimate of seroprevalence (6.7%; confidence interval: 5.0% - 8.3%) was higher than Rainier's estimate of natural immunity (5.3%) and lower than Rainier's estimate of total immunity (i.e., either natural immunity or immunity from vaccination) (9.3%) for February 2021.
- We use test specimen collection date for new cases but have only lab report date for negative tests. To better align these two outcomes, we redistributed negative test counts. These counts were reallocated among the laboratory report day and the two days prior, according to distribution of positive cases (by specimen date) occurring over those same three days. Because Rainier's  $R_e$  uncertainty is partially based on variation in percent positive, this redistribution of negative cases may cause the  $R_e$  confidence intervals to narrow.
- Point estimates should be interpreted with caution due to considerable uncertainty behind COVID-19 model assumptions and limitations to the methods.

Rainier now takes vaccination data into account -- both in estimating historical  $R_e$  and in scenarios projecting future counts of diagnosed and hospitalized cases (assuming specified COVID-19 transmission rates). Detailed documentation of the model's vaccination component is currently being prepared by the Institute for Disease Modeling. We describe those methods briefly here.

- For this report, Rainier assumed<sup>6</sup> that a proportion of vaccinated individuals would be protected from SARS-CoV-2 infection 21 days after each vaccine dose: on average 58.0% of those vaccinated after the first dose, and an additional 24.4% after the second dose (for a total of 82.4%). Among vaccinated people not protected from SARS-CoV-2 infection, Rainier assumes roughly 20% to be protected from experiencing severe COVID-19 symptoms (i.e., hospitalization or death) but still able to transmit the virus.
- Rainier's estimate of immunity from vaccination may be conservative – that is, slightly lower at any given point in time because it assumes no immunity develops until three weeks following a dose.
- Another limitation is Rainier's use of these same assumptions for all the vaccines; hence, for this report the single-shot Johnson & Johnson vaccine was considered equivalent to first-doses of the Pfizer or Moderna vaccines. This limitation is not expected to have a large influence on results since the Johnson and Johnson vaccines currently constitute only about 2% of total vaccine doses administered to-date in Oregon. However, this vaccine may be modeled separately in the future as it becomes more frequently administered.

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<sup>6</sup> Dagan, Noa, et al. "BNT162b2 mRNA Covid-19 vaccine in a nationwide mass vaccination setting." *New England Journal of Medicine* (2021). Available online at <https://www.nejm.org/doi/pdf/10.1056/NEJMoa2101765>

## Appendix 2: Summary of External COVID-19 Forecasts

CDC compiles state-level forecasts from numerous national modelers, and produces an ensemble forecast. For Oregon, CDC's ensemble forecast for [diagnosed cases](#) predicts case counts to increase through mid-May, from about 4,800 to 6,100 per week. CDC's ensemble forecast for [hospitalizations](#) predicts that Oregon daily admissions will also increase through mid-May, from 34 to 53 per day.<sup>7</sup>

Institute for Health Metrics and Evaluation's April 15th [forecast](#) for Oregon estimates that daily new infections will most likely decline through mid-August.

Oregon Health and Science University produces a weekly COVID-19 forecast for Oregon, available [here](#). They present projections under various scenarios. Their forecast (referred to as "primary scenario") suggests hospital occupancy will increase over the next month, and then begin to decline by late May from population-level immunity.

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<sup>7</sup> CDC ensemble forecasts are dated April 19, 2021; accessed on April 21, 2021.