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

Results as of 4-2-2021, 9:30 am

PURPOSE OF THIS STATUS UPDATE

This update describes trends in COVID-19 transmission over time and projects 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 March 31 from the Oregon Pandemic Emergency Response Application (Opera) on COVID-19 testing, total diagnosed cases,[1] hospitalized cases, and deaths among people living in Oregon. To account for delays in reporting, diagnosed cases with a specimen collection date after March 23 were not used; we used the same cutoff date for hospital admissions and deaths.[2] In the model, cases tested on March 23 reflect exposures that occurred around March 17.

Rainier has been updated since the last report by adjusting for immunity in estimating R_e over time and incorporating vaccination plans into the scenarios. Additional information about the methods, including the vaccination update, can be found in Appendix 1.

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 early January, people in Oregon had driven cases down and kept the estimated R_e below 1. In mid-March, however, the trend of decreasing cases stopped, and the R_e appears to have increased to above 1. As of March 17, the statewide R_e was likely between 0.74 and 1.49, with a best estimate of 1.12. The best-estimate R_e averaged 1.03 over the week ending on March 17.

[1] Total diagnosed cases include confirmed (positive test) and presumptive cases (symptoms with epidemiologic link).
[2] 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.

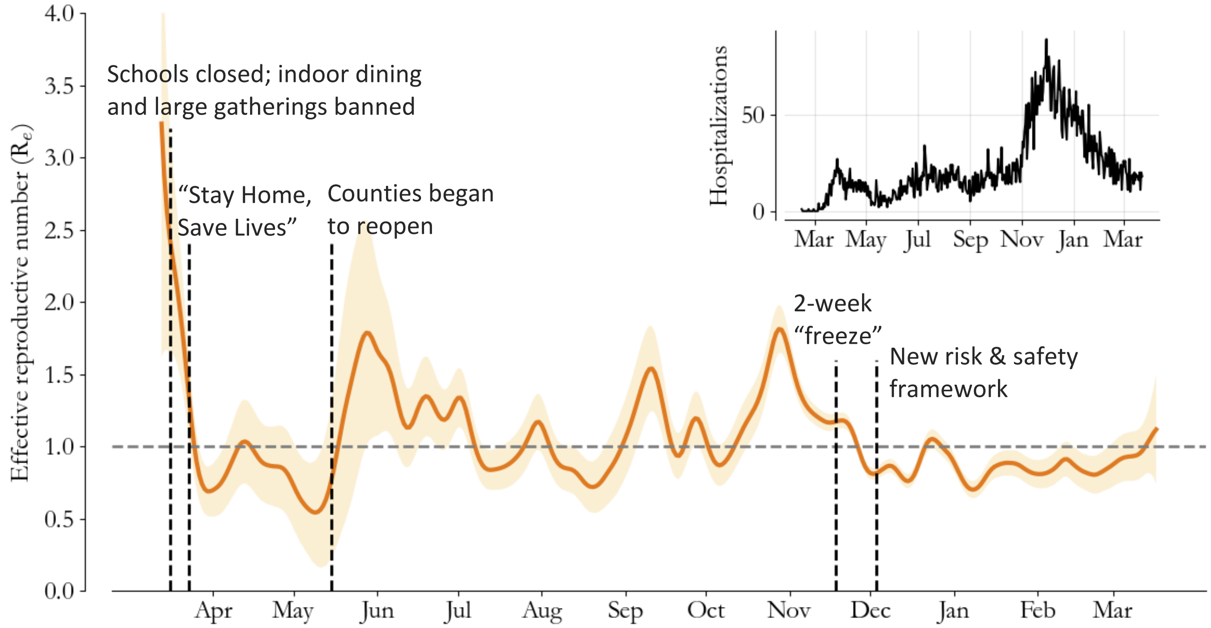

Figure 1: *R_e estimates over time for Oregon, with shaded 95% confidence interval.* [3] *Graph insert is the number of new hospitalizations over time in Oregon, a key input for the estimates. R_e = 1 is the threshold for declining transmission.*

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).

Our best estimate of the R_e for March 17 (1.12) is similar to the estimate for that date[4] from Harvard, Yale, and Stanford (1.16), and higher than that from Covid Act Now (1.02) and IHME (1). Both Harvard, Yale, and Stanford and Covid Act Now estimate R_e has increased since March 17 (to 1.58 and 1.08, respectively).

[3] 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.

[4] Model R_e estimates are dated March 17, 2021, except for IHME's, which is dated March 18. All were accessed on April 1, 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 March 17, but it is above 1.

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 averages of both diagnosed cases and hospitalizations saw a rapid declines since January, but both metrics stopped declining in March, with new diagnosed cases starting to increase.

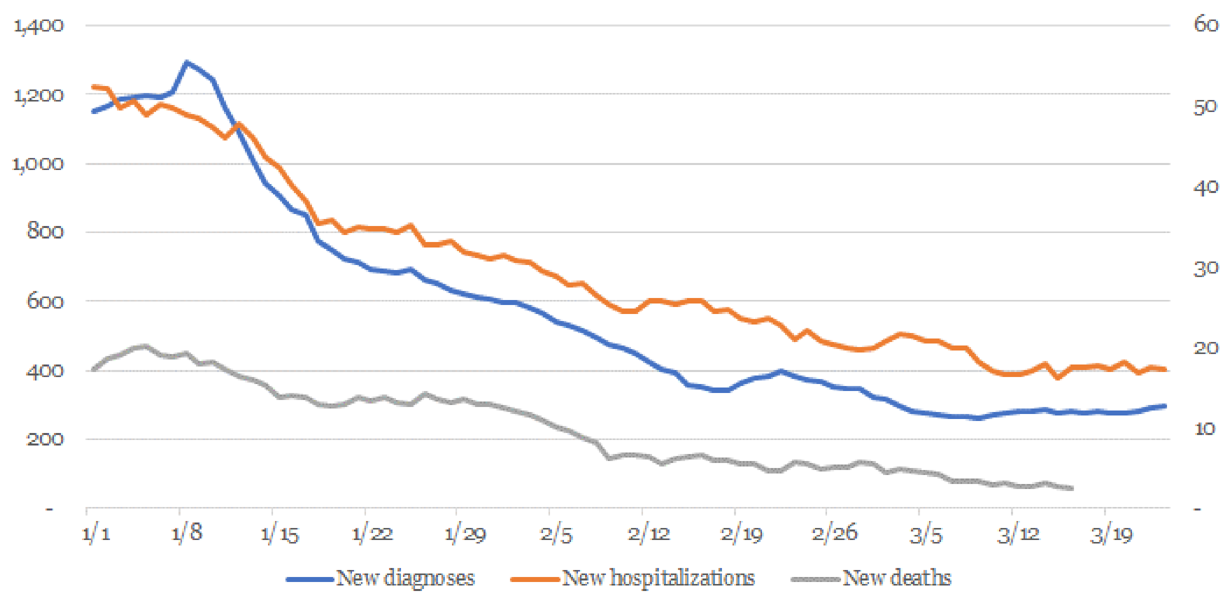

Figure 2: *Seven-day rolling average numbers of new diagnosed cases (left axis), new hospitalizations (right axis), and new deaths (right axis) due to COVID-19. Dates reflect when individuals had a test specimen collected (diagnosed cases), were admitted to the hospital, or when they died.*

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.

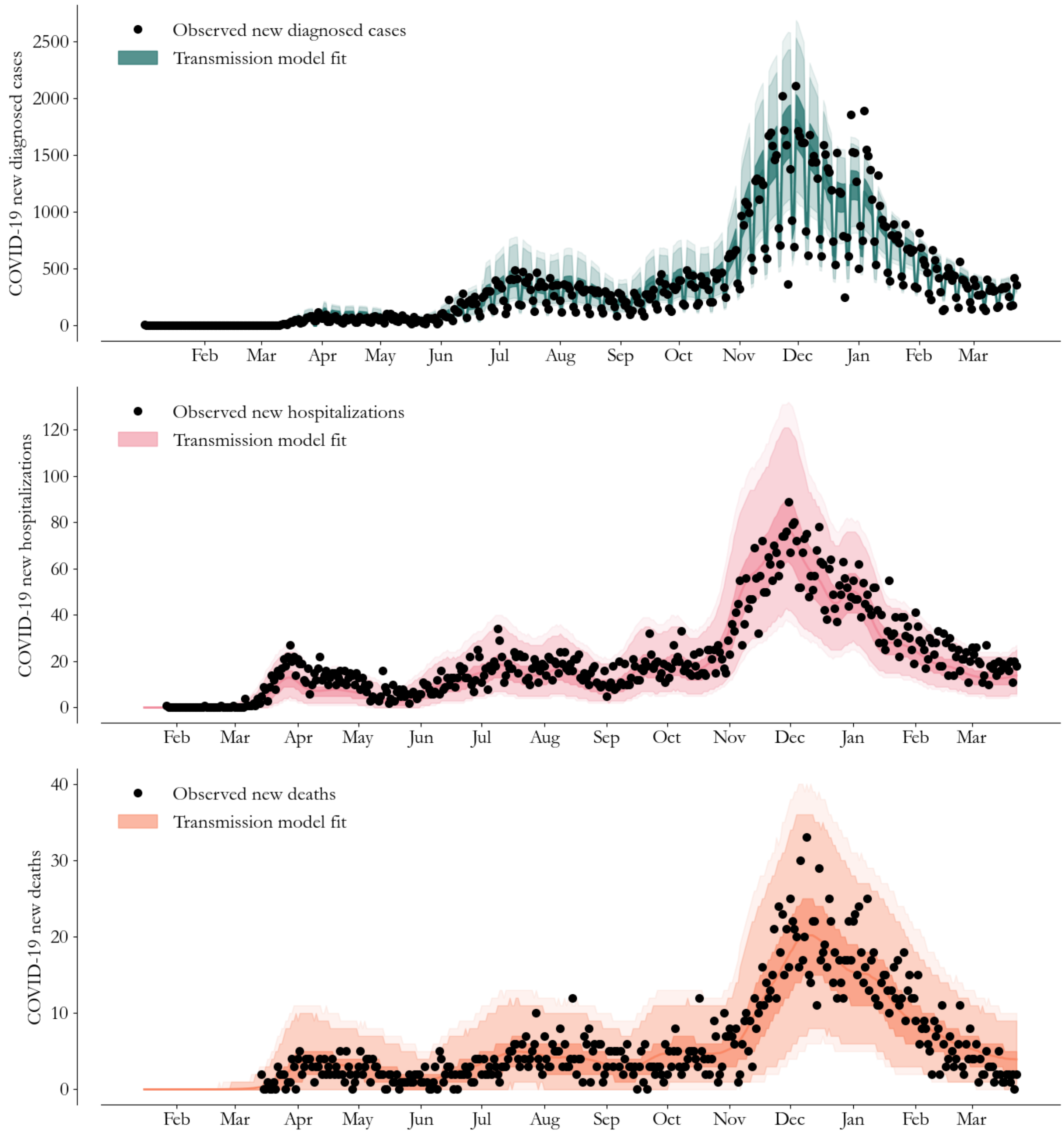

Figure 3: *Fitting the transmission model to Oregon's COVID-19 data on diagnosed cases, hospitalizations, and deaths. The lines represent the mean of 10,000 runs; the 25th-75th percentiles are given in dark shaded areas, 2.5th-97.5th percentiles in the lighter shade, and 1st-99th percentiles the lightest 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.*

Covid-19 trends after the data cutoff

Since we did not include events occurring after March 23 in our modeling dataset, we examined counts of Oregon COVID-19 hospital occupancy to see if trends have changed since that date. Data from HOSCAP, which is updated daily, indicate that hospital occupancy has been increasing since March 26.

Population-level immunity

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

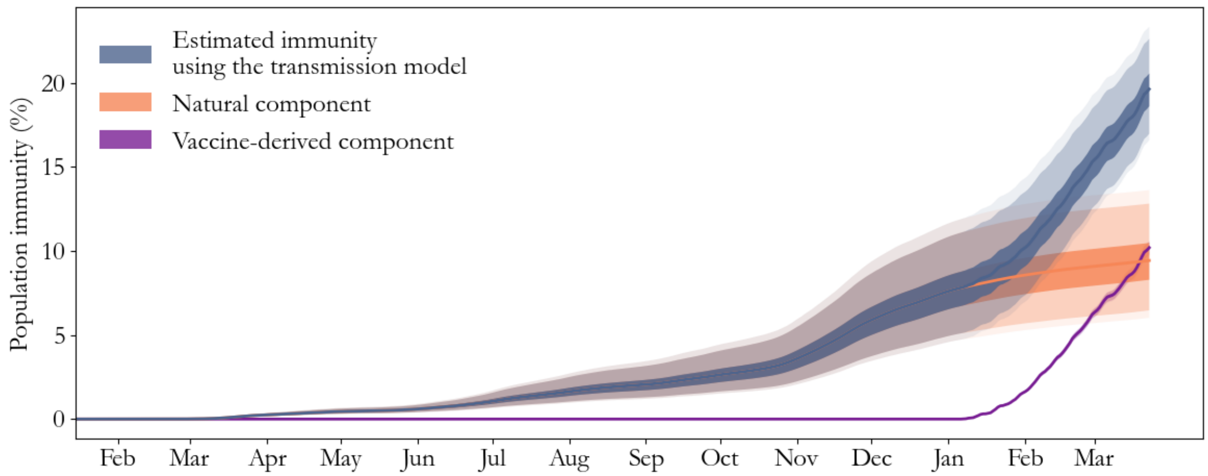

Figure 4: *Population-level immunity to SARS-CoV-2 infection over time. The "natural component" consists of people who developed and then recovered from COVID-19. The "vaccine-derived component" consists of people who were not previously infected, but who achieved immunity from a vaccination dose administered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

Rainier estimates that as of late March, the population-level immunity to SARS-CoV-2 is 19.6% (95% confidence interval: 17.0% - 22.6%), with 9.4% (6.5% - 12.8%) from natural immunity and 10.2% from vaccination (9.8% - 10.5%). This estimate of natural immunity is higher than CDC's commercial laboratory seroprevalence survey estimate for Oregon in late February (6.7%; confidence interval: 5.0% - 8.3%). Rainier's estimate of natural immunity assumes all people infected & recovered are immune and have remained immune. 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.

Scenario Projections

With the fitted model, we can explore outcomes under future scenarios. That is, we do 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, and some Oregon forecasts generated by others are summarized in Appendix 2.

For the current report, we modeled what would happen to case and hospitalization trends under three future scenarios having different transmission rates. 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 March 17, the estimated rate of transmission corresponded to an *Re* of 1.12.

For all of these scenarios, we assume the estimated rate of transmission for March 17 remains constant through March 23 and any changes start March 24. 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 March 17 persisted.
    - We would see a steady increase in diagnosed cases. For the two-week period between April 7 and April 20, the projected number of new diagnosed cases would rise to 130 per 100,000 people. This rate translates to a daily average of 390 cases.
    - New hospitalizations would increase to 17 per day by April 20.
- If the transmission rate increased by 20%, This scenario is intended to illustrate what would happen over the next month if, due to some combination of changing behavior and the spread of more infectious variants, the rate of transmission were to increase.
    - New diagnosed cases would reach 195 per 100,000 people for the two-week period between April 7 and April 20; this rate translates to a daily average of 585 cases.
    - New hospitalizations would increase to 27 per day by April 20.
- If the transmission rate decreased by 20%. This scenario is intended to illustrate what would happen over the next month if people became more adherent to

prevention recommendations -- wearing a mask, physical distancing, and avoiding indoor gatherings, and if more infectious variants saw only limited growth.

- New diagnosed cases would fall to 86 per 100,000 people for the two-week period between April 7 and April 20; this rate translates to a daily average of 260 cases.
- New hospitalizations would decrease to 11 per day by April 20.

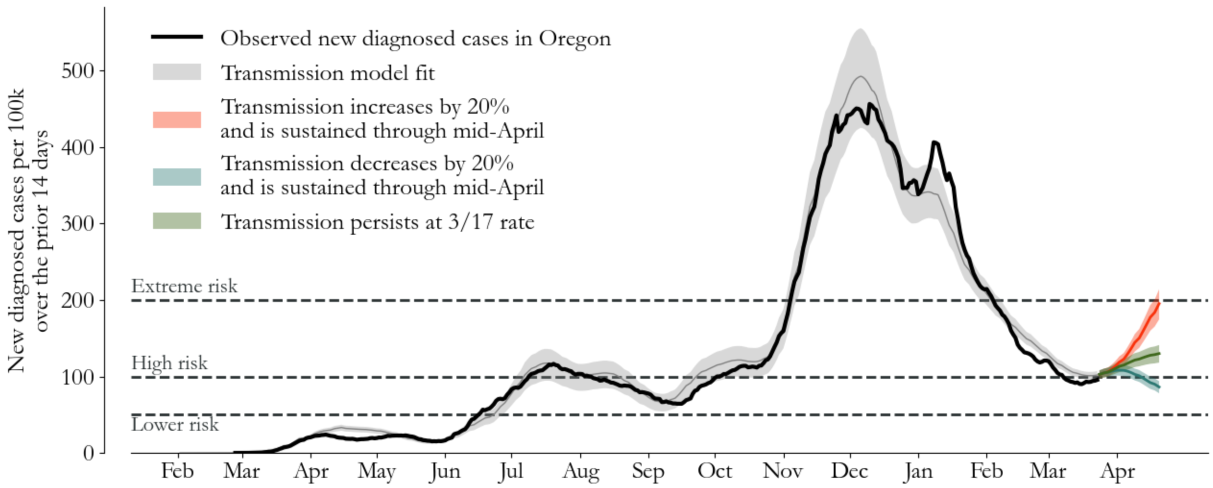

Figure 5: *Observed diagnosed cases (per 100k population over the previous 14 days) for Oregon and projected cases under two scenarios. The black line shows observed cases, while the grey shaded area shows the 25th-75th percentile range of the model fit. The colored lines show diagnosed cases projected if the transmission rate estimated for March 17 persists (blue), increases by 20% after March 23 (red), or decreases by 20% after March 23 (green) Shaded areas: 25th-75th percentile ranges. The risk levels of COVID activity (dashed horizontal lines) are defined by the [Oregon Framework for County Risk Levels](#).*

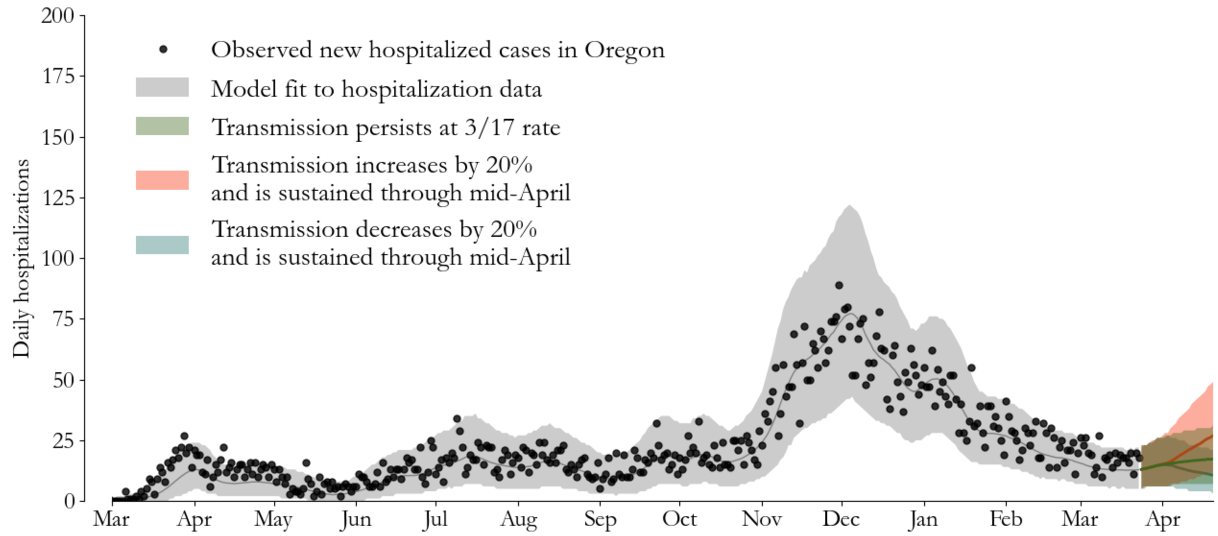

Figure 6: *Observed hospitalized cases for Oregon and projections under two scenarios. Black dots show observed daily counts, while grey region is the model-based 95% confidence interval. The colored lines line show hospitalizations projected if the transmission rate estimated for March 17 persists (blue), increases by 20% after March 23 (red), or decreases by 20% after March 23 (green) Shaded areas: 2.5th-97.5th percentile ranges.*

CDC's and OHSU's forecasts suggest COVID-19 hospitalizations will be increasing in the month ahead in Oregon (Appendix 2) rather than flattening, and our hospital occupancy numbers this week have been increasing. In addition, recent trends in measures of mask wearing and mobility from other studies suggest that protective health behaviors might be waning again in Oregon, further supporting the possibility that cases will increase unless there are behavior changes. The Institute for Health Metrics and Evaluation (IHME) has reported results from the Premise Survey, suggesting mask wearing in public might be decreasing slightly in Oregon. 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.

The scenarios presented in this report highlight how COVID-19 hospitalizations over the coming months will continue to depend on our collective efforts. Although over one 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.
- 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. In addition, this report 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 age-specific infection hospitalization ratios (IHRs) based on CDC COVID-19 Planning Scenarios, as well as a mean exposure-to-hospitalized time of 12 days. Note that Rainier adjusts the overall IHR over time based on the data.
- 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[5] 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.
- One 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.

[5] 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 slightly through late-April, from about 2,300 to 2,400 per week. CDC's ensemble forecast for hospitalizations predicts that Oregon daily admissions will increase slightly through late-April, from about 17 to 20 per day.[6]

Institute for Health Metrics and Evaluation's April 1st forecast for Oregon estimates that daily new infections will most likely decline through June.

Oregon Health and Science University produces a weekly COVID-19 forecast for Oregon, available here. They present projections under various scenarios, with their forecast (referred to as primary scenario on slide 17) suggesting hospital occupancy will increase.

[6] CDC ensemble forecasts are dated March 29, 2021; accessed on March 31, 2021.