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

Results as of 8-19-2021, 9am

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 3-4 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 to four 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 August 18 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, as well as hospital occupancy data from Oregon's Hospital Capacity Web System (HOSCAP). To account for delays in Opera reporting, diagnosed cases with a specimen collection date after August 10 were not used; we used the same cutoff date for deaths, and a cutoff date of August 2 for hospital admissions.[2] In the model, cases tested on August 10 reflect exposures that occurred around August 4.

Due to surge-related delays in hospitalizations being reported to Opera, we used hospital occupancy data from HOSCAP to estimate the number of daily hospital admissions between August 3 and August 10.

See Appendix I for more information on methods.

RESULTS

Effective reproduction number (R_e)

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 fluctuated up and down over time, with dramatic shifts often happening quickly.

After increasing sharply starting in late June, the best-estimate R_e has declined somewhat since late July but remains well above 1 (indicating continued exponential growth in infections). Over the week ending August 4, the best estimate R_e averaged

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

1.69. On the date of August 4, the statewide R_e was likely between 1.47 and 1.65, with a best estimate of 1.56.

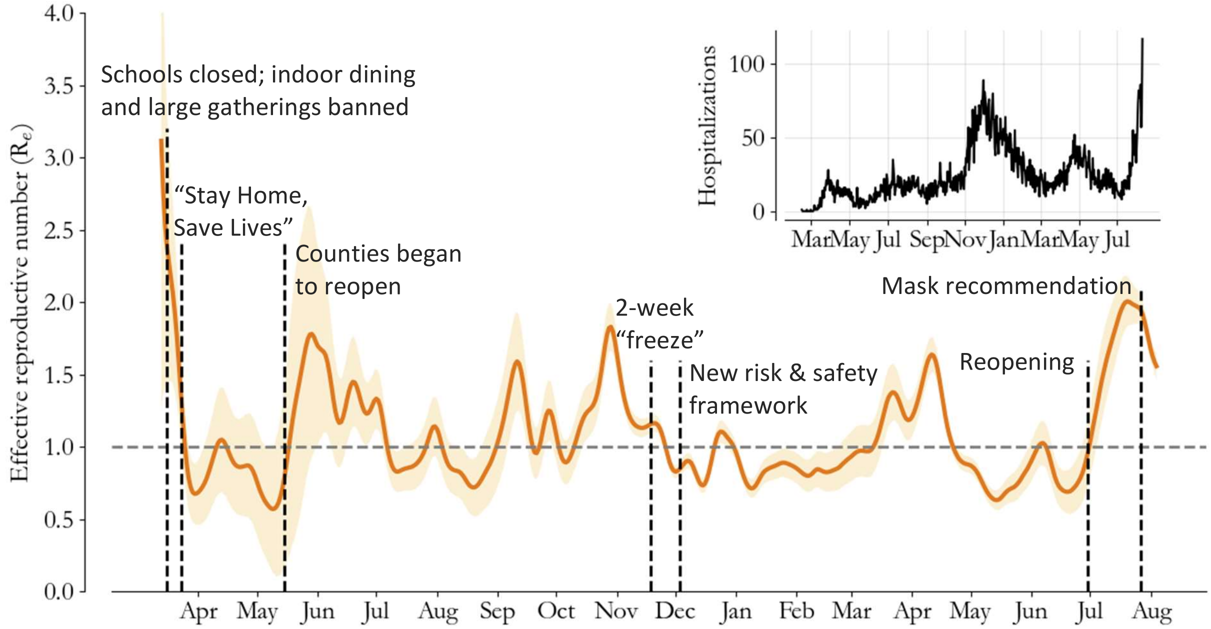

***Figure 1:** R_e estimates over time for Oregon, with shaded 95% confidence interval.*[3] *Graph insert is the number of new hospitalizations over time in Oregon, a key input for the estimates. R_e = 1 is the threshold for declining transmission.*

The observed 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, changes in variants, and/or immunity (either from vaccination or recovering from infection). The summer surge in R_e corresponded to the increase in the Delta variants (B.1.617.2 and AY.3) among cases in Oregon (OHA Variant Dashboard)[4], as well as state reopening on June 30th. The recent modest decline in R_e suggests people might be starting to adopt more protective behaviors after the news of the surge and preventive recommendations. Indeed, data from a survey of Facebook users suggest mask wearing in public has been increasing since late July in Oregon (CMU survey).

It is important to note that these estimates are based on statewide averages, yet the rate of increasing cases and hospitalizations vary dramatically by county (OHA County

[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] By the week ending August 8, the highly-infectious Delta variants (B.1.617.2 and AY.3) comprised 96% of genetically-sequenced viral samples in Oregon (OHA Variant Dashboard).

Dashboard), race, ethnicity, age (COVID-19 Weekly Report), and vaccination status (COVID-19 Monthly Report).

Our best estimate of the R_e for August 4 (1.56) is higher than recent estimates[5] from Harvard, Yale, and Stanford (1.34) and Covid Act Now (1.30).

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 diagnosed cases and hospitalizations had been generally decreasing from late April through June, but both began to increase in early July (reflecting increasing transmission beginning in late June / early July). The number of deaths has been increasing since mid-July, and recent death data are more subject to reporting delays than other metrics.

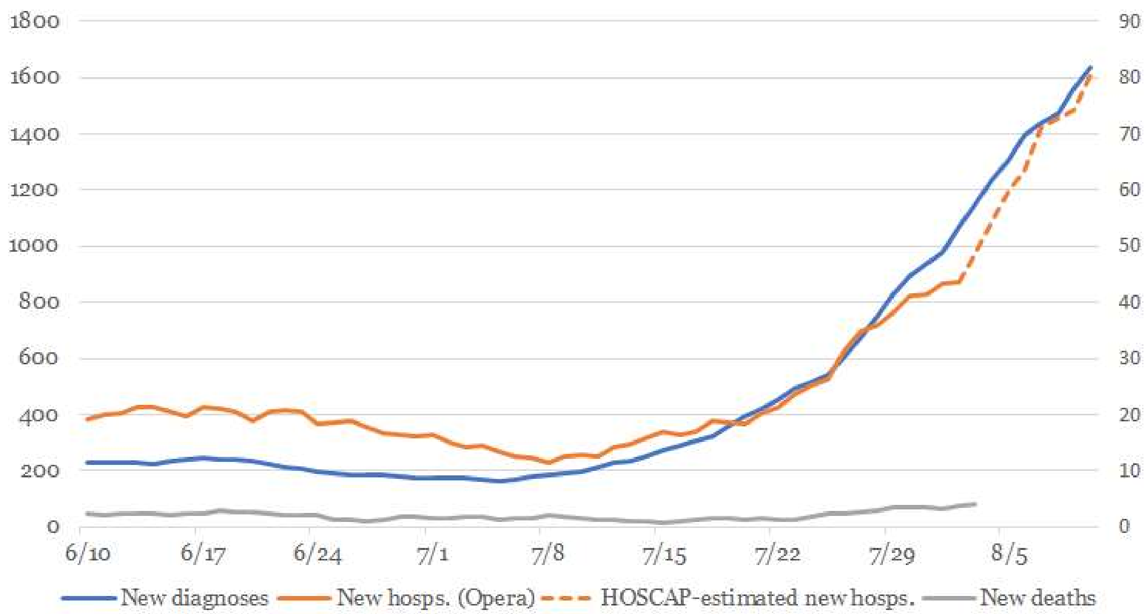

Figure 2: *Seven-day rolling average numbers of new diagnosed cases (left axis), new hospitalizations (right axis), and new deaths (right axis) due to COVID-19. Dates reflect when individuals had a test specimen collected (diagnosed cases), were admitted to the hospital, or when they died. HOSCAP-estimated hospitalizations were based on hospital occupancy data because of delays in reporting hospitalizations to Opera; see Appendix 1 for those methods.*

[5] Model R_e estimates are dated August 4, 2021. All were accessed on August 17, 2021. An exact estimate from CMMID was not available, but it appeared to be approximately 1.2. The latest estimate from Institute for Health Metrics and Evaluation, 1.51, is for July 22.

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.

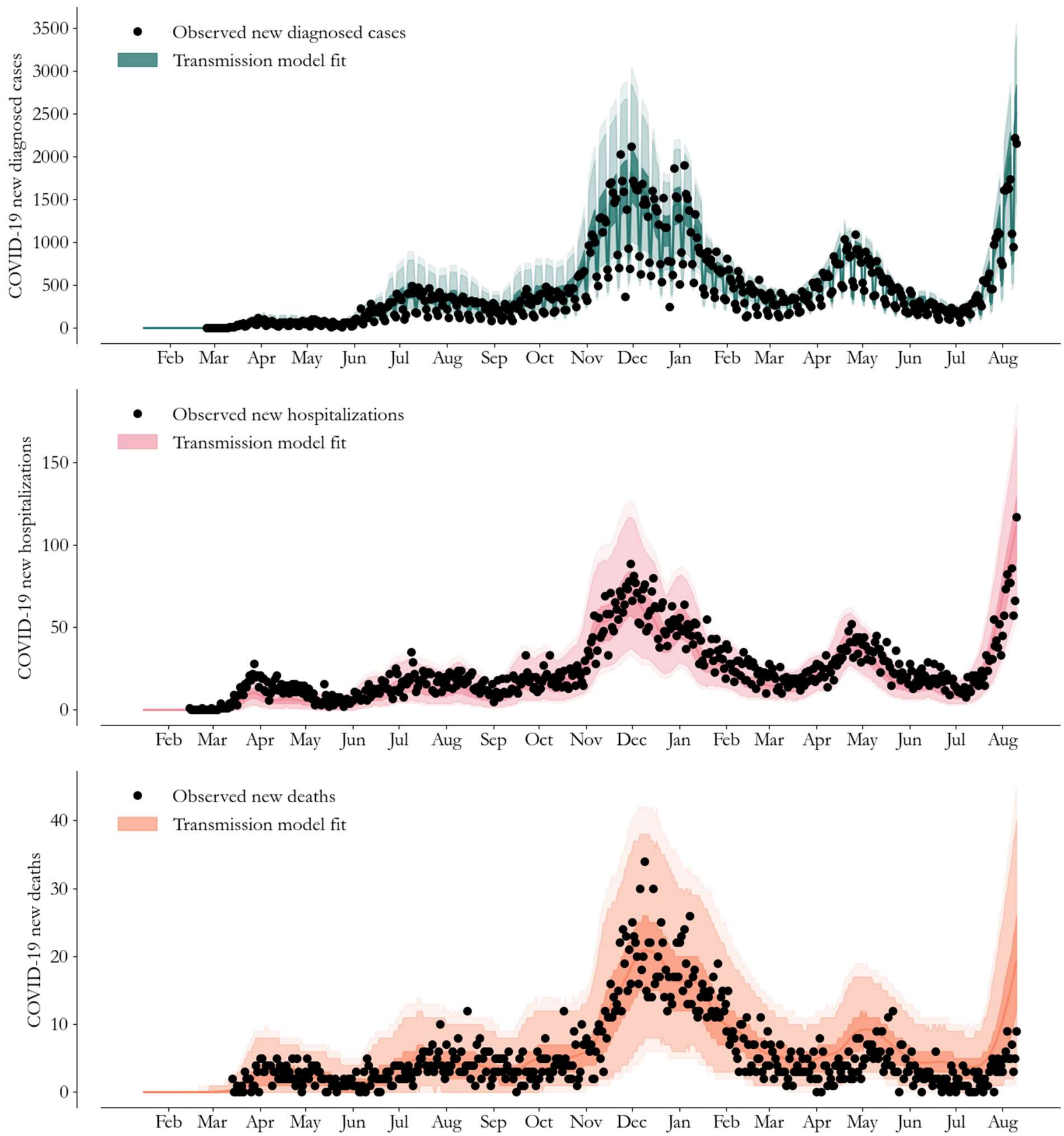

Figure 3: *Fitting the transmission model to Oregon's COVID-19 data on diagnosed cases, hospitalizations, and deaths. The lines represent the mean of 10,000 runs; the 25th-75th percentiles are given in dark shaded areas, 2.5th-97.5th percentiles in the lighter shade, and 1st-99th percentiles the lightest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

Population-level immunity

Figure 4 includes estimates of population-level immunity from SARS-CoV-2 infection over time.

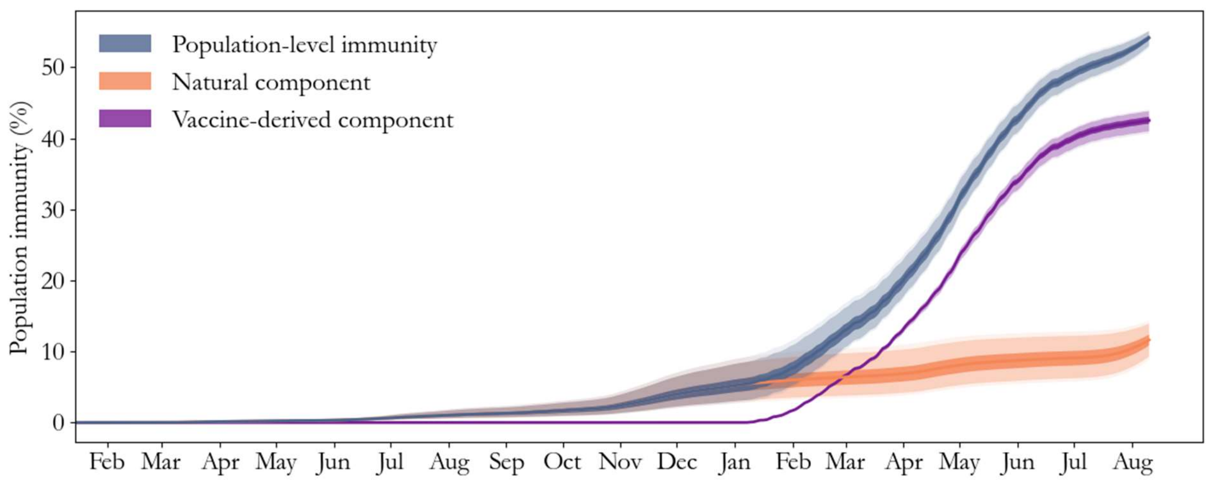

Figure 4: *Estimated population-level immunity to SARS-CoV-2 infection over time. The "natural component" consists of people who developed and then recovered from COVID-19. The "vaccine-derived component" consists of people who were not previously infected, but who achieved immunity from a vaccination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

Rainier estimates that as of August 10, the population-level immunity to SARS-CoV-2 was 54.1% (95% confidence interval: 53.0% - 55.1%). The estimated immunity from vaccination (42.5%) is over three times the estimate for natural immunity (11.6%).

Immunity from vaccination is helping prevent further spread of COVID-19. If we remove all of those who have immunity from the model calculations and look at the rate of infection, we see each infection spreading on average to 3.31 new people as of August 4. That is to say, without any immunity (largely due to vaccination), our estimated population R_e would be 3.31 instead of 1.56, and new infections would be increasing at a much faster rate.

COVID-19 trends after the data cutoff

Since we did not include COVID-19 data occurring after August 10 in our modeling dataset due to reporting delays in all the COVID-19 outcomes in Opera, we examined counts of Oregon COVID-19 hospital occupancy to see if trends have changed more recently. Data from HOSCAP indicate that hospital occupancy increased by 215 COVID-19 patients between August 10 and August 18.

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 particular 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 only one scenario: what would happen to trends of cases and people requiring hospitalization if the recent transmission rate continued. This scenario assumes recent vaccination levels will continue in the upcoming weeks. Figures 5 and 6 illustrate what would happen over the next month if the transmission rate for August 4 persisted:

- We would see a continued exponential increase in diagnosed cases. For the two-week period between August 25 and September 7, the projected number of new diagnosed cases would increase to 1,750 per 100,000 people. This rate translates to a daily average of 5,250 cases.
- By September 7, there would be 300 people per day requiring hospital admission.

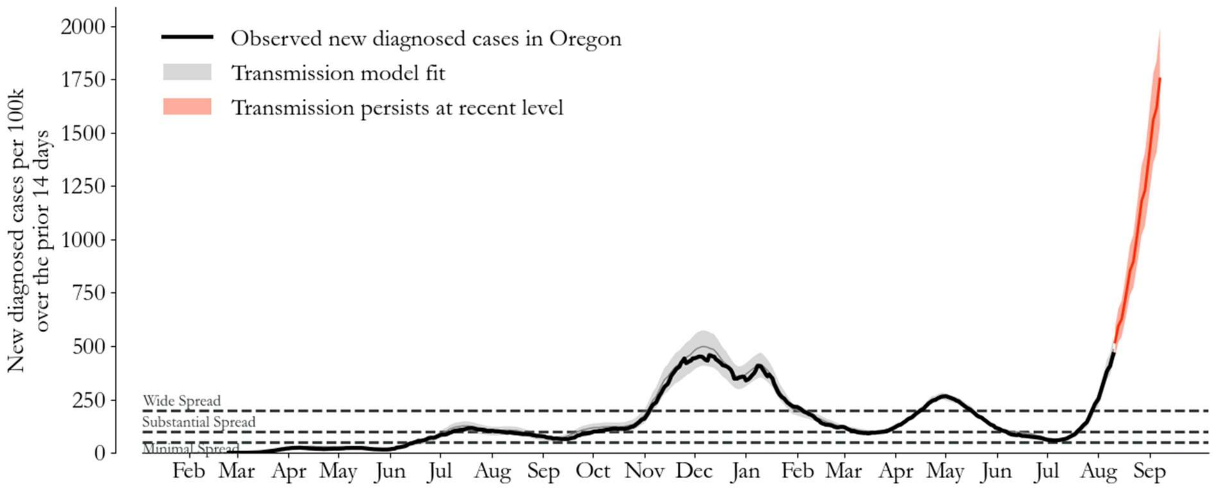

Figure 5: *Observed diagnosed cases (per 100k population over the previous 14 days) for Oregon and projection scenario. The black line shows observed cases, while the red line shows diagnosed cases projected if the transmission rate estimated for the week ending August 4 persists. Shaded areas: 25th-75th percentile ranges of the model fit. The dashed horizontal lines correspond to levels of [Oregon Community Spread](#).*

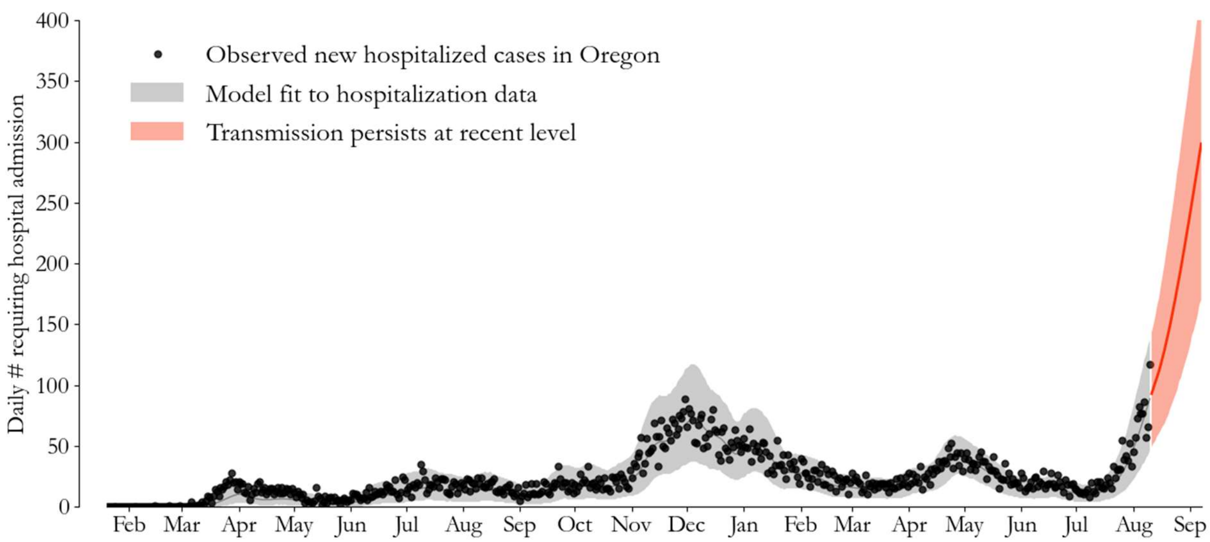

Figure 6: *Observed hospitalized cases for Oregon and projection scenario. Black dots show observed daily counts, while the grey line shows model fit. The red line shows hospitalizations projected if the transmission rate estimated for the week ending August 4 persists. Shaded areas: 2.5th-97.5th percentile ranges.*

Discussion

Oregon's COVID-19 cases and hospitalizations have continued to increase dramatically over the past month. Consistent with our scenario projection assuming transmission remains at the current level, forecasts from OHSU and compiled by the CDC suggest that COVID-19 cases and hospitalizations in Oregon will continue to increase in the month ahead (Appendix 2).

These alarming increases could be curbed if people were to adopt more protective measures (e.g., vaccinations, mask wearing indoors in public places) (IHME report). There is hope Oregonians might be working towards that -- even before the recent statewide indoor mask mandate (Aug 11 press release), there have been some signs of improvement in wearing masks (CMU survey), and the number of people being vaccinated daily has increased slightly (daily doses).

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.
- Rainier estimates 11.6% of Oregonians have natural immunity, but the actual proportion is unknown. CDC's latest estimate of proportion infected in Oregon based on commercial laboratory data is lower than our estimate (4.3% vs 11.6%), but their seroprevalence tests might not detect antibodies among all those previously infected. In contrast, CDC estimates nationally that only one in four COVID-19 infections were reported (CDC burden); if that were the case in Oregon, the proportion of Oregonians previously infected would be about 24% (Oregon cases).
- 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 dates in 2020 (4/1, 6/23, 9/29, 11/1, 11/28, 12/15, 12/27) and 2021 (1/15, 3/7, 4/10, 4/22, 5/21).
- 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 assume that COVID-19 reported cases reflect a higher detection rate among symptomatic infections than asymptomatic infections, and that the symptomatic infection rate increases 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 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.
- Due to surge-related delays in hospitalizations being reported to Opera, we used occupancy data from HOSCAP to estimate the number of daily hospital admissions between August 1 and August 10. These estimates as based on the assumption that the typical relationship between HOSCAP daily occupancy and preceding Opera admissions have stayed consistent, but this assumption would be incorrect if the average patient length-of-stay changed concurrently with the recent surge in hospitalizations.
- There is evidence that the Delta variants have a shorter latent period than prior dominant strains, resulting in less time between subsequent generations of infections. While our model already assumed a relatively short latent period (4 days), if Delta has an even shorter latent period, Rainier would be overestimating our recent R_e. We do not expect that a change in the latent period would affect our scenario projections.

Rainier 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 being prepared by the Institute for Disease Modeling. We describe those methods briefly here.

- For this report, Rainier assumed[6] 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

[6] 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

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 total immunity from vaccination may be high due to higher rates of breakthrough cases associated with Delta variants, and/or waning immunity from people who received their shots early in 2021. Due to recent vaccination levels, however, any discrepancy in this estimate would likely have minimal effect on scenario projections over the next 4 weeks.
- Conversely, Rainier's estimate of immunity from vaccination may be conservatively slow – 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 constitute only about 4% of total vaccine doses administered to-date in Oregon (Vaccine Dashboard). However, this vaccine may be modeled separately in the future as it becomes more frequently administered.

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 will continue to increase over the next month, reaching 16,440 for the week ending September 11. CDC's ensemble forecast for hospitalizations predicts that Oregon daily admissions will peak around September 10, reaching 200 new people requiring hospitalization per day[7].

Institute for Health Metrics and Evaluation's August 5 forecast for Oregon estimates that without universal mask use, daily new infections will continue to increase through mid-September.

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 continue to increase in the coming weeks, peaking around September 1.

[7] CDC ensemble forecasts are dated August 16, 2021; accessed on August 18, 2021.