BRIEF REPORT: COVID-19 EPIDEMIC TRENDS AND PROJECTIONS IN OREGON

Results as of 5/13/2020, 8:00pm

ACKNOWLEDGEMENTS

This is a brief update to the Institute for Disease Modeling's (IDM's) previous reports. IDM provided Oregon Health Authority (OHA) with the programming for the models in this update and reviewed this report. OHA wishes to thank IDM for their extensive support and technical assistance, especially Cliff Kerr, Katherine Rosenfeld, Brittany Hagedorn, Dina Mistry, Daniel Klein, Assaf Oron, Prashanth Selvaraj, Jen Schripsema, and Roy Burstein (Contact: covid@idmod.org).

RESULTS SUBJECT TO CHANGE

Please note that the data reported here are continually being updated. For daily up-to-date information visit the OHA COVID-19 web page. The results in this brief report should be considered preliminary and subject to change as more data become available, the science to inform the model assumptions expands, and modeling methods continue to be refined. While these results can be used to understand the potential effects of different scenarios, it is important to note, that the 80% forecast intervals for these predictions are wide, so point estimates should be interpreted with caution.

KEY FINDINGS

Infections to date

- These model simulations suggest that there has been upwards of 10,000 cumulative infections in Oregon by May 6th, of which approximately 3,200 have been diagnosed based on the local epidemiologic data.

Success of Oregon's interventions

- The aggressive interventions in Oregon have been effective in dramatically reducing transmission rates.
- The data suggest that the aggressive intervention effects on transmission rates might be waning slightly, with the number of recent new cases appearing to be at a fairly steady low number, rather than declining.

Future projections

- If we assume interventions effective as the current interventions are continued, the model projects the number of new infections would be relatively stable, but slowly increasing (about 125 to 155), with cumulative infections growing to about 17,000 over the next 6 weeks.
- However, relatively small increases in transmission levels in the community could cause a much larger increase in infections. For example, under the scenario with interventions reducing transmission by 55% (vs. 65%), the model projects about 4,000 more cumulative infections (21,000 vs. 17,000), 260 more new infections per day (415 vs. 155), and 14 more new severe cases per day (26 vs. 12) by June 17th.

PURPOSE OF THIS REPORT

To project how interventions with different levels of effectiveness would change the trend in COVID-19 cases in Oregon.

METHODS

This brief report uses methods consistent with the previous Institute for Disease Modeling (IDM) report from May 7, 2020 (May 7 IDM Report), but uses the latest version of IDM's modeling software (Covasim version 1.0.2) and newer data from Orpheus on COVID-19 cases (Orpheus description). Covasim (Covasim code) is an individual-based ("agent-based") COVID-19 transmission model. More information about the methods is in Appendix 1. The Orpheus data file was obtained on May 11th, but data after May 6th were considered incomplete because of lags in reporting.

INTERVENTIONS

Oregon implemented numerous measures to slow the transmission of COVID-19 over time, including:

- On March 8, 2020, Governor Brown declared an emergency due to the public health threat.
- On March 12, 2020: A large number of measures were put in place, such as bans on gatherings of more than 250 people, as detailed here.
- On March 16, 2020: Schools were closed statewide, as detailed here. Further measures were put in place on March 16th and 17th, including the closure of restaurants and bars and gatherings of more than 25 people, as detailed here.
- On March 19, 2020: Non-urgent health care procedures were suspended to conserve personal protective equipment and hospital beds.
- On March 23, 2020: Aggressive interventions, namely the "Stay Home, Save Lives" recommendations, were put in place.
- On April 22, 2020: Testing guidelines were revised to allow for expanded testing, including testing of people who are asymptomatic and work in care settings or are in congregate settings; they were refined on May 1, 2020 (Revised testing guidelines).
- Since the beginning of the epidemic in Oregon: Public health staff have routinely investigated diagnosed cases and then notified people who cases identify as close contacts of their exposure. Because of limited public health resources in Oregon, public health staff had only been able to actively follow up with contacts in households and congregate settings. Contacts have been asked to voluntarily stay in quarantine for 14 days after their last known exposure. Any diagnosed cases have been asked to voluntarily stay isolated for at least 72 hours after their symptoms resolve. Contact

tracing efforts have recently started to expand to prepare for reopening, as mentioned below (see also May 12 weekly report).

REOPENING

On May 1, 2020, Oregon announced plans for phased relaxation of community mitigation strategies, with additional expansion of testing and contact tracing to keep transmission rates low (Reopening Plans May 1, 2020). Some key changes have included:

- On May 1, 2020: Certain elective and non-urgent medical procedures resumed (Medical Procedures May 1, 2020).
- On May 2, 2020: The widespread use of face coverings was encouraged (Face Coverings May 2, 2020).
- On May 5, 2020: Some parks, outdoor recreation facilities, and areas across Oregon were opened for day use (Parks May 5, 2020).
- On May 7, 2020: Governor Brown published detailed guidance on reopening. This included requirements for counties to reopen, such as having sufficient capacity for testing and contact tracing. The guidance also called for the widespread public use of face coverings, maintaining physical distance of six feet between individuals as much as possible, and following good hygiene and disinfection practices (Reopening Guidance May 7, 2020).

RESULTS

As stated in the May 7th IDM report, the results in this brief report should be considered preliminary and subject to change as more data become available, the science to inform the model assumptions expands, and modeling methods continue to be refined (see Appendix 2 for information on the limitations).

Epidemic trends to date

The model was calibrated by modifying the assumptions from the literature to best fit data from Orpheus on confirmed positive COVID-19 diagnoses, number of tests completed, hospitalizations (referred to as severe cases below), intensive care unit (ICU) admittance (referred to as critical cases below, and included in severe case counts), and deaths for Oregon. The model was run 8 times in calibration to get more stable estimates than in the previous IDM reports.

The calibration provides evidence that Oregon's interventions -- combined with increased hygiene and other measures that appear to have begun earlier -- have dramatically reduced the burden of COVID-19 in Oregon (Figure 1).

- The data are consistent with a stepped reduction in transmission in Oregon, beginning with a 5% decrease in transmission by March 8th up to a 75% decrease in transmission after March 23rd. Indeed, while the interventions before March 23rd appeared to have slowed epidemic growth, the additional aggressive measures implemented on March 23rd (i.e., "Stay Home, Save Lives") appear to have sharply curtailed that growth.
- The data suggest that the aggressive intervention effects on transmission rates might be waning slightly (to a 65% decrease in transmission after April 4th), with the number of recent new cases appearing to be at a fairly steady low number, rather than declining. It is important to continue monitoring cases carefully to make sure transmission rates do not increase more dramatically.
- We examined Safegraph (Safegraph) and Oregon vehicle count data to assess how mobility measures compared to the trends in cases. Both the Safegraph data and Oregon vehicle data suggest reductions in public mobility beginning around March 15th, reducing steadily and peaking around April 7th. Mobility appears to be slightly increasing since mid-April (Appendix 4).

Of note, because testing guidelines were updated April 22nd to expand testing and presumptive cases were recently added, we might be seeing a temporary increase in number of new diagnoses (Figure 1) (see also May 12 weekly report). We suggest monitoring this pattern closely over time to see if this continues, if the effects of the interventions are waning further, and/or if the model parameters about disease dynamics need to be adjusted.

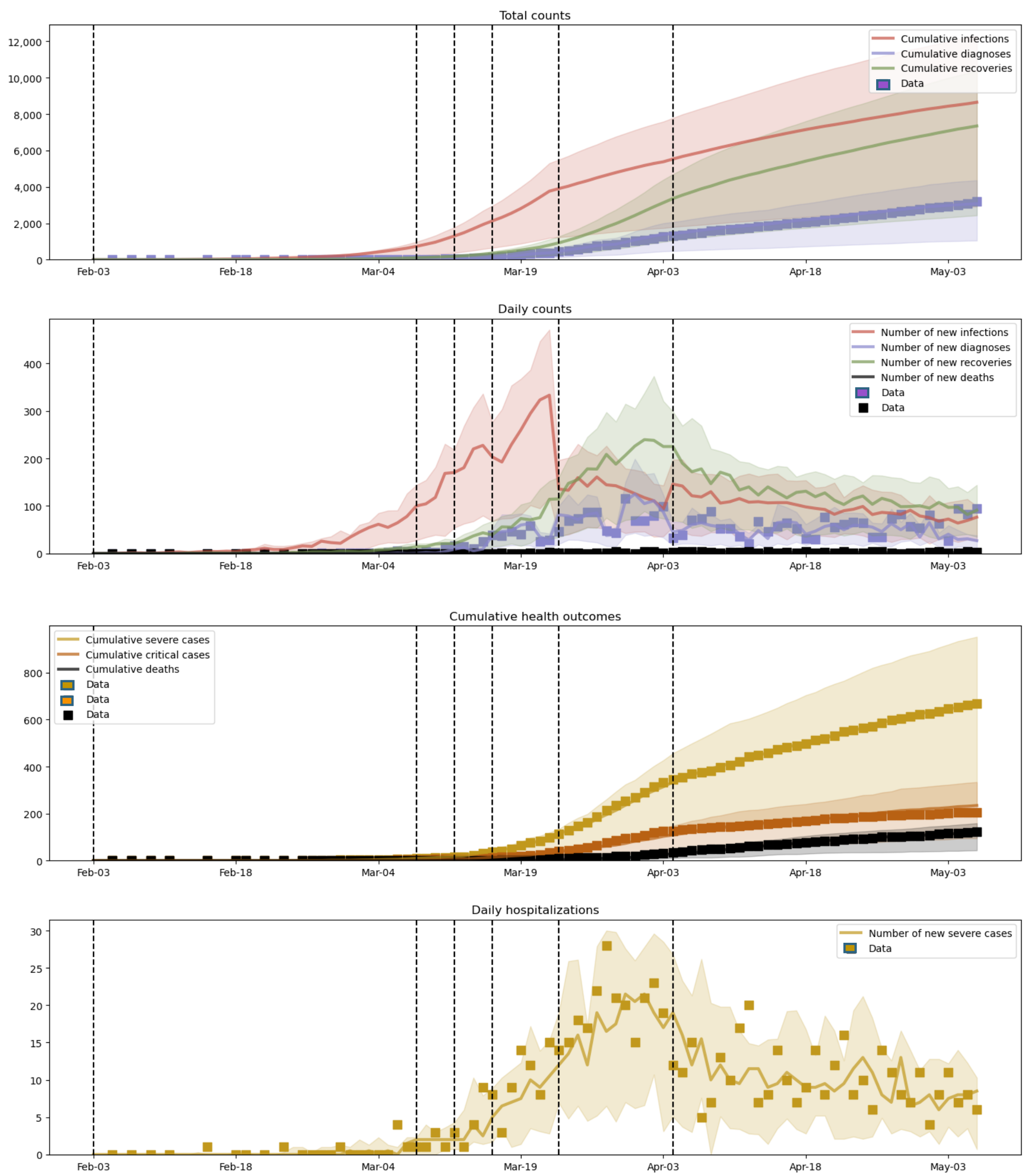

Figure 1: Best-fit model calibration with Oregon case data. Dotted vertical lines correspond to simulation start date (February 1st) and estimated reductions in transmission relative to baseline, from left to right, of 5% (March 8th), 10% (March 12th), 35% (March 16th), 75% (March 23rd), and 65% (April 4th). Raw data are presented as squares; estimates from the calibration are presented as lines. Note: The estimated reductions in transmission are imprecise, especially given some are based on few data points. The shaded areas represent variability among the calibration runs.

Scenario projections

Based on the calibrated model, we ran the forecast model 11 times to simulate the epidemic and produce forecast intervals (Figure 2). These model simulations estimate that there has been upwards of over 10,000 cumulative infections in Oregon by May 6th (Figure 2), of which 3,200 had been diagnosed based on the local epidemiologic data.

We modeled three future scenarios from May 15th until June 17th, assuming interventions with different levels of effectiveness in reducing transmission.

1) We assume interventions as effective as the current ones are continued that **would reduce transmission by 65%** compared to baseline**.** This could be a combination of community mitigation strategies and expanded testing and contact tracing. Under this scenario:
    - The model projects the number of new infections per day would be relatively stable, but slightly increasing (from about 125 to 155), with cumulative infections growing from an estimated 12,000 to about 17,000 by June 17th (Figure 2). The number of new severe cases per day would be about 12.[1]

2) We assume that some relaxation of community mitigation strategies, but continued expansion of testing and contact tracing together **would reduce transmission by 55%.** Under this scenario:
    - The model projects about 4,000 more cumulative infections (21,000 vs. 17,000), 260 more new infections per day (415 vs. 155), and 14 more new severe cases per day (26 vs. 12) by June 17th, compared to the 65% reduction scenario (Figure 2).[1]

3) We assume that some relaxation of community mitigation strategies, but continued expansion of testing and contact tracing together **would reduce transmission by 45%.** Under the scenario:
    - The model projects that cases would rise more quickly, resulting in about 12,000 more cumulative infections (29,000 vs. 17,000), 870 more new infections per day (1,025 vs. 155), and 36 more severe cases per day (48 vs. 12) by June 17th, compared to the 65% reduction scenario (Figure 3).[1]

These results suggest that the epidemic is very sensitive to changes in policies, practices, or public adherence to community mitigation strategies. While these results can be used to understand the potential effects of different scenarios, it is important to note, that the 80% forecast intervals for these predictions are wide, reflecting their uncertainty.[2]

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[1] Per-day scenario differences are based on average of last 4 days (June 14th-17th) to stabilize estimates.

[2] "By default, the forecast intervals used correspond to the 10th and 90th percentiles of the simulated trajectories. Although these forecast intervals bear some similarities to confidence or credible intervals, since they are typically produced through a combination of stochastic variability and parameter uncertainty, they do not have a rigorous statistical interpretation." (from page 18 of IDM report)

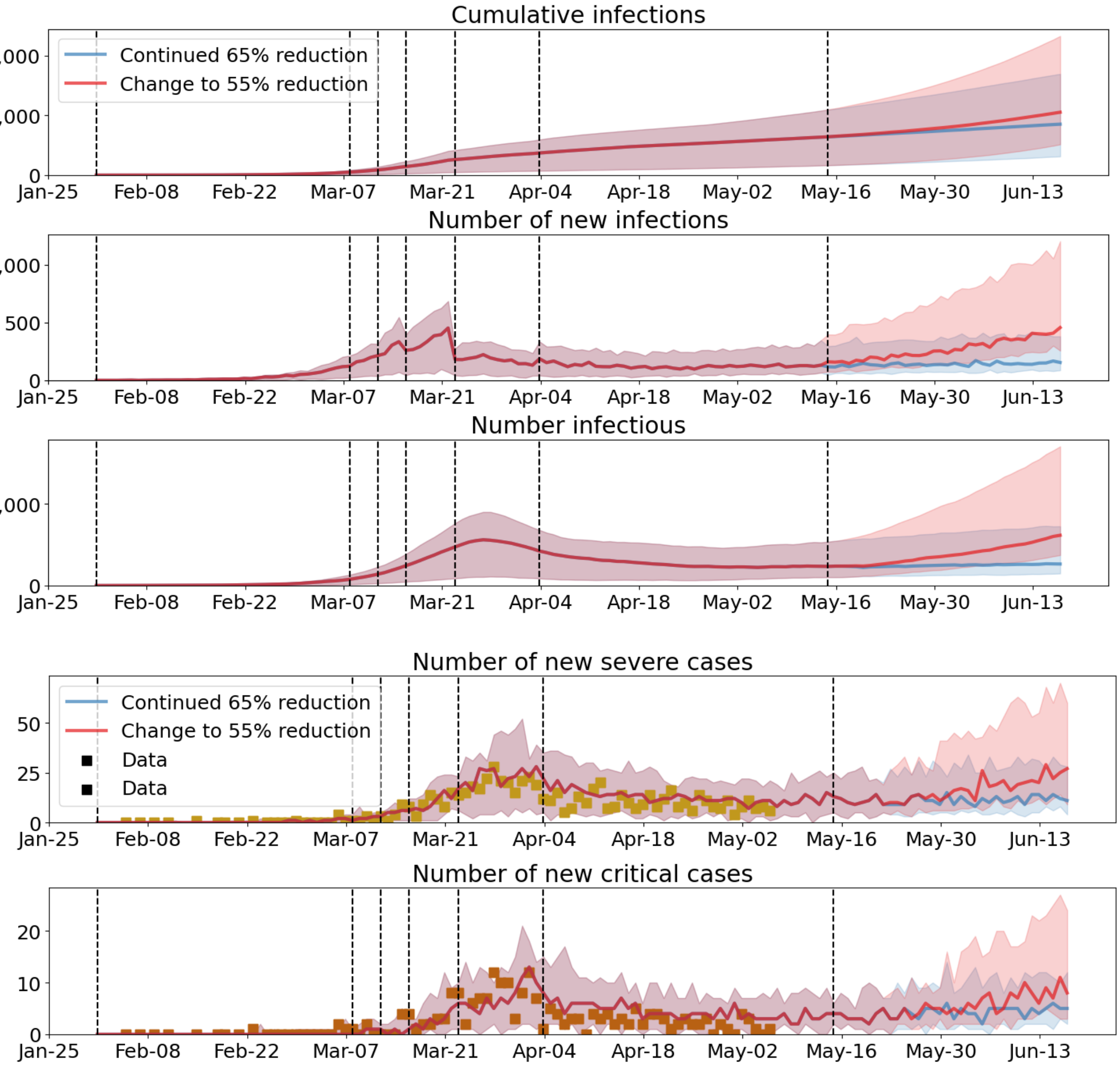

Figure 2: Model projections for the next 6 weeks, assuming that starting May 15th: 1) interventions continue that reduce transmission by 65% (blue line), and 2) there is a change to interventions that reduce transmission by 55% (red line). Raw data are presented as squares; estimates from the models are presented as lines. The lighter shaded areas correspond to 80% forecast intervals (i.e., 10th and 90th percentiles of the projection).

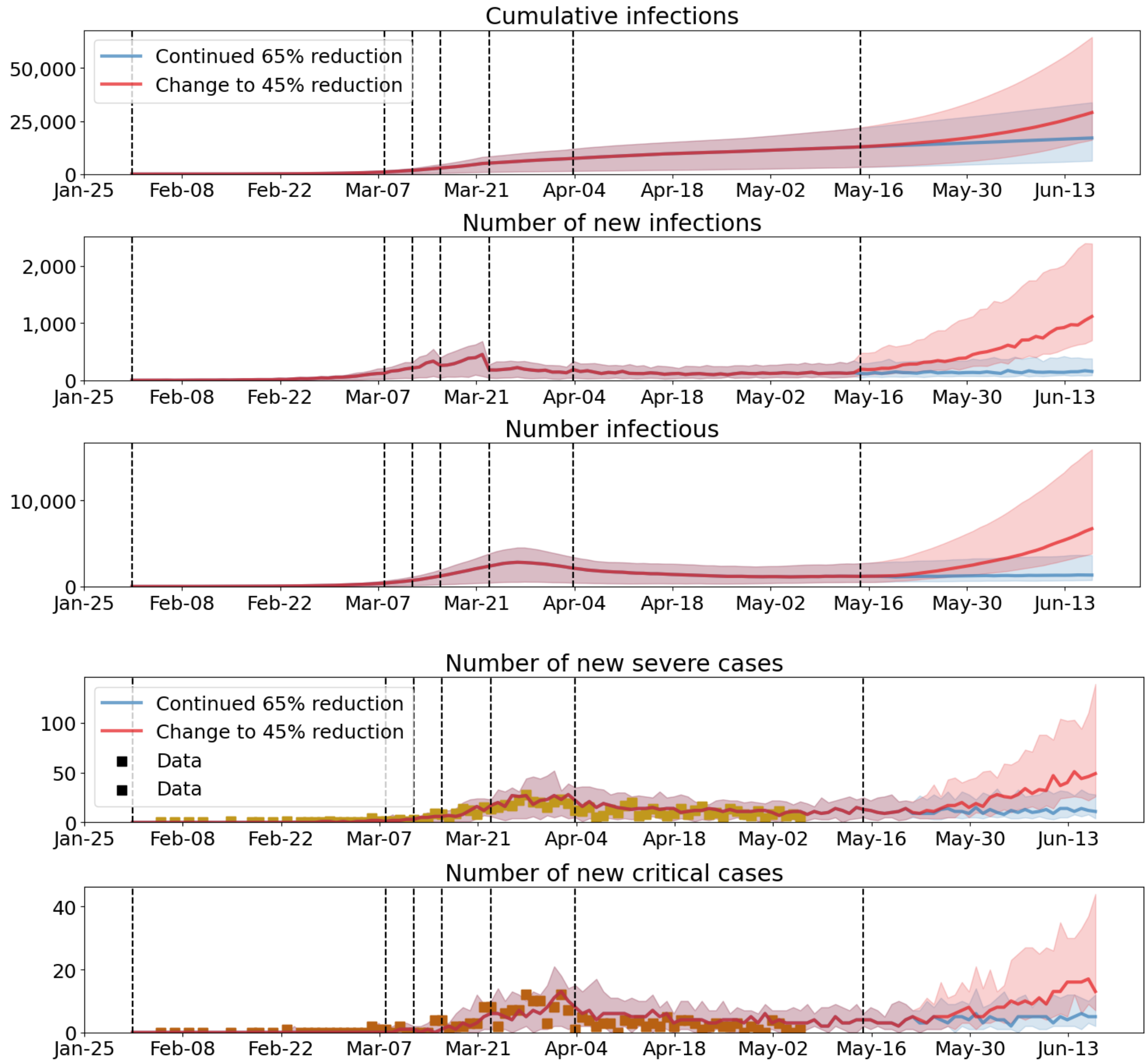

Figure 3: Model projections for the next 6 weeks, assuming that starting May 11th: 1) interventions continue that reduce transmission by 65% (blue line), and 2) there is a change to interventions that reduce transmission by 45% (red line). Raw data are presented as squares; estimates from the models are presented as lines. The lighter shaded areas correspond to 80% forecast intervals (i.e., 10th and 90th percentiles of the projection).

The difference in these future scenarios is also illustrated by examination of the estimated effective reproduction number (Re) over time (Appendix 3). Re is the expected number of secondary cases that a single case generates. The 65% scenario keeps the projected Re close to 1.

APPENDICES

Appendix 1: Detailed transmission model methods

We applied Covasim version 1.0.2, an individual-based (i.e., “agent-based”) COVID transmission model with parameters informed by the literature; the full source code is available on GitHub. This is an updated version from the last IDM report. The methods and assumptions for Covasim are described in detail here.

The model was calibrated by modifying the assumptions to best fit data from Orpheus on confirmed positive COVID-19 diagnoses, number of tests completed, hospitalizations (referred to as severe cases below), intensive care unit (ICU) admittance (referred to as critical cases below, and included in severe case counts), and deaths for Oregon.

Our model assumed random network connections and used default parameters from Covasim version 1.0.2, except for the following changes:

1) Population age distribution was based on American Community Survey 2018 single-year estimates for Oregon. We used a simulation population size to 250,000 with Covasim’s population rescaling functionality enabled.
2) The COVID-19 virus had a pre-intervention Beta value of 0.021, instead of 0.016 (based on observed hospitalizations before interventions took effect).[3]
3) Infected patients were 10% more likely to become hospitalized (and to subsequently become critically ill and/or die) across age groups.
4) Critical patients first spent a mean of 1 day in severe care, instead of 3 days.
5) The probability of symptomatic individual being tested was adjusted such that the overall positive result rate was approximately 4%.

The model simulation begins on 2020-02-01. It is not possible to calibrate the model with a single importation event near the date of the first diagnosis (2020-02-27), which is consistent with the fact that this case was community acquired, implying other infections occurred before this date. To match observed epidemic trends, five infected individuals are assumed by 2020-02-01. This indicates either multiple importation events, or a single importation occurring earlier.

[3] With an average of 20 contacts per individual per day and a mean duration of infectiousness of 8 days, this per-day probability roughly translates to an R0 of 3.

Appendix 2: Limitations

The results in this brief report should be considered preliminary and subject to change as more data become available, the science to inform the model assumptions expands, and modeling methods continue to be refined. There are several limitations important to note. First, the projections included in this report are based on the best available local data and evidence as of May 11th, 2020, but the local collection of epidemiologic data on COVID-19 cases may lag in ways we did not account for, and data improvement efforts are ongoing. Second, the model assumes that no cases were “imported” from elsewhere over time, but such cases would cause increases in local transmission. Third, for simplicity, we assumed random network connections and a combined effect of various interventions for the future scenarios (e.g., physical distancing, testing, and contact tracing) on overall transmission rates, but Covasim does have the ability to incorporate more complex network dynamics and specific intervention effects (as described here). We will explore those options with IDM in the future. Fourth, we set the simulation population size to 250,000, but will increase this for future models if the number of projected cases increases. For the scenario in this report that assumed 45% reduction in transmission, the Re started to decrease slightly (1.75 to 1.60; Appendix 3), possibly because the number of people already infected constituted about 10% of the simulation population by the end of the scenario. Accordingly, we may have underestimated of the number of cases in that scenario. Last, there remain significant unknowns, including information about the disease (e.g., the proportion of asymptomatic infections) and public compliance with recommendations (e.g., physical distancing, hygiene, and face coverings).

Appendix 3: Projected Effective Reproductive Number

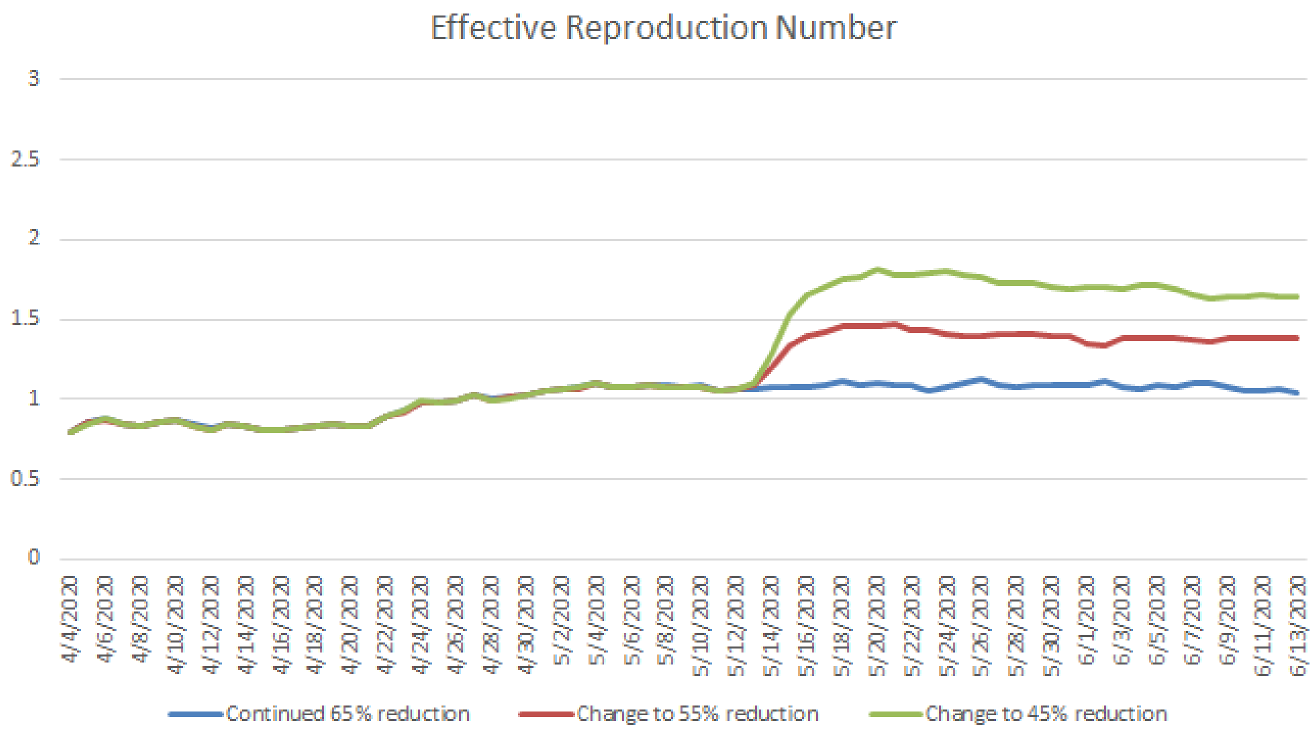

Figure 4: Projected effective reproduction number (Re) over the next 6 weeks, assuming that starting May 15th: 1) interventions continue that reduce transmission by 65% (blue line), 2) there is a change to interventions that reduce transmission by 55% (orange line), and 3) there is a change to interventions that reduce transmission by 45% (green line). Re is the expected number of secondary cases that a single case generates.

Appendix 4: Mobility Data

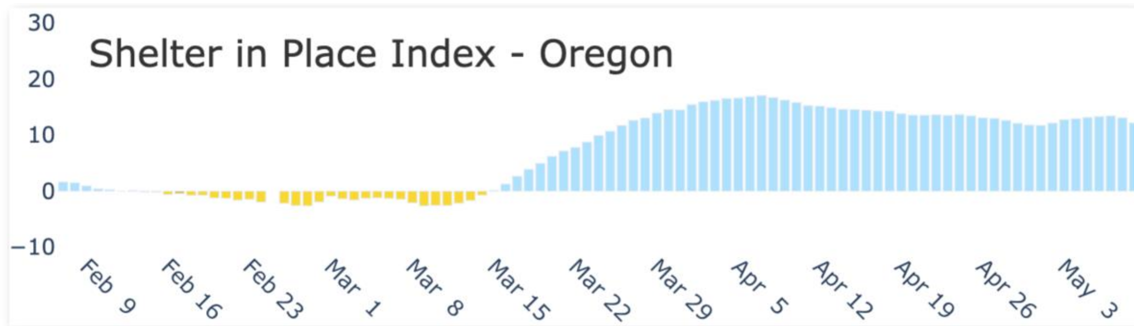

Figure 5: Data are from [Safegraph](), which uses smartphone data to create an index representing change (as a difference) in the percent of people staying home, compared to baseline (defined as the average percent of people staying home across the 7-day period ending February 12, 2020). As an example, if the baseline percentage staying home was 20%, and the estimate is 30% staying home on a particular date, then the index value for that date would be 10% (i.e., 30% minus 20%).

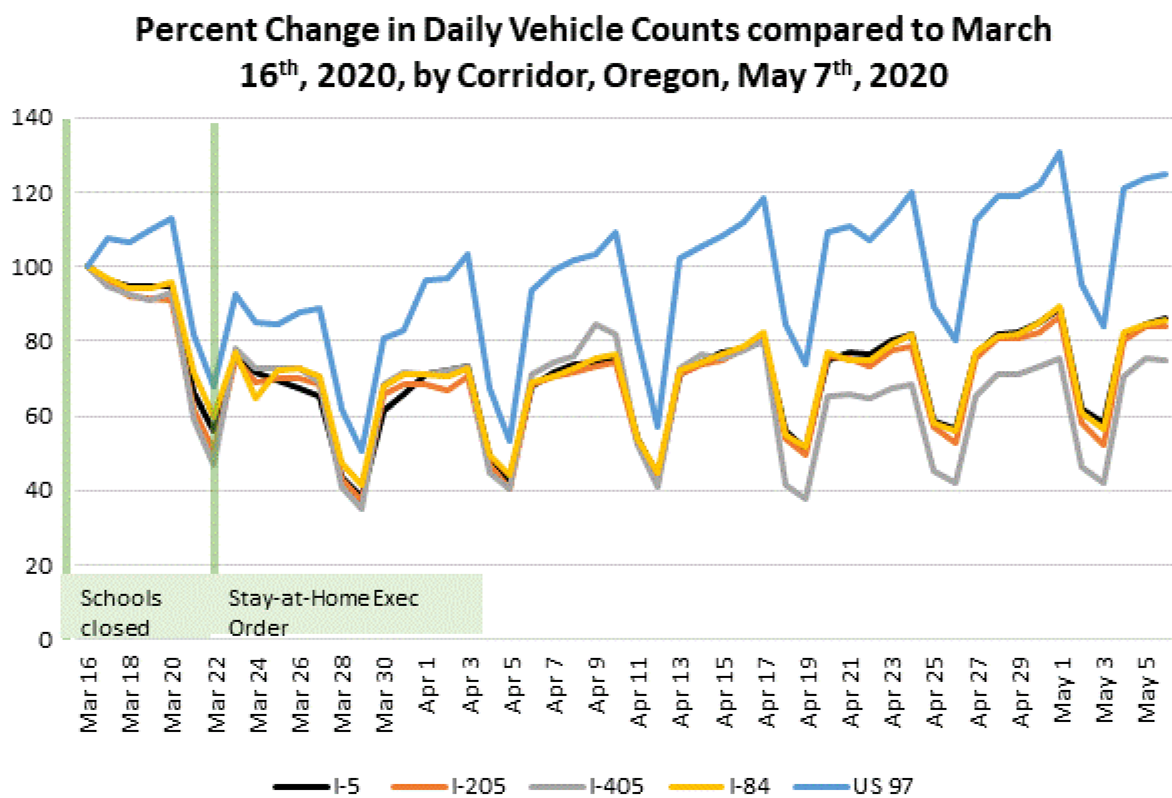

Figure 6: Data are from Oregon Department of Transportation.