**Eight-week model projections of COVID-19 in New York City**
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We present the results of model projections of COVID-19 epidemic outcomes under different control scenarios, including new weekly number of total infections, hospitalizations, ICU admissions, and deaths for the next 8 weeks (i.e. March 22 – May 16, 2020; Tables 2-3 and Figures 1-5). In addition, we project healthcare demand, including number of hospital beds and ICU beds needed for each week under each scenario (Table 4 and Figures 6-7). Key findings are highlighted below.

## 1. Model Form

Susceptible-Exposed-Infectious-Removed (SEIR) model accounting for reporting delay for case diagnosis, and delay from infection to hospitalization, ICU admission, and death for estimating the numbers of hospitalization, ICU, and death by week, respectively.

## 2. Data

Confirmed cases of COVID-19 in New York City (Weeks 10-12 of 2020, as of March 19, 2020), provided by NYC DOHMH.

## 3. Model Training and Assumptions

Bayesian inference approach in which the DOHMH data are used to partially constrain the model parameters and state variables prior to making a projection. The form is similar to that used for influenza forecasting; however, here the data are very limited (3 weeks) so the model is less well constrained. Initial prior ranges are set as: transmission rate ($\beta$): [0.5, 1]; latency period ($T_{ei}$): [2, 5] days; infectious period ($T_{ir}$): [2, 5] days; mean reporting delay (i.e., from viral shedding to being diagnosed; Td.mean): [3, 9] days; standard deviation of reporting delay (Td.sd): [1, 3] days; and reporting rate (i.e., the proportion of infections that are diagnosed; $\alpha$): [5, 80]%. These parameters are estimated based on the weekly confirmed case data.

In addition, for the delay from infection to hospitalization, ICU, and death, we used reported time from symptom onset of SARS-CoV-2 to the corresponding event (Yang et al. 2020; Zhou et al. 2020; Wang et al. 2020). To compute the numbers of different health outcomes from the model estimated total infections, we used the following probability ranges: 2.25-7.5% for hospitalization (severe and critical cases); 0.6-2% for ICU and 0.15-1.25% for mortality. These probabilities are based on reported numbers among diagnosed cases in China (China CDC, 2020) and other countries and assuming a 15-25% ascertainment rate (Li et al., 2020). To compute the healthcare demands for each week, we used reported retention times in hospitals and ICU (Zhou et al. 2020) for corresponding estimates. See further details below.

## 4. Model Scenarios

Seasonality: There are 4 endemic coronaviruses infecting humans (OC43, 229E, NL63, HKU1). These viruses typically cause mild cold-like symptoms and exhibit a pronounced seasonality with peak incidence in January-February and very little incidence in summer. The cause of this seasonality is unknown, but its presence has led to speculation that SARS-CoV-2, the virus causing COVID-19, may wane during summer months in New York City. Consequently, we used the seasonality of OC43, which is well observed and a betacoronavirus, like SARS-CoV2, to estimate a seasonal reduction of transmissibility for SARS-CoV2 during summertime. We then generated projections from the 2 forms for all scenarios: 1) With seasonal changes to virus transmissibility; and 2) Without seasonality.

We generated the following projections, each with 10 model runs to provide a distribution of possible outcomes:

No Control (i.e. Worst Case) Scenario: For these projections, the model posterior (i.e. an ensemble of model simulations with parameters and state variables as estimated following training with weekly confirmed case data) *estimated with data from Week 10 (March 1-7) of 2020 (an earlier week with minimal interventions)* was integrated 8 weeks into the future to create a reference, no control, “worst case” scenario.

As Is (i.e. Status Quo) Scenario: For these projections, the model posterior *estimated using data from Week 10 through Week 12 (i.e. Mar 1-19, 2020), the most recent week,* was integrated 8 weeks into the future to create a reference, As Is, “status quo” scenario. While very preliminary, these projections provide a rough assessment of effectiveness of current interventions, compared to the "no control" scenario.

Control Scenarios: Five control scenarios, using the model posterior as initial conditions and adjustment of model parameters (relative to the As Is scenario estimates) to represent different levels of interventions:

1. Moderate (10-30%) reduction in contact rate (via social distancing)
2. Moderate (10-30%) reduction in contact rate (via social distancing) and moderate (10-25%) reduction in infectious period (via case isolation/self-quarantine/treatment, etc.)
3. Large (30-50%) reduction in contact rate (via social distancing) and no reduction in infectious period
4. Large (30-50%) reduction in contact rate (via social distancing) and moderate (10-25%) reduction in infectious period (via case isolation/self-quarantine/treatment, etc.)
5. Large (30-50%) reduction in contact rate (via social distancing) and large (30-50%) reduction in infectious period (via case isolation/self-quarantine/treatment, etc.)

Note there is no particular specification of how reductions in contact rates or spread are achieved. In a model of this form different reduction options (e.g. isolation vs. quarantine) are not represented explicitly; rather, they are effected by adjusting the estimated (posterior) contact rate and infectious period within the model, relative to estimates for the most recent week (the As Is scenario).

**Model Output**

We use the model to estimate new weekly numbers of total infections, reported/observed infections, hospitalizations, patients in ICU, and deaths. For the latter three health outcomes we accounted for delay from infection to corresponding event as described above.

- Total infections are directly estimated by the model without a delay and are an unobserved quantity that includes subclinical/undiagnosed infections.
- Reported/observed infections include a reporting delay; the reporting rate estimated at the most recent week was used for the entire projection period.

- For hospitalizations, we assume 15-30% of reported infections are hospitalized. We base this from a study in China, which found that ~20% of confirmed cases in China were severe or critical (China CDC, 2020).
- For ICU, we assume 4-8% of reported infections are critical and enter ICU (China CDC, 2020). Note that these estimates may be lower than observed in NYC where 60% of
- For deaths, we assume 1-5% of individuals with reported infections die (WHO, 2020).

To support logistics and planning, we also use the model to estimate the numbers of hospital beds and ICU beds needed each week under each scenario:

- Estimates of demand for hospital beds are based on new hospitalizations each week and length of stay in hospital (Mean=11 days; SD=5.2 days, per Zhou et al. 2020).
- Estimates of demand for ICU beds are based on new ICU admissions each week and length of stay in the ICU (Mean=8 days; SD=5.9 days, per Zhou et al. 2020).

We also report the estimated attack rate as the number of New Yorkers (total population size: 8,398,744 as of 2018) infected in the next 8 weeks.

**Results**

Estimation of infection numbers and health outcomes through March 21, 2020.
The model-inference system (assuming seasonality the same as OC43 coronavirus) estimated that there were 37,460 [median and interquartile range (IQR): 25,912 – 69,870; same below] total infections by March 21, 2020. In comparison, a total of 5515 confirmed cases were reported during this period. This discrepancy likely stemmed from the delay in reporting and under-reporting (i.e. many infected individuals experience mild symptoms and do not seek medical care). Estimated reporting rate was particularly low in the first couple weeks but have increased substantially in the most recent two weeks. Given this potential large number of undocumented infections, it remains important to continuously monitor suspected infections for transmission control as well as increase rates of testing and improve reporting for better situation awareness.

In addition, the model-inference system estimated a total of 809 (IQR: 446 – 1,413) hospitalizations, 135 (IQR: 72 – 238) ICU admissions, and 13 (IQR: 5 – 29) deaths by March 21, 2020 (note that the mean was 34 deaths). Table 1 shows the estimated numbers by week for total infections, hospitalizations, ICU admissions, and deaths, using models assuming the same seasonality as OC43 coronavirus and no seasonality, separately. In general, estimates assuming no seasonality were slightly higher than those assuming OC43 seasonality (Table 1). Below, we mainly present results from the model runs with seasonality.

Of note, despite the large increases in confirmed cases, after accounting for reporting rate, our model-inference system estimated that both the transmission rate and infectious period have decreased slightly in the last two weeks, likely thanks to the prompt response of New Yorkers. However, as noted below, continued and more stringent transmission controls may be needed in the coming weeks to avoid overwhelming the healthcare systems.

Projections of epidemic outcomes for the coming 8 weeks.
Figures 1-5 show the projected epidemic curves under different control scenarios for total infections, confirmed cases, hospitalizations, ICU admissions, and deaths, separately. Estimates under the two seasonality assumptions are also compared in the figures. Table 2

and 3 show the projected cumulative and weekly numbers of total infections, hospitalizations, ICU admissions, and deaths for the model runs (only for runs with seasonality in Table 3).

The projected attack rate for the no control ('worst case'), as run with seasonality, had a median of 6.7 million total infections (IQR: 5 M – 7.4 M; or 79.9%, IQR: 59.8 – 88.6% of the population) during the next 8 weeks. In comparison, the projected attack rate under the As Is (status quo) scenario had a median of 5.8 M (IQR: 2.2 M – 7.4 M; or 68.6%, IQR: 26.8 – 88.0% of the population). Further reduction in transmission rate by 10-30% relative to the current estimates (i.e. Control Scenario 1) would lower the attack rate to 2.1 M (IQR: 452 K – 5.2 M). The attack rate would be substantially reduced to 845 K (IQR: 217 K – 3.2 M) and 471 K (IQR: 148 K – 1.9 M) under Control Scenario 2 (i.e. 10-30% reduction in contact rate and 10-25% reduction in the infectious period) and Control Scenario 3 (i.e. 30-50 reduction in contact rate) respectively. The attack rate would be further reduced to 263 K (IQR: 105 K – 1.0 M) and 140 K (IQR: 73 K – 416 K) under Control Scenarios 4 and 5 with 30-50% reduction in contact rate as well as a similar reduction in the infectious period. Accordingly, other health outcomes would be reduced under all five control scenarios and more substantially under scenarios with reductions in both contact rate and infectious period (Tables 2-3 and Figures 1-5). Note that these projections are substantially higher than those reported in our last report, partly due to updated model parameter estimates per the latest available data and partly due to a shift in projection period by 1 week from the start of the pandemic and inclusion of 1 additional week.

Projections of hospital- and ICU bed demands for the coming 8 weeks.
Figures 6-7 show the projected demands for hospital beds and ICU beds by week under different scenarios, separately, compared to current capacity. Table 4 shows the projected numbers by week under different scenarios for the model runs with seasonality.

Based on inventory of available hospital/ICU beds as of March 19, 2020, under the current status quo, our estimates suggest that demand for hospital beds would exceed the current capacity in 2 weeks (i.e., by the Week of April 5; Table 4) and demand for ICU beds would exceed the current capacity in 1 week (i.e. by the Week of March 29). To avoid exceeding current capacity, further transmission reduction will be needed that produces the effects described in control scenarios 3-5.

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**Table 1.** Estimated numbers of total infections, hospitalizations, ICU admissions, and deaths in Weeks 10 to 12 of 2020, the three weeks with more than 1 case reported. Numbers are median and (interquartile range, IQR).

| Seasonality | Week | Total Infections | Hospitalizations | ICU | Deaths |
|---|---|---|---|---|---|
| Per OC43 | 10 | 5321.5 (3279.9, 7928.7) | 32.5 (17.5, 53.5) | 2.7 (1.3, 5.4) | 0 (0, 0) |
| Per OC43 | 11 | 10545.2 (4999.8, 20937.3) | 213.3 (104.4, 381.4) | 28.7 (14.2, 52.2) | 1.1 (0.4, 2.7) |
| Per OC43 | 12 | 24377.7 (14105.2, 44678.8) | 570.6 (204.2, 1045.6) | 101 (39.8, 190.3) | 11.1 (3.4, 26) |
| None | 10 | 5837.7 (3691.8, 8846.2) | 33.5 (18.4, 56.6) | 3 (1.4, 5.6) | 0 (0, 0) |
| None | 11 | 12674.8 (5552, 26664.5) | 231.4 (105.4, 428.6) | 31.1 (13.6, 57.1) | 1.1 (0.3, 2.8) |
| None | 12 | 25322.1 (15198, 59879.4) | 571.1 (158.2, 1177.5) | 101.4 (33.1, 204.8) | 10.8 (3.3, 25.5) |

**Table 2.** Estimated cumulative numbers of total infections, hospitalizations, ICU admissions, and deaths for the coming 8 weeks. Numbers are median and (interquartile range, IQR). Note that these projections are substantially higher than those reported in our last report, partly due to updated model parameter estimates per the latest available data and partly due to a shift in projection period by 1 week from the start of the pandemic and inclusion of 1 additional week.

| Seasonality | Intervention | Total Infections | Hospitalizations | ICU | Deaths |
|---|---|---|---|---|---|
| Per OC43 | No Control | 6707019 (5021589, 7444533) | 257757 (162242, 368672) | 55721 (33983, 82168) | 8716 (3702, 16212) |
| Per OC43 | As Is | 5764159 (2248619, 7389486) | 201224 (72995, 333162) | 43054 (14840, 74265) | 5989 (1839, 13427) |
| Per OC43 | Scenario 1 | 2054288 (452483, 5172161) | 72577 (18157, 199779) | 14981 (4009, 43289) | 2205 (582, 7055) |
| Per OC43 | Scenario 2 | 845361 (217286, 3158043) | 34699 (9681, 125445) | 7336 (2168, 27023) | 1220 (343, 4404) |
| Per OC43 | Scenario 3 | 471522 (148026, 1942882) | 19950 (6698, 76423) | 4368 (1471, 16256) | 750 (234, 2670) |
| Per OC43 | Scenario 4 | 262800 (104982, 1011547) | 12307 (4832, 43211) | 2768 (1086, 9566) | 501 (173, 1724) |
| Per OC43 | Scenario 5 | 139691 (72905, 416105) | 6879 (3195, 19197) | 1603 (724, 4453) | 305 (115, 869) |
| None | No Control | 7135250 (5874811, 7690082) | 283870 (183720, 400238) | 62530 (39766, 89596) | 10046 (4504, 18185) |
| None | As Is | 6348576 (2903428, 7616210) | 228358 (95956, 360996) | 50176 (19016, 80079) | 7090 (2224, 15132) |
| None | Scenario 1 | 2842570 (601937, 5942673) | 102984 (23481, 239644) | 21267 (4956, 51781) | 3084 (708, 8883) |
| None | Scenario 2 | 1251816 (266699, 4124355) | 49791 (11620, 167489) | 10604 (2597, 36427) | 1724 (412, 5906) |
| None | Scenario 3 | 698446 (179486, 2830978) | 28453 (7746, 114320) | 6180 (1743, 23980) | 1026 (274, 3826) |
| None | Scenario 4 | 370176 (123618, 1571155) | 16653 (5417, 65778) | 3706 (1242, 14461) | 672 (200, 2500) |
| None | Scenario 5 | 178581 (84682, 635198) | 8530 (3464, 29150) | 2002 (823, 6623) | 383 (133, 1234) |

**Table 3.** Projected weekly epidemic outcomes under different scenarios for the coming 8 weeks. Numbers are median and (interquartile range, IQR). Note that there are time lags from infection to hospitalization, ICU admission, or death; as such, dividing the numbers (e.g. deaths ÷ total infections) will *not* give accurate estimates of risks (e.g. infection mortality risk).

| Intervention | Week | Total Infections | Hospitalizations | ICU admissions | Deaths |
|---|---|---|---|---|---|
| No control (worst case) | 13 | 67695 (36251, 137463) | 1300 (672, 2602) | 220 (123, 436) | 26 (12, 55) |
| | 14 | 190711 (90115, 404941) | 3747 (1701, 7765) | 600 (278, 1243) | 60 (22, 142) |
| | 15 | 486338 (203170, 1026835) | 10231 (4245, 22612) | 1686 (718, 3641) | 171 (61, 421) |
| | 16 | 991677 (412038, 1669925) | 25055 (9746, 52090) | 4225 (1703, 9362) | 455 (155, 1152) |
| | 17 | 1261368 (638394, 1777522) | 46114 (19533, 78110) | 8785 (3603, 16420) | 1080 (359, 2567) |
| | 18 | 1095933 (558351, 1509059) | 53886 (27328, 83593) | 11993 (6006, 19207) | 1843 (684, 3847) |
| | 19 | 745709 (286375, 1151973) | 46258 (23360, 71389) | 11555 (6280, 17366) | 2051 (856, 3936) |
| | 20 | 385577 (102950, 789115) | 31915 (11896, 52528) | 8515 (3800, 13546) | 1684 (662, 3191) |
| As Is (status quo) | 13 | 56734 (30550, 133934) | 1271 (656, 2590) | 217 (121, 434) | 26 (12, 55) |
| | 14 | 128411 (53244, 395675) | 2948 (1362, 7699) | 515 (237, 1212) | 58 (22, 139) |
| | 15 | 292232 (93090, 987805) | 6784 (2544, 22072) | 1178 (456, 3497) | 138 (48, 387) |
| | 16 | 584643 (157106, 1496334) | 14909 (4397, 49047) | 2578 (822, 8578) | 307 (95, 1018) |
| | 17 | 756432 (223069, 1489536) | 27394 (7465, 65410) | 5229 (1426, 14326) | 650 (170, 2169) |
| | 18 | 726760 (211236, 1289493) | 34769 (10207, 65718) | 7662 (2182, 15398) | 1082 (285, 2884) |
| | 19 | 552894 (143781, 1039308) | 31800 (9636, 57547) | 7851 (2307, 14086) | 1240 (369, 2896) |
| | 20 | 351581 (72210, 782531) | 23572 (6320, 46389) | 6273 (1808, 11670) | 1101 (307, 2450) |
| Ctrl 1: 10-30% reduction in contact rate | 13 | 51094 (27762, 119874) | 1250 (648, 2539) | 215 (120, 429) | 26 (12, 55) |
| | 14 | 89540 (38012, 270274) | 2552 (1197, 6536) | 469 (218, 1084) | 57 (22, 136) |
| | 15 | 135993 (45160, 484321) | 4474 (1731, 14135) | 852 (339, 2460) | 118 (42, 323) |
| | 16 | 192152 (49474, 696944) | 6668 (2034, 23824) | 1312 (436, 4536) | 195 (62, 644) |
| | 17 | 251052 (54149, 764440) | 9183 (2265, 31795) | 1833 (501, 6814) | 279 (75, 1028) |
| | 18 | 285295 (55718, 720211) | 11764 (2459, 33505) | 2506 (548, 7779) | 376 (84, 1329) |
| | 19 | 273104 (53137, 629999) | 12770 (2498, 32143) | 2903 (589, 7674) | 452 (91, 1438) |
| | 20 | 234785 (42939, 529790) | 12032 (2312, 28133) | 2890 (574, 6806) | 455 (95, 1375) |
| Ctrl 2: 10-30% reduction in contact rate & 10-25% in infectious period | 13 | 48701 (26523, 115030) | 1245 (645, 2525) | 214 (120, 429) | 26 (12, 55) |
| | 14 | 75076 (31980, 229257) | 2399 (1129, 6132) | 449 (210, 1038) | 57 (21, 135) |
| | 15 | 95177 (30908, 351758) | 3671 (1420, 11646) | 731 (294, 2121) | 110 (39, 300) |
| | 16 | 105084 (25840, 431074) | 4549 (1363, 16915) | 964 (315, 3444) | 159 (50, 532) |
| | 17 | 106757 (20196, 430889) | 4925 (1134, 19680) | 1092 (278, 4371) | 187 (48, 725) |
| | 18 | 104463 (15543, 372195) | 5041 (907, 19000) | 1148 (229, 4566) | 198 (40, 813) |
| | 19 | 90952 (11734, 315714) | 4763 (692, 16886) | 1126 (180, 4071) | 193 (33, 751) |
| | 20 | 74751 (8514, 254767) | 4132 (523, 14216) | 1009 (134, 3533) | 177 (25, 673) |
| Ctrl 3: 30-50% reduction in contact rate | 13 | 41058 (22627, 94714) | 1211 (630, 2440) | 211 (119, 422) | 26 (12, 55) |
| | 14 | 50651 (22673, 150562) | 1967 (941, 4858) | 394 (186, 881) | 55 (21, 129) |
| | 15 | 54200 (18886, 194977) | 2446 (996, 7311) | 523 (219, 1458) | 88 (32, 231) |
| | 16 | 54442 (14647, 225797) | 2578 (838, 9250) | 583 (203, 1976) | 103 (34, 334) |

| | | | | | |
|---|---|---|---|---|---|
| | 17 | 54874 (11201, 253584) | 2586 (638, 10608) | 589 (157, 2348) | 105 (28, 396) |
| | 18 | 54440 (8756, 258108) | 2556 (494, 11429) | 579 (125, 2603) | 104 (22, 444) |
| | 19 | 53718 (6722, 237277) | 2554 (382, 11598) | 582 (96, 2717) | 103 (18, 471) |
| | 20 | 49501 (5107, 213773) | 2445 (291, 10803) | 574 (74, 2630) | 99 (14, 466) |
| Ctrl 4: 30-50% reduction in contact rate and 10-25% reduction in infectious period | 13 | 39385 (21804, 91052) | 1206 (629, 2433) | 211 (119, 422) | 26 (12, 55) |
| | 14 | 43416 (19220, 129994) | 1862 (892, 4586) | 382 (181, 855) | 55 (21, 128) |
| | 15 | 39049 (13178, 142272) | 2038 (829, 6097) | 463 (193, 1283) | 82 (30, 216) |
| | 16 | 30645 (7741, 131848) | 1824 (574, 6577) | 442 (153, 1514) | 85 (28, 277) |
| | 17 | 23531 (4392, 116299) | 1416 (342, 6166) | 355 (94, 1464) | 72 (19, 278) |
| | 18 | 17560 (2471, 98968) | 1062 (192, 5297) | 272 (54, 1300) | 55 (11, 249) |
| | 19 | 13504 (1421, 80867) | 790 (108, 4508) | 206 (30, 1109) | 41 (7, 209) |
| | 20 | 9882 (775, 62744) | 591 (59, 3597) | 154 (17, 900) | 30 (4, 175) |
| Ctrl 5: 30-50% reduction in both contact rate & infectious period | 13 | 35473 (19823, 82752) | 1195 (624, 2408) | 210 (119, 419) | 26 (12, 55) |
| | 14 | 29308 (12745, 89174) | 1628 (783, 3976) | 354 (167, 788) | 54 (20, 126) |
| | 15 | 17822 (5768, 65440) | 1348 (545, 4031) | 343 (144, 940) | 70 (26, 184) |
| | 16 | 8872 (2087, 39304) | 809 (249, 2956) | 229 (78, 802) | 53 (17, 174) |
| | 17 | 4356 (757, 23567) | 395 (91, 1776) | 119 (31, 502) | 30 (7, 116) |
| | 18 | 2169 (276, 13851) | 192 (33, 1059) | 59 (11, 297) | 14 (3, 68) |
| | 19 | 1074 (99, 8374) | 95 (12, 624) | 29 (4, 177) | 7 (1, 40) |
| | 20 | 514 (36, 4880) | 47 (4, 375) | 14 (2, 103) | 3 (0, 23) |

**Table 4.** Projected weekly healthcare demands under different scenarios for the coming 8 weeks. Numbers are median and (interquartile range, IQR).

| | | Based on rates in China | | Based on NYC rate as of Mar 15, 2020: 60% hospitalized needed ICU |
|---|---|---|---|---|
| Intervention | Week | Hospital Bed Needs | ICU Bed Needs | ICU beds needs |
| No control (worst case) | 13 | 1485 (824, 2970) | 190 (97, 387) | 428 (219, 871) |
| | 14 | 4107 (1836, 8717) | 504 (185, 1109) | 1135 (417, 2496) |
| | 15 | 11265 (4386, 24989) | 1398 (498, 3160) | 3146 (1120, 7110) |
| | 16 | 27782 (10361, 59164) | 3402 (1167, 7910) | 7654 (2626, 17797) |
| | 17 | 52739 (21039, 98187) | 6743 (2362, 14262) | 15172 (5314, 32090) |
| | 18 | 67400 (32441, 113250) | 9274 (3551, 17785) | 20868 (7991, 40017) |
| | 19 | 64088 (30426, 104672) | 8919 (3597, 16429) | 20068 (8093, 36966) |
| | 20 | 46728 (19105, 80048) | 6504 (2142, 12969) | 14635 (4820, 29180) |
| As Is (status quo) | 13 | 1467 (807, 2970) | 187 (96, 381) | 421 (217, 858) |
| | 14 | 3410 (1485, 8419) | 442 (162, 1064) | 993 (364, 2393) |
| | 15 | 7696 (2795, 24178) | 993 (323, 2970) | 2235 (727, 6681) |
| | 16 | 16898 (4909, 54732) | 2146 (563, 6880) | 4829 (1266, 15480) |
| | 17 | 32555 (8380, 83039) | 4055 (1003, 11920) | 9124 (2257, 26820) |
| | 18 | 43053 (12196, 87705) | 5559 (1437, 13771) | 12508 (3233, 30985) |
| | 19 | 42124 (13225, 80906) | 5506 (1548, 12406) | 12389 (3483, 27913) |
| | 20 | 32920 (9725, 65754) | 4380 (1112, 10507) | 9854 (2503, 23641) |
| Ctrl 1: 10-30% reduction in contact rate | 13 | 1439 (801, 2876) | 187 (96, 386) | 420 (216, 869) |
| | 14 | 2966 (1296, 7252) | 403 (146, 945) | 907 (329, 2127) |
| | 15 | 5190 (1960, 16152) | 718 (239, 2157) | 1617 (537, 4852) |
| | 16 | 7971 (2450, 27752) | 1086 (291, 3716) | 2442 (654, 8361) |
| | 17 | 11049 (2826, 38682) | 1450 (344, 5351) | 3262 (774, 12039) |
| | 18 | 14170 (2929, 42861) | 1869 (360, 6590) | 4206 (809, 14828) |
| | 19 | 15756 (3083, 42202) | 2109 (382, 6336) | 4745 (860, 14256) |
| | 20 | 15605 (2968, 38315) | 2037 (385, 6140) | 4584 (866, 13816) |
| Ctrl 2: 10-30% reduction in contact rate & 10-25% in infectious period | 13 | 1440 (792, 2868) | 187 (95, 381) | 422 (213, 857) |
| | 14 | 2841 (1218, 6909) | 381 (136, 927) | 857 (305, 2085) |
| | 15 | 4339 (1617, 13492) | 613 (200, 1829) | 1379 (450, 4116) |
| | 16 | 5699 (1694, 20450) | 808 (218, 2911) | 1818 (490, 6549) |
| | 17 | 6073 (1461, 23809) | 857 (189, 3498) | 1928 (425, 7871) |
| | 18 | 6370 (1238, 24505) | 888 (149, 3638) | 1999 (335, 8185) |
| | 19 | 6030 (947, 22547) | 853 (126, 3363) | 1918 (283, 7568) |
| | 20 | 5440 (744, 19560) | 724 (94, 2878) | 1628 (211, 6476) |
| Ctrl 3: 30-50% reduction in contact rate | 13 | 1389 (771, 2784) | 184 (98, 369) | 413 (219, 831) |
| | 14 | 2365 (1039, 5647) | 340 (128, 766) | 766 (288, 1724) |
| | 15 | 3006 (1167, 8892) | 440 (141, 1273) | 991 (318, 2865) |
| | 16 | 3307 (1056, 11416) | 478 (138, 1668) | 1074 (310, 3752) |

| | | | | |
|---|---|---|---|---|
| | 17 | 3229 (864, 12776) | 487 (107, 1942) | 1096 (241, 4370) |
| | 18 | 3156 (640, 14293) | 464 (89, 2098) | 1044 (200, 4720) |
| | 19 | 3125 (502, 14824) | 439 (64, 2006) | 988 (144, 4514) |
| | 20 | 3044 (392, 14027) | 445 (51, 2066) | 1001 (115, 4649) |
| Ctrl 4: 30-50% reduction in contact rate and 10-25% reduction in infectious period | 13 | 1375 (772, 2790) | 180 (92, 365) | 406 (207, 821) |
| | 14 | 2292 (996, 5408) | 312 (119, 734) | 703 (268, 1651) |
| | 15 | 2605 (1013, 7703) | 387 (131, 1133) | 870 (294, 2549) |
| | 16 | 2402 (774, 8540) | 362 (102, 1286) | 814 (229, 2893) |
| | 17 | 1897 (495, 7930) | 279 (64, 1213) | 627 (143, 2730) |
| | 18 | 1467 (290, 7053) | 221 (37, 1066) | 498 (84, 2398) |
| | 19 | 1105 (166, 6099) | 155 (21, 896) | 349 (48, 2017) |
| | 20 | 824 (90, 4950) | 115 (12, 735) | 259 (27, 1653) |
| Ctrl 5: 30-50% reduction in both contact rate & infectious period | 13 | 1397 (780, 2727) | 177 (90, 369) | 399 (202, 830) |
| | 14 | 2027 (890, 4780) | 292 (103, 684) | 656 (232, 1539) |
| | 15 | 1932 (757, 5548) | 289 (95, 810) | 650 (213, 1824) |
| | 16 | 1262 (424, 4531) | 191 (55, 680) | 431 (123, 1530) |
| | 17 | 676 (175, 2819) | 98 (23, 422) | 221 (52, 950) |
| | 18 | 317 (62, 1667) | 45 (8, 248) | 102 (17, 559) |
| | 19 | 155 (24, 962) | 24 (3, 146) | 53 (6, 328) |
| | 20 | 78 (9, 574) | 11 (1, 83) | 24 (2, 187) |

**Figure 1.** Projected total number of **new infections** under different control scenarios. Blue lines and points show median estimates for the model training period; red lines show projected median numbers with seasonality (solid lines) or without seasonality (dashed lines); shaded regions shown the interquartile ranges (IQR) for model estimates with seasonality (in orange) or without seasonality (in yellow).

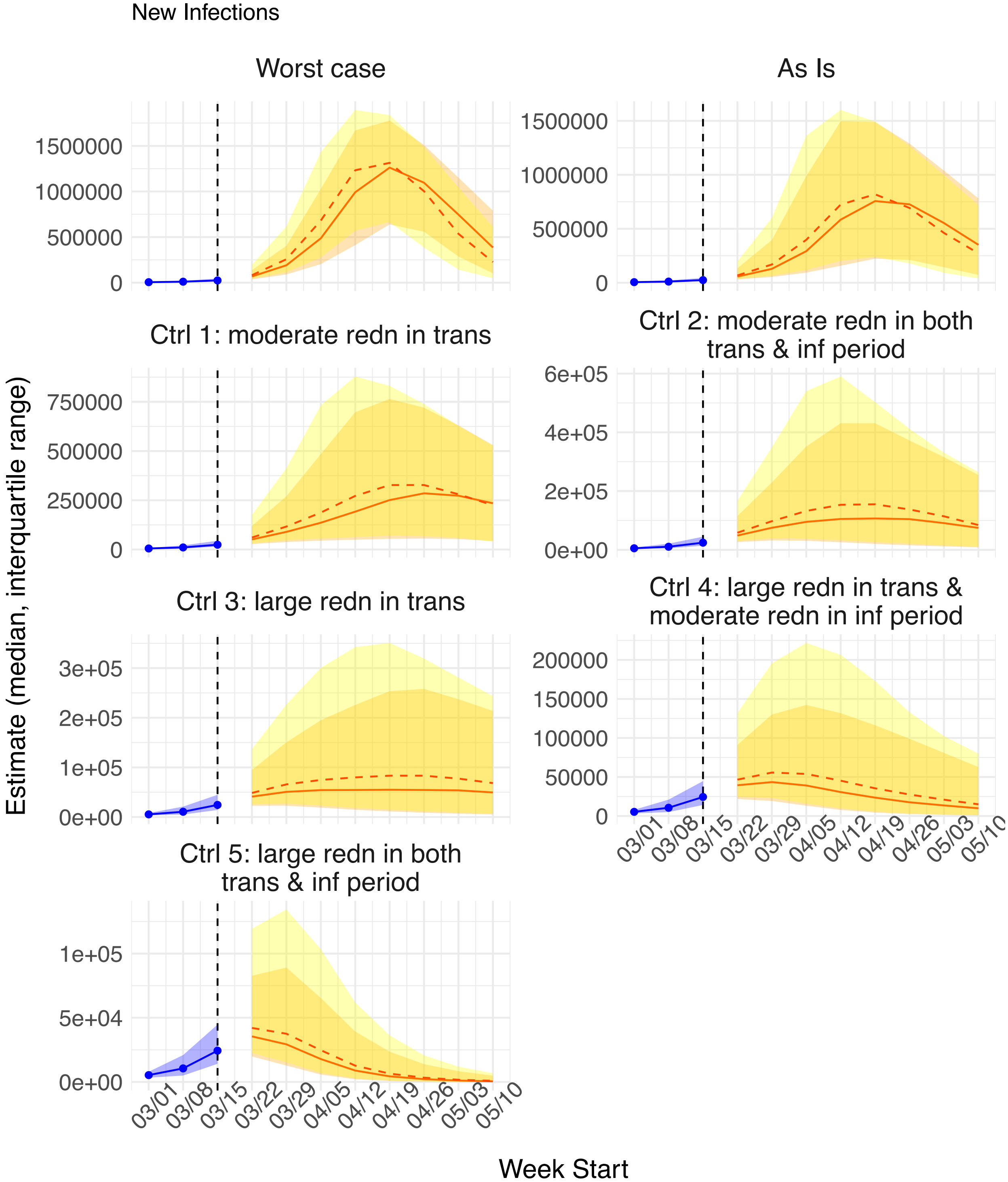

**Figure 2.** Projected total number of **new confirmed cases** under different control scenarios. Blue lines and points show median estimates for the model training period; red lines show projected median numbers with seasonality (solid lines) or without seasonality (dashed lines); shaded regions shown the interquartile ranges (IQR) for model estimates with seasonality (in orange) or without seasonality (in yellow).

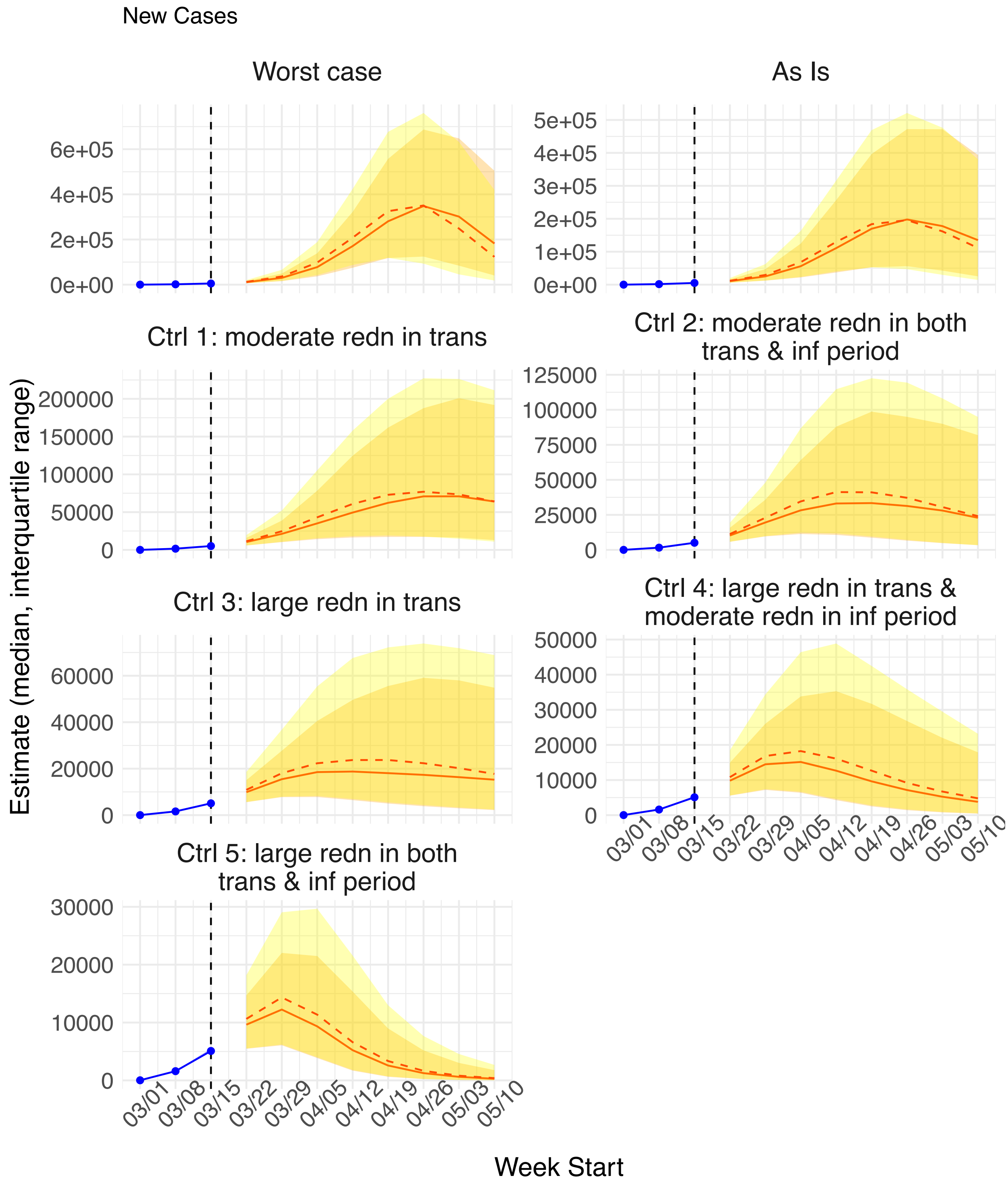

**Figure 3.** Projected total number of **new hospitalizations** under different control scenarios. Blue lines and points show median estimates for the model training period; red lines show projected median numbers with seasonality (solid lines) or without seasonality (dashed lines); shaded regions shown the interquartile ranges (IQR) for model estimates with seasonality (in orange) or without seasonality (in yellow).

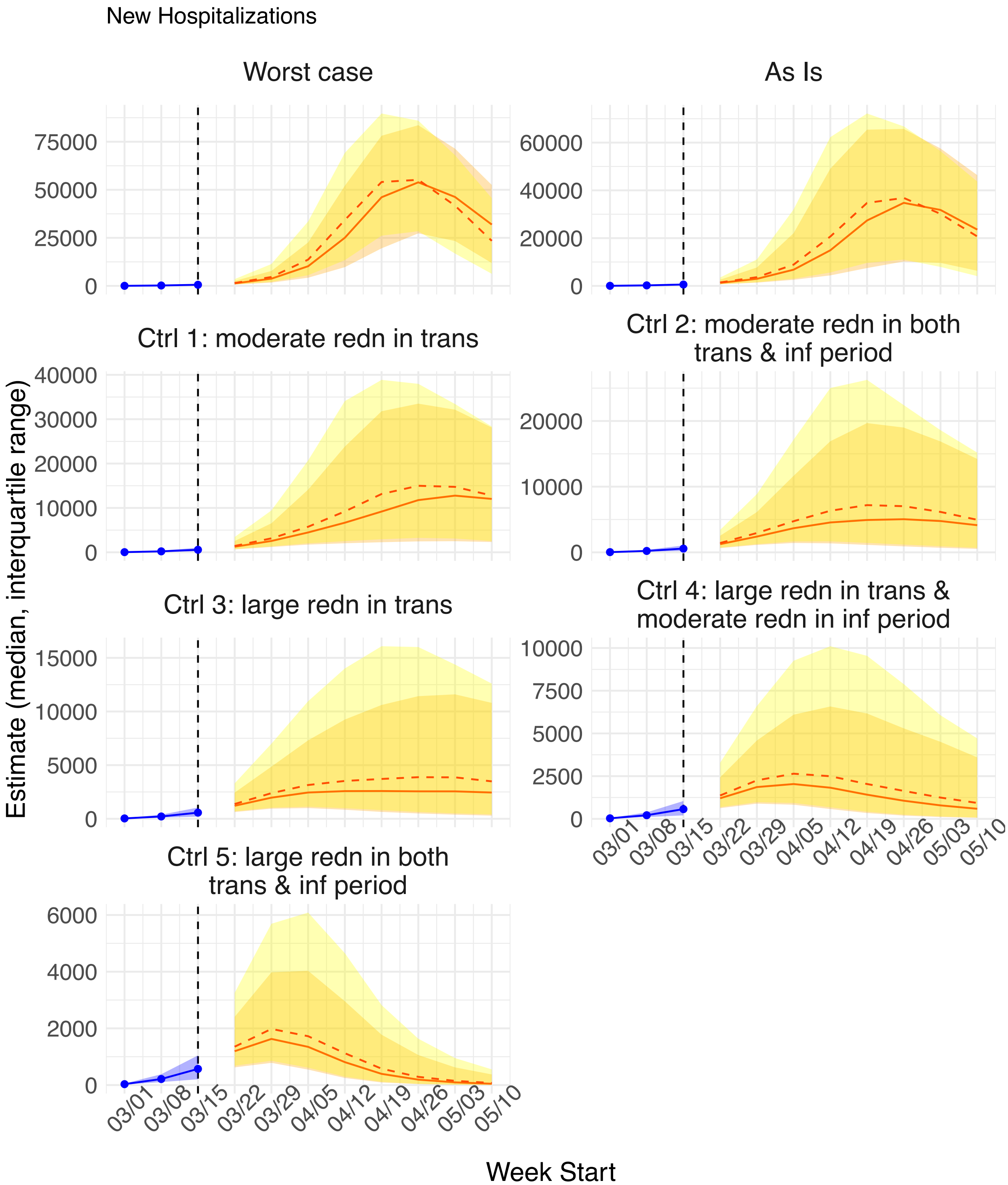

**Figure 4.** Projected total number of **new ICU admissions** under different control scenarios. Blue lines and points show median estimates for the model training period; red lines show projected median numbers with seasonality (solid lines) or without seasonality (dashed lines); shaded regions shown the interquartile ranges (IQR) for model estimates with seasonality (in orange) or without seasonality (in yellow).

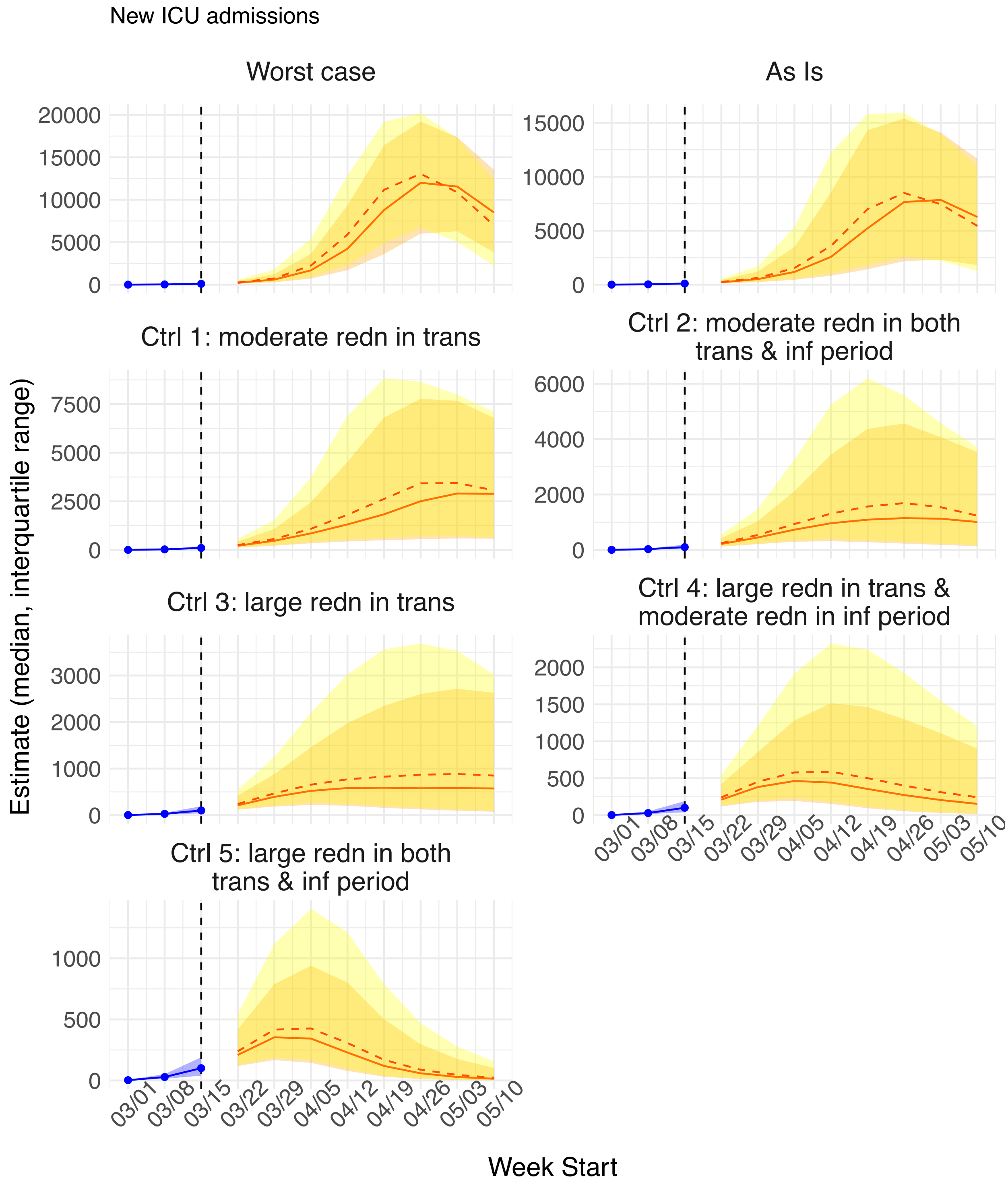

**Figure 5.** Projected total number of **new deaths** under different control scenarios. Blue lines and points show median estimates for the model training period; red lines show projected median numbers with seasonality (solid lines) or without seasonality (dashed lines); shaded regions shown the interquartile ranges (IQR) for model estimates with seasonality (in orange) or without seasonality (in yellow).

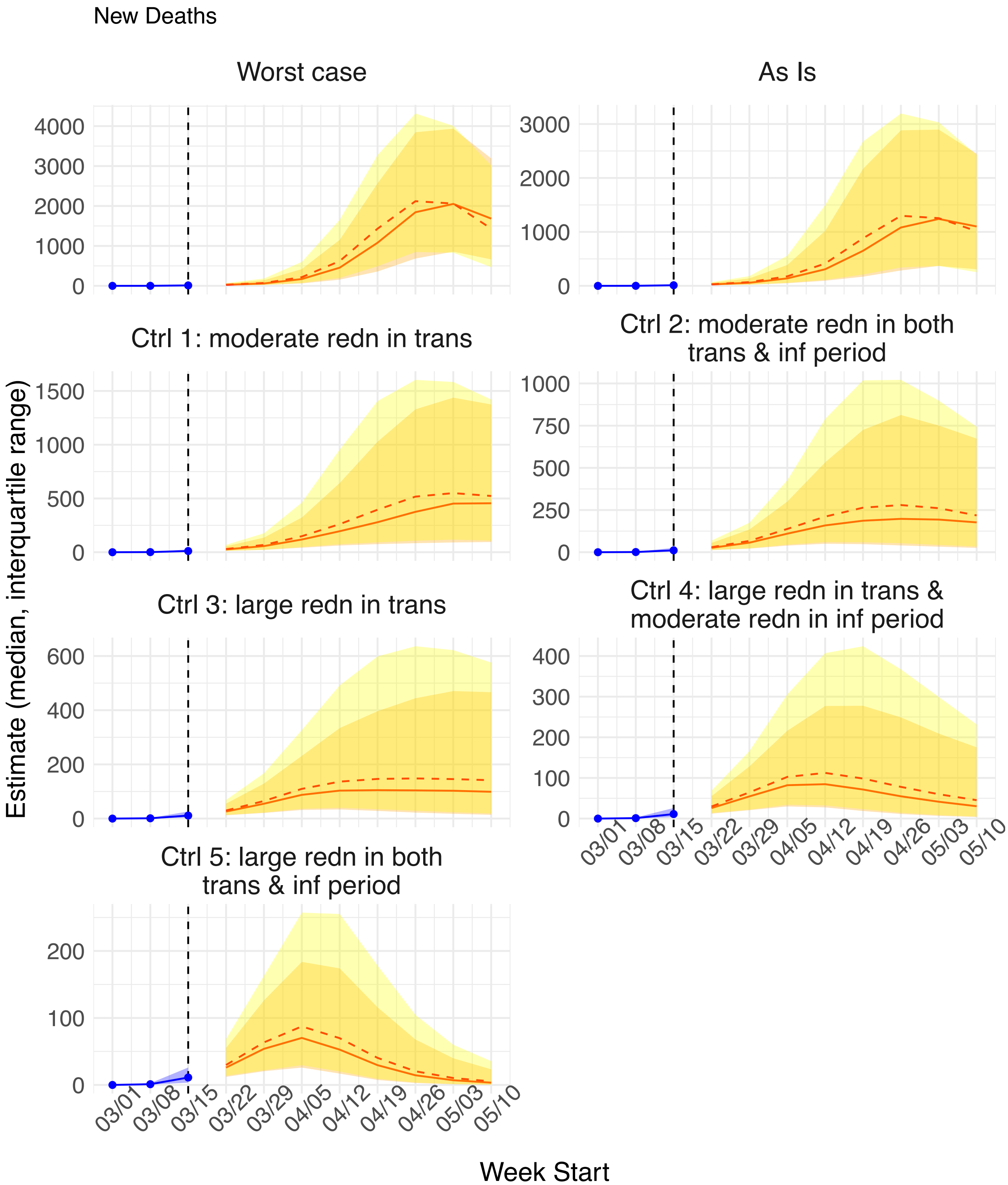

**Figure 6.** Projected **hospital bed needs** under different control scenarios. Blue lines and points show median estimates for the model training period; red lines show projected median numbers with seasonality (solid lines) or without seasonality (dashed lines); shaded regions show the interquartile ranges (IQR) for model estimates with seasonality (in orange) or without seasonality (in yellow). Plotted values indicate the *maximum demand over 7 days of a given week*. Black horizontal long-dash lines show the number of beds available in NYC as of March 19, 2020; black horizontal short-dash lines show the total number of beds exist in NYC as of March 19, 2020.

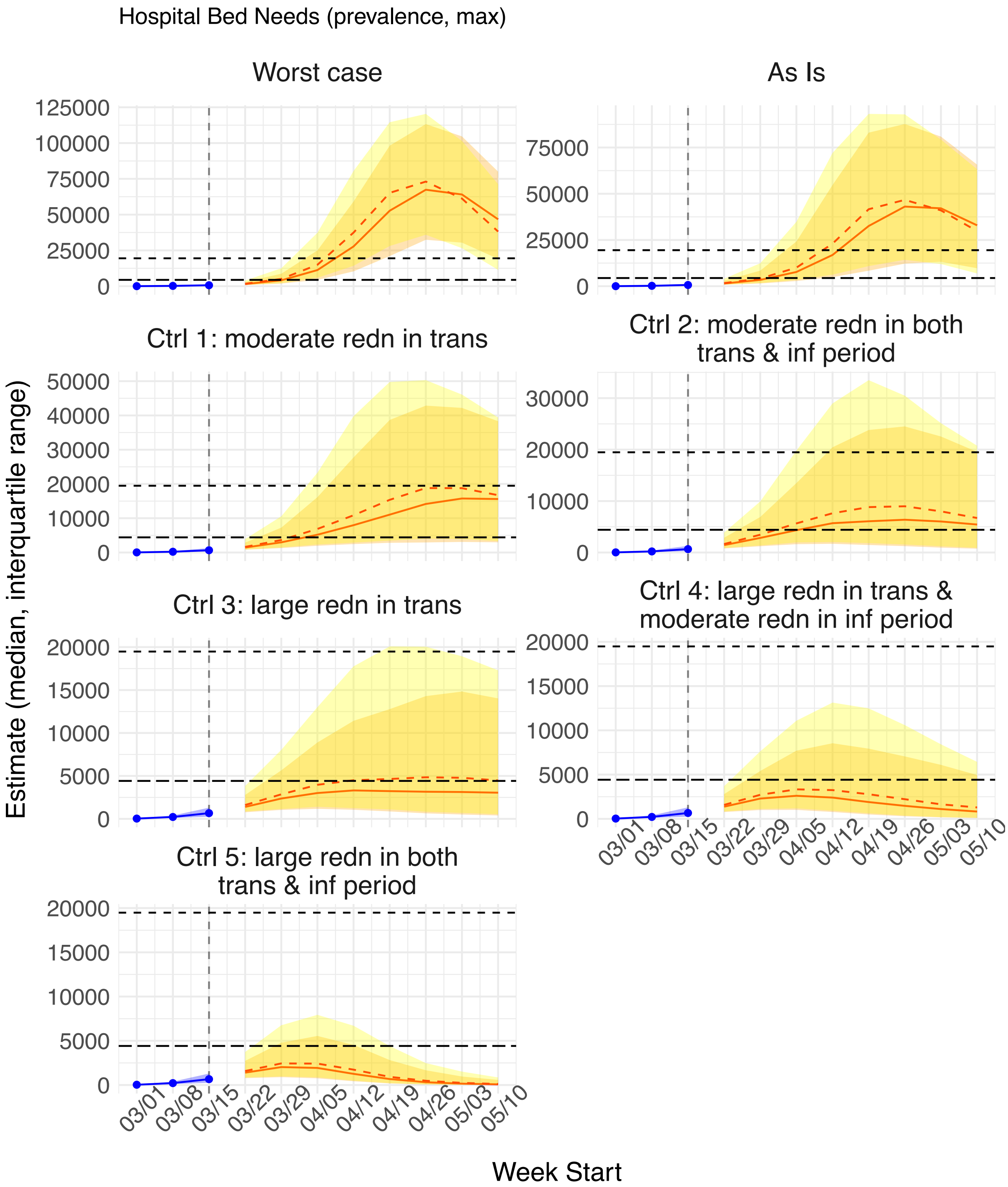

**Figure 7.** Projected **ICU bed needs** under different control scenarios. Blue lines and points show median estimates for the model training period; red lines show projected median numbers with seasonality (solid lines) or without seasonality (dashed lines); shaded regions shown the interquartile ranges (IQR) for model estimates with seasonality (in orange) or without seasonality (in yellow). *Plotted values are the maximum demand over 7 days of a given week*. Black horizontal long-dash lines show the number of beds available in NYC as of March 19, 2020; black horizontal short-dash lines show the total number of beds exist in NYC as of March 19, 2020. Note these projections did not adjust for the potentially higher rate of ICU admission among hospitalized in NYC as shown in Table 4.