Vanderbilt COVID-19 Modeling Team Report for Tennessee

May 13, 2020

This report provides a snapshot of current COVID-19 infections and hospitalizations across Tennessee and in the two most populous regions.

Tennessee is now in a new phase of its coronavirus mitigation strategy that combines continued social distancing with the expansion of business operation protocols in many counties across the state. On April 24, our team released our third report: it presented possible scenarios that could unfold. We looked specifically at the impact of lifting business restrictions on the time it might take before the state reached 1,000 concurrent hospitalizations under those scenarios.

This report builds on our earlier reports by providing descriptive analyses of recent case growth and COVID-19 hospitalizations in Tennessee. We document how both the data and the model have changed since our first report was released in early April. In doing so, we aim to provide additional transparency about how our projections compare to state-reported data.

There are two important things to know about the data presented here. First, with an incubation period of up to 14 days, cases reported through this week likely reflect infections transmitted up to 2 weeks ago. Second, because of this time lag, **we believe it is too early to assess the impact of businesses reopening across the state or of more Tennesseans resuming activities outside their homes. Therefore, data presented here should be considered a new "baseline" for monitoring changes moving forward.**

Calculations using state data received through May 11 show the statewide transmission number, or "R," to be 0.96 (Confidence interval: 0.90 – 1.04). Transmission numbers in the regions around Nashville and Memphis are similarly estimated at around 1.0 (Nashville area: 0.92-1.09, Memphis area: 0.91-1.10). Given the overlapping confidence regions for all three of these numbers (shown in parentheses) they are statistically indistinguishable from each other, and no region of the state has an R that differs significantly from 1.0.

While the transmission number has remained relatively stable since our last report, over the last two weeks there have been distinct "spikes" in reported positive cases and an increase in the average number of positive cases reported per day. Since our last report Tennessee has reported a large number of cases in congregate settings (e.g., within prisons and nursing homes) and has seen continued case growth in the community. Tennessee is now operating "drive-thru" testing centers in 37 counties across the state. As of this writing, at least one new case was tested and confirmed positive within the last 10 days in 77 of 95 counties statewide.

This raises an important question. Is this increase in cases because there is more widespread testing, because more people are getting infected, or both? This question remains difficult to answer with certainty, especially given widespread testing in congregate settings. In the Appendix, we explain how

we are adapting our model to better answer this question in the future so that projections we might make if the transmission number (R) deviates from 1.0 will reflect the state experience to date.

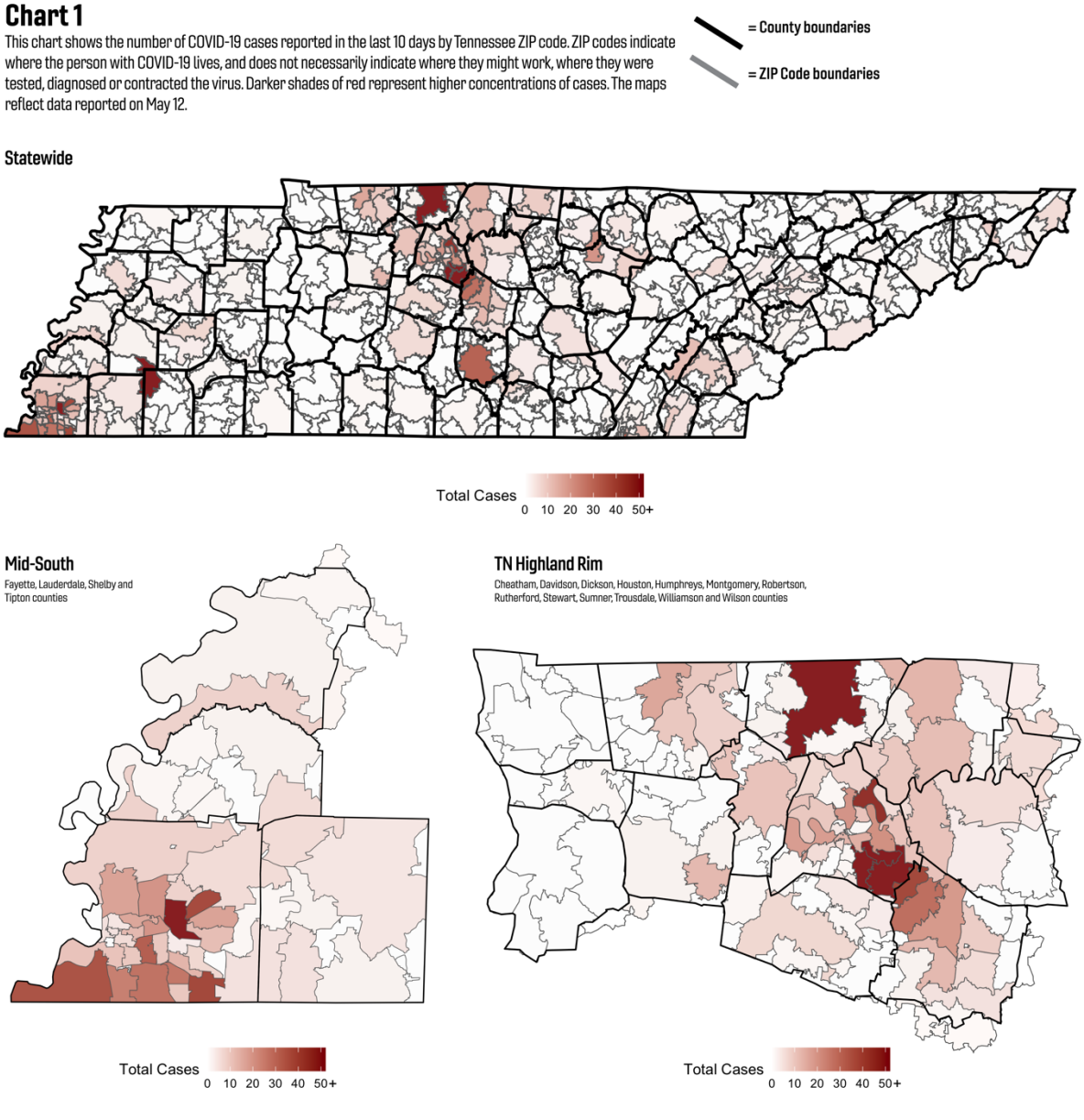
1: Recent Case Growth

The maps below provide information on confirmed positive infections statewide and in the two most populated regions. Each map shows the number of positive cases tested and reported within the last 10 days. Some of the areas with the highest case growth numbers include those where there are known outbreaks in correctional facilities.

ZIP code areas shaded in dark red on the maps above had at least 50 positive cases tested over the last 10 days. Cases are attributed to the place the infected individuals live, so the maps will not necessarily reflect where

Chart 1

This chart shows the number of COVID-19 cases reported in the last 10 days by Tennessee ZIP code. ZIP codes indicate where the person with COVID-19 lives, and does not necessarily indicate where they might work, where they were tested, diagnosed or contracted the virus. Darker shades of red represent higher concentrations of cases. The maps reflect data reported on May 12.



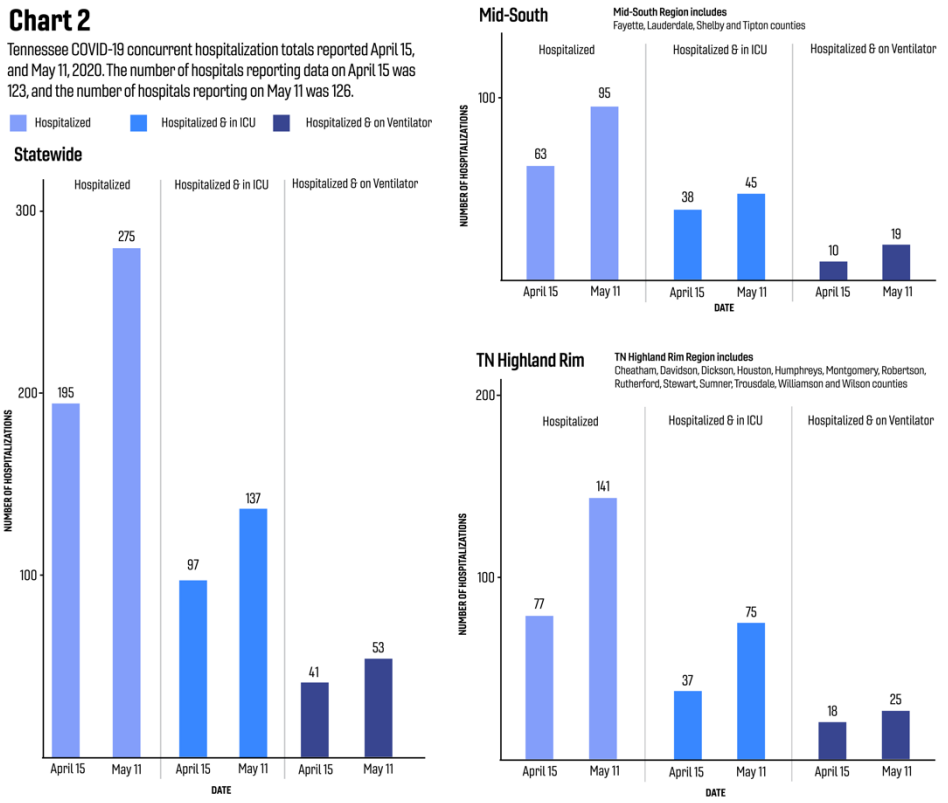
infected individuals work or engage in other activities. The map also does not indicate where these individuals may have been infected or diagnosed. It is essential for public health agencies to contact infected individuals and trace the individuals they have been near regardless of place of residence.

2: COVID-19 Hospitalizations

Across Tennessee, as of May 11, 275 individuals were currently hospitalized with COVID-19. Regionally, the highest numbers seen as of May 11 were in the health care coalitions in Tennessee Highland Rim (which includes metropolitan Nashville) and the Mid-South (which includes Memphis). Unlike the data presented in the maps above, the numbers presented in Chart 2 below are by hospital location and may not indicate where patients live. We expect to see the highest numbers of hospitalizations in areas with the largest hospitals, which in Tennessee are Memphis and Nashville.

Chart 2

Tennessee COVID-19 concurrent hospitalization totals reported April 15, and May 11, 2020. The number of hospitals reporting data on April 15 was 123, and the number of hospitals reporting on May 11 was 126.



As of the second week of May, the state is not at a point of stressing hospital capacity. New cases occurring across the state over the past month have, however, led to statewide hospitalizations increasing by 40 percent overall: hospitalizations in the Tennessee Highland Rim area have almost doubled. Continued attention to hospital capacity and greater resources directed towards testing and tracing are warranted.

Appendix:
How Has the Vanderbilt Model Changed Over Time?

The analyses above make clear that Tennessee faces an evolving epidemic as Tennesseans begin to engage in more economic activity outside their homes, and as testing capacity continues to expand. In the midst of this, however, the data available to date are consistent with a relatively stable transmission situation since our April 16 report. We stress, however, that this relative stability is best viewed as a new "baseline" for evaluation of further changes as business restrictions are lifted—and not as an evaluation of the impact to date of the expiration of the Safer at Home orders.

These dynamics do raise the question, however, of how our model assumptions and data have adapted. Our first modeling report was released approximately one month ago, on April 10. That report was based on an estimated statewide transmission number (R) of 1.4. That estimate reflected the most current data available at that time. As part of the April 10 report, we modeled three scenarios under different assumptions about how the transmission number could evolve into the future.

The "continued progress" scenario in the April 10 report assumed that the transmission number would gradually reduce to 1.0 by mid-May. That scenario yielded an estimated "peak" of concurrent hospitalizations of about 1,200 in mid-May.

As we shared in our April 16 modeling report, the state in fact achieved a statewide transmission number of 1.0 by mid-April—a month before the original "continued progress" scenario anticipated. This effectively reduced the growth of COVID-19, as it meant that cases (and hospitalizations) were no longer growing exponentially. In the scenario with a transmission number at 1.0 in our April 24 report, the underlying estimate was the number of people concurrently in the hospital (i.e. at one time) would plateau at 250-300 statewide.

Indeed, as reported above, concurrent hospitalizations remain at around 300 statewide. (Note this number differs from the number ever hospitalized, which the state reports as 1,363 as of May 12th.) However, as also reported above, over the last two weeks the state has also reported "spikes" in the number of positive cases—yet no similar "spike" in hospitalizations has been observed, raising questions about why these two metrics (cases and hospitalizations) may not be more tightly linked. The answer is likely related to testing, which has been extensive in Tennessee.

Also as noted above, since mid-April Tennessee has opened "drive-thru" testing centers in 37 counties and has engaged in near-universal testing of individuals in congregate settings such as prisons, jails, nursing homes, and homeless shelters. This expansion in the scope and capacity of testing has very likely resulted in a larger proportion of total infections being tested and reported.

The recent changes in testing capacity in Tennessee makes modeling COVID-19 trends difficult because the rise in the number of cases could either reflect improved detection of existing infections as testing capacity increases, evidence of an increase in transmission, or both. Teasing apart these factors has been an important focus of our work over the last few weeks.

To accommodate these challenges, and to tune the model to the recent data, we have adapted our model and its assumptions in several important ways. First, our model has always assumed that only a proportion of active infections are tested and reported. Given increased testing, we now assume that this proportion increased after April 22—the first day the "drive-thru" testing centers opened statewide.

Second, we have adjusted our modeling assumptions based on the state's Hospital Resource Tracking System (HRTS) data. Since late April, the HRTS data have become more reliable as more hospitals have been reporting daily case totals. Based on these data, we now assume that 4% of active infections require hospitalization—down from 5% in our initial reports. In addition, we assume an average hospital length of stay of 7 days—which is considerably lower than the 17 days used initially based on previous research on the duration of flu hospitalizations. Finally, to more closely match state-reported mortality data we now assume a fatality rate of 0.9%, down slightly from the 1.0% rate used in our earlier reports. These modeling assumption changes, as well as daily updates to the transmission number, represent the only major changes to our model over the last month.

Chart 3

Calibration of the Vanderbilt model to statewide COVID-19 cases and fatalities reported by the state.

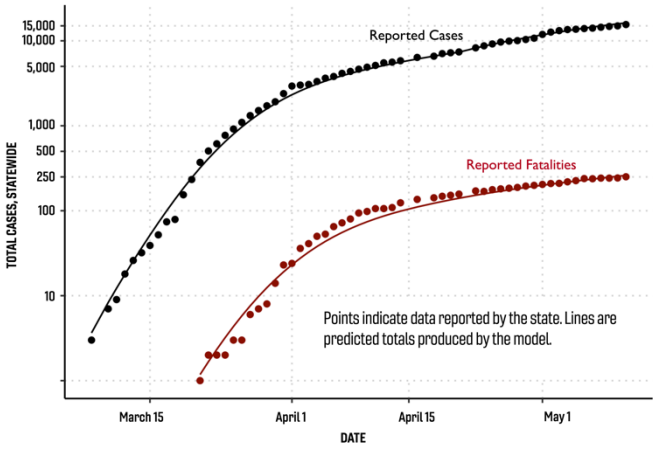
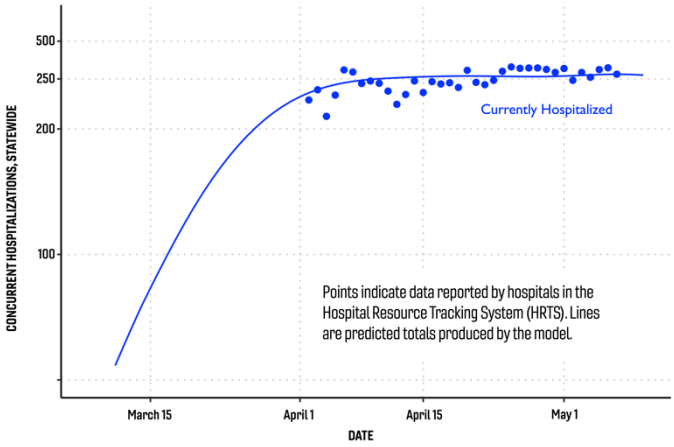


Chart 4

Calibration of the Vanderbilt model to concurrent statewide COVID-19 hospitalizations.



Charts 3 and 4 compare reported cases and deaths, as well as concurrent hospitalizations, to model predictions based on the assumptions above. While the future remains unknown, the figures demonstrate that, with these updates, the Vanderbilt model remains well calibrated to the Tennessee experience to date.

This report was prepared by John Graves, PhD, associate professor of Health Policy and director of the Center for Health Economic Modeling, Melissa McPheeters, PhD, research professor in the Department of Health Policy and co-director of the Center for Improving the Public's Health Through Informatics, Melinda Buntin, PhD, Mike Curb Professor of Health Policy and Chair, Department of Health Policy. Statistical and epidemiological support was provided by Shawn Garbett, MS, assistant in the Department of Biostatistics and Peter Rebeiro, PhD, MHS, assistant professor of medicine and biostatistics at VUMC. Data analysis and presentation support were provided by Jake Lowary, Leonce Nshuti, and Zilu Zhou; the team received input from Vanderbilt's Health Policy and Public Health Advisory Panel.