

COVID-19 in North Carolina

Assessing North Carolina Hospital Capacity: June 2020 Update

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Introduction

This brief updates a [mid-April brief](#) examining the near-term capacity of NC hospitals in light of COVID-19. Our prior analysis reported statewide results; this analysis incorporates more recent data, updates methods for estimating hospital capacity, and adds regional results. As changes in population mobility and contact rates may influence infection rates, this brief aims to provide quantitative context for the recent growth in hospitalizations.

In this brief, we show an overall increase in pressure on the statewide health care system between April and June. Fewer empty beds are available, but the statewide growth rate of COVID-19-related hospitalizations has decreased.

Importantly, this increased pressure on hospitals is distributed unevenly across the state. The regions surrounding Greenville, Charlotte, and the Triangle are experiencing more substantial tightening of near-term capacity than other regions.

Over the last several months, hospital leaders planned for various contingencies to address a potential influx of patients. Hospitals can flex (i.e., implement “surge” capacity) to some extent to accommodate increased demand. Regional monitoring of near-term forecasts, such as those presented here, can be used to calibrate state and hospital surge response.

Two preliminary comments are worth bearing in mind when interpreting our conclusions:

First, any changes to factors influencing COVID-19-related hospitalizations are likely to have a lagged effect. We expect that the current analysis reflects population behavior and resulting infection rates in the prior 2-3 weeks. Hence, we will need to update these numbers in the coming weeks.

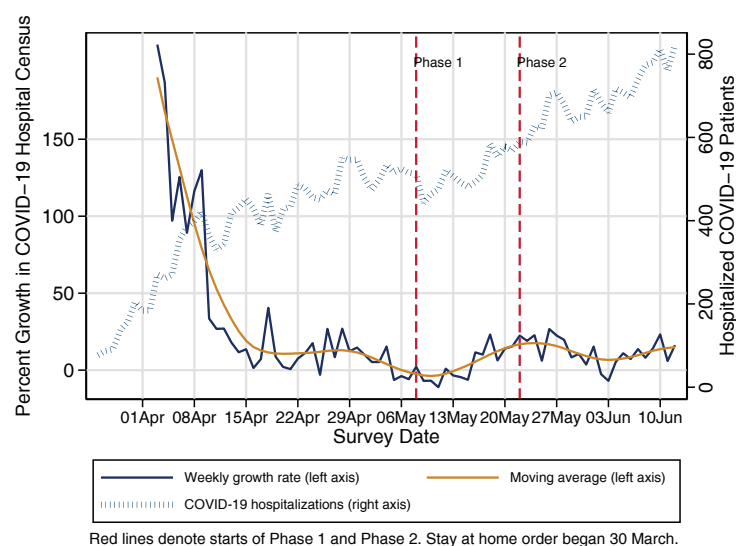
Second, our analysis focuses only on one public health outcome: avoiding a too-rapid influx of patients to the point of exceeding hospital capacity. These updated results can be considered in the context of other trends, such as testing and tracing capacity, rate of positive test results, and local outbreak concentration, among others.

Recent trends and developments related to hospital supply and demand

Exhibit 1 summarizes recent trends in North Carolina hospitalizations associated with COVID-19. In the month of April, COVID-19 hospitalizations increased from about 300¹ to 500 (right axis) at a weekly growth rate of around 16 percent (left axis). The growth rate then became flat to slightly negative until roughly May 15, when it began to increase again. Since May 15, the weekly growth rate has increased to 6-20 percent (left axis).

Exhibit

1 Trends in COVID-19 hospitalizations in North Carolina



Meanwhile, as illustrated in Exhibit 2, next page, currently-available daily acute hospital beds have decreased by over 4,000 beds from early April to the present, as defined by hospital-reported maximum staffed capacity.¹ This could be due to several factors: reintroduction of elective procedures in hospital operations,^{2,3} increases in hospitalizations related to increased public travel and activity, possible increases in avoided care, or other issues. Should more beds become needed, some but not all of this reduction in available beds can be addressed via management decisions by hospitals and/or decisions by policy officials.

¹ See Methods appendix for how we estimate hospitalizations and capacity from survey reports.

² As fear of COVID-19 surge subsides, NC hospitals resume non-urgent surgeries. The News & Observer. <https://www.newsobserver.com/news/local/article242322451.html>

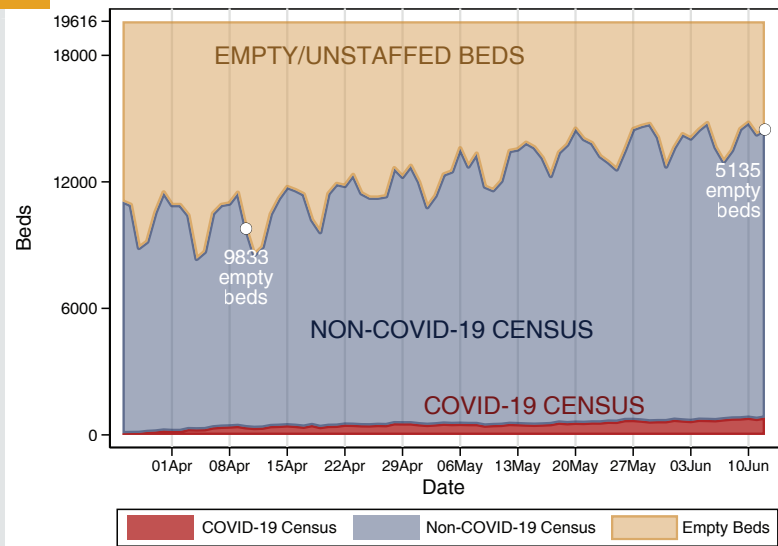
³ Hospitals Resume More Non-COVID-19 Procedures. WUNC.

<https://www.wunc.org/post/hospitals-resume-more-non-covid-19-procedures>

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Exhibit

2 NC "regular" available hospital beds decreased by almost 4700 since April



Three factors — the hospitalization growth rate, recent census, and number of available beds — can be combined to project the number of weeks until acute bed capacity is reached, assuming no changes in growth rate or available beds (i.e., with the continuation of current conditions). Hospitals have developed plans for various levels of surge — the temporary expansion of acute bed capacity to meet an influx of COVID-19 patients. To show the potential of these measures to relieve pressure on the system, we also analyze the impact of surge beds on capacity based on the number of beds hospitals report as potential surge capacity.

In early April, using slightly different methods than used in this brief, we reported that it would take just under 16 weeks for statewide hospital demand to exceed available supply at then-current conditions. Given the changing conditions since mid-April, described to the right, we now find an available "runway" of statewide "regular" hospital capacity of approximately 15 weeks if the recent COVID-19 hospitalization growth rates remain constant for the next few weeks. (Exhibit 3, next page)

If hospital-reported surge beds are added to the total available bed capacity, the statewide "runway" would increase from approximately 15 weeks to 20 weeks.

Summary of key changes since mid-April

- First, as noted on left, while hospital operating capacity is dynamic and can be changed in response to projected demand, there are currently fewer available beds to absorb increased COVID-19-related demand across North Carolina hospitals.
- As of April 10, 9 weeks prior to June 12, there were approximately 9,833 empty acute beds available statewide (excluding surge beds).⁴
- As of June 12, the date of analysis in this brief, there were approximately 5,135 empty acute beds available statewide, which could expand by an additional 5,785 surge beds. Combined with the 823 COVID-19 current hospitalizations, this leaves an available bed count of 5,958 for COVID-19 hospitalizations (11,743 if steps are taken to implement available surge capacity).
- Second, the COVID-19 hospitalization growth rate in North Carolina slowed markedly, then rose again more recently.
- In early April, the weekly growth in COVID-19 hospitalizations started above 150% and moderated to around 15% by mid-month.
- From mid-April to mid-May, however, COVID-19-related hospitalization growth was relatively flat, and sometimes negative. That month of relatively constant total COVID-19 hospitalizations provided some additional "runway," though the growth rate has once again increased.
- As of June 12, the average 7-day growth in COVID-19 hospitalizations is 14.3%.
- Third, there are now more people being treated for COVID-19 in North Carolina hospitals than there were last month.
- In early April, there were approximately 300 COVID-19-related hospitalizations statewide.
- As of June 12, this number has climbed to 823 COVID-19-related hospitalizations statewide.

⁴ See appendix for method.

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Exhibit Growth curves required to hit "regular" capacity within various weeks (not including additional surge beds)

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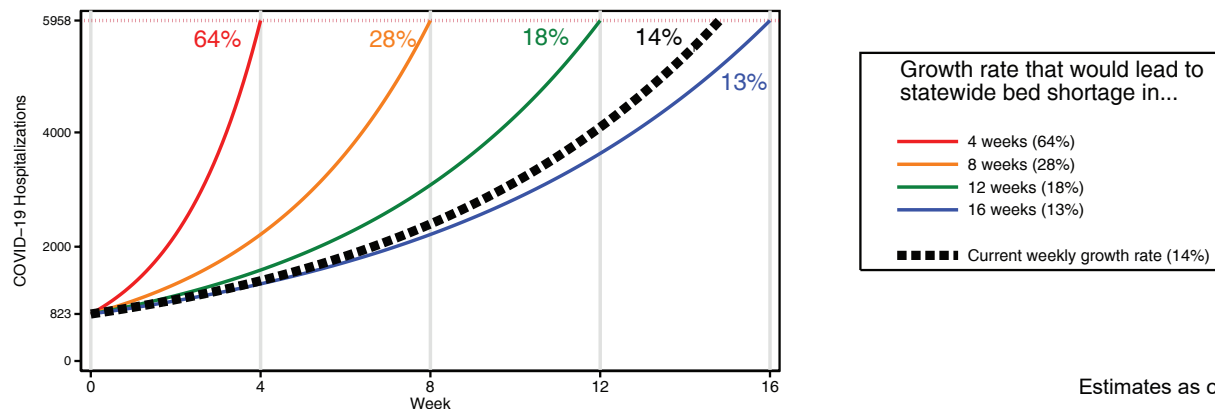


Exhibit 3, above, and discussed on the previous page, shows that the state has approximately 15 weeks before hitting "regular" capacity (without extra surge beds). This is down from 16 weeks in our April 17 brief, when the growth rate was higher, but there were more available beds.

Regional analyses

The statewide hospital bed "runway" has declined slightly overall since April, and the change is more acute at a regional level.

For purposes of public health planning and response, the State has historically divided North Carolina's 100 counties into seven Public Health Regional Surveillance Team (PHRST) regions, which we characterize here using the largest city (e.g. "Charlotte") or set of cities (e.g. "Triangle") in the region. (Exhibit 4)

Exhibit 5 reports hospitalizations by PHRST region. A few trends are noteworthy:

- Charlotte (7, purple) and the Triangle (4, light blue) regions both saw a decreasing trend in hospitalizations through mid-May, with a considerable increase since then.
- The Triad region (5, green) saw a marked increase in hospitalizations since late April. Growth in this region has slowed and started to reverse over the last two weeks.
- Both Fayetteville (3, red) and Greenville (1, navy) saw modest increases since early May, with Greenville seeing a recent increase.
- Asheville (7, yellow) and Wilmington (2, orange) regions have seen increases but still have a modest number of hospitalizations compared to the other regions.

Exhibit

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Estimated COVID-19 cases in hospital, by PHRST region

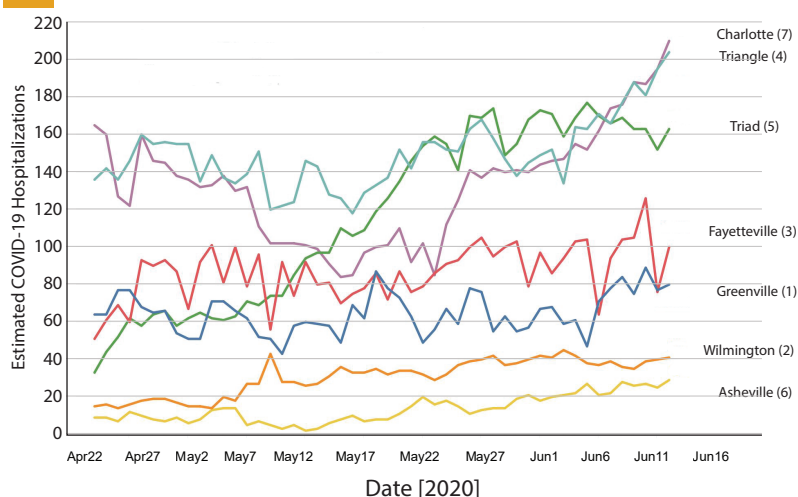
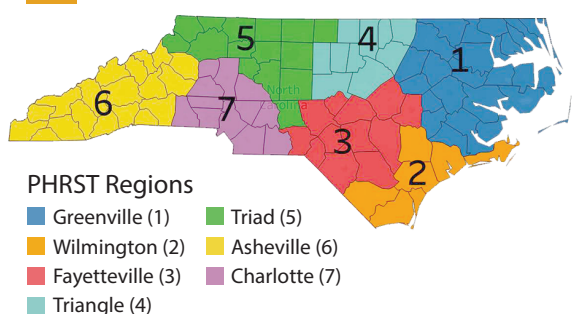


Exhibit Public Health Regional Surveillance Team (PHRST) Regions

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Exhibit 6 summarizes COVID-19 hospitalizations, acute bed capacity, and recent percent growth in COVID-19 hospitalizations by PHRST region. The final column depicts a range of the number of weeks to reach hospital capacity if current conditions hold in each region.

■ The Greenville, Triangle and Charlotte regions appear to face the most short-term pressure, with about 6-7, 7-10 weeks and 9-13 weeks of hospital capacity, respectively, if current conditions hold. The Greenville region's growth over the last week of data was particularly high at 43 percent.

■ We project the remaining PHRST regions have at least 18 weeks until reaching regional hospital capacity if current conditions hold. It is important to note, however, that the hospitalization growth rate is a major driver of this projection. When we conducted our initial analyses last week, the Greenville region's rate was much lower, giving it more weeks until hitting capacity.

Exhibit 6 COVID-19 hospitalization and acute bed capacity metrics by PHRST region

	No.	Color in exhibits	Estimated COVID-19 hosp's as of June 12	Estimated available hospital capacity	Percent growth over 7 days, June 5-12	Weeks to capacity, no surge beds	Weeks to capacity with surge beds
Greenville	1	Navy	80	755	43.2	6.2	6.9
Charlotte	7	Purple	210	1,291	30.6	6.8	10.2
Triangle	4	Lt. blue	204	1,113	20.7	9.0	13.3
Wilmington	2	Orange	41	247	10.0	18.9	26.9
Asheville	6	Yellow	29	444	1.2	220.5	280.7
Fayetteville	3	Red	100	811	-6.4	Negative growth	Negative growth
Triad	5	Green	163	1,573	-11.7	Negative growth	Negative growth
Statewide			823	5,958	14.3	14.8	19.9

■ The recent slowing and reversal of growth in hospitalizations in the Triad region (Region 5) has extended the time-to-capacity projection from earlier estimates that were affected by large percentage growth. While the Triad's rapid increase has tapered, it is a region that remains important to monitor given trends as reported in Exhibit 5 (previous page).

Data caveats

Our primary data source is a daily survey of hospitals describing their utilization and capacity. This survey is not completed by every hospital every day, so analysis with incomplete data is challenging. Also, hospitals are always adjusting their capacity based on the number of patients and operational factors. Here, we make assumptions about daily variation in regional inpatient capacity. How reasonable they are will vary by hospital. For example, a hospital may staff for 100 beds on a Monday night but only 80 on a Saturday night. Perhaps the staff is insufficient for a sustained period of staffing for 100 beds, or perhaps that hospital could staff 120 beds relatively easily. Smaller surges for shorter periods will be more possible than larger surges over longer periods; calling in a couple of extra nurses on a Wednesday is easier than standing up a field hospital requiring 100 nurses. To summarize: we use reported staffing to estimate capacity rather than other measures, like average census or licensed beds.⁵ We also recognize that expansion is possible, but not necessarily easy. It can also be difficult to sustain certain surge efforts over a long period; for example, healthcare providers need time off and may fall ill.

The growth in hospitalization rate is the key driver of time to reaching capacity, thus the time horizon over which the growth rate is calculated affects the projections. The Triangle, for example, has seen a 21 percent increase in hospitalizations over the last week, but looking at a longer time horizon, the growth rate is lower. What is our best estimate of the growth in COVID-19 hospitalizations over the next month? Is it the growth we have had since May 15? Or is the recently rapidly increasing reported case rate a harbinger of faster growth? This is a key point of uncertainty.

There are various "relief valves" possible within the hospital system to ease some pressure from increasing demand. For example, hospitals can moderate or cease procedures to open up beds. Because pressure is regional, it allows for some intra-regional pressure management (e.g., transferring patients in high-stress regions to low-stress regions); hospitals and emergency management agencies implement this approach during times of hurricanes or other disasters.

⁵ North Carolina Rural Health Research Program. Occupancy Rates in Rural and Urban Hospitals: Value and Limitations in Use as a Measure of Surge Capacity. <http://www.shepscenter.unc.edu/download/19926/>

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Key takeaways

- This brief underscores that conditions related to COVID-19 in North Carolina are dynamic and somewhat more threatening now than they were a month ago.
- Recent statewide growth in hospitalizations for COVID-19 and the decrease in available acute bed capacity has reduced the number of weeks until hospital demand could reach available capacity, assuming present conditions continue.
- However, conditions across the state vary; some regions are more at risk of facing pressure on the hospital system than others.
 - Hospitals in three regions, Region 1 (Greenville), Region 7 (Charlotte) and Region 4 (Triangle), are most at risk of reaching capacity in the next couple of months. However, it is possible that the constantly “shifting winds” of viral spread could cause currently stable regions, or counties within them, to experience sudden growth requiring rapid mitigation, underscoring the need to avoid complacency.
- Several variables can extend the “runway” of available hospital capacity, including rate of infection spread, length of hospital stay per patient, and total available hospital capacity. Surge beds can be added, and hospitals have processes by which they assess planned procedures in the coming days and act accordingly; hospitals taking action to empty beds (e.g., moderating or cancelling elective procedures) can help increase available capacity to a point. However, the COVID-19 hospitalization growth rate — a result of infection spread — is the primary driver of how quickly capacity is projected to be reached.
- Our findings further underscore the dynamic nature of policy efforts to address COVID-19. At the onset of the pandemic, most models predicted dire conditions predicated on the absence of policy intervention (and thus the rapid spread of the virus). Policy-makers and the public then acted and slowed viral spread. That slowing made forecasts more optimistic, which then led to calls for reopening. As population mobility and contact rates have changed and the opportunity for community spread has increased, the number of reported cases has also increased. Given that reported cases are a function of testing volume and strategy, it is prudent to continue monitoring hospitalizations, a method for which we have demonstrated here.
- The focus of this brief is on acute beds. However, nearly every model of COVID-19 has projected that ICU capacity is more likely to be reached than acute beds. Thus, it is reasonable to expect ICUs will reach capacity sooner than the acute bed timeline to capacity.
- Finally, as we noted in our prior brief, reopening policies can be calibrated with technical strategies (such as those we use here) to avoid exceeding hospital capacity, but any chosen strategy involves complex tradeoffs with profound ethical, social, and economic consequences. The only true long-term solutions are to fully eradicate the virus and/or develop a broadly effective and safe treatment for the disease it causes.

Appendix: Methods

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■ **Hospitalization Data & Interpretation:** Hospitalization data come from the North Carolina Medical Surge Survey report, distributed by the NC Department of Health and Human Services. Hospitals respond to the survey daily, submitting their “total staffed inpatient capacity,” “total inpatient census,” “number of COVID-19 patients in hospital,” and “number of additional surge beds available,” among other numerical responses, which are summed in daily summary reports. We refer to these daily reports by the date the hospitals responded to the survey, which predates public release of the results.

The daily report also includes the percentage of North Carolina hospitals that responded to the survey that day. This response rate typically varies between roughly 70 to 90 percent, so one source of day-to-day variation is differing hospitals reporting or not reporting daily. Another source of variation is hospital staffing decisions. A hospital that is not currently under pressure may not need to staff all of its available beds, and thus, on low-staffed days, would report fewer beds in the “total staffed inpatient capacity” survey field, despite being able to staff more beds if needed.

Additional surge beds would require putting additional plans into action to staff those beds and make them available, and may not be as immediately available as beds that are typically used. However, they provide an important additional source of capacity if hospitals were to experience extremely high demand.

■ **Bed Capacity:** The capacity of a hospital is a function of many variables. One commonly used measure is the number of licensed beds. This may vary from the number of beds available in the short term to treat patients. For example, a licensed bed may be in a wing that is under construction or shut down long ago. Furthermore, available staff (e.g., nurses) is a key factor in bed availability. To estimate the maximum “regular” statewide available acute bed capacity from the incomplete and varying survey responses, we use the maximum number of staffed beds reported by a region on any day, assuming that reflected a day when nearly all “regular” beds were staffed.

For example, over the time period May 26 to June 12, Region 7 (Charlotte) reported a range of staffed beds between 4,672 and 4,946. We thus used 4,946 as our best estimate of “regular” (non-surge) available capacity in that region.

This method may be a slight undercount, because no region has yet been under enough pressure that it would need all its hospitals to staff their absolute maximum number of beds, but we also understand that maintaining maximum staffing levels over a long time period is difficult. Thus, this could also be considered an optimistic level to maintain.

Separate from what we are calling “regular” capacity above, we are also cognizant of hospitals’ planned surge capacities, recognizing they require “flipping different switches” and special efforts to achieve staffing in those surge plans. We are reflecting the availability of planned surge beds by displaying the both the number of weeks of “runway” hospitals have with just regular capacity, as estimated above, and also the weeks of runway if surge beds are included (Exhibit 6). We used the surge beds reported by each region on the most recent day included in our analysis, June 12.

■ **Growth Rates:** We calculate growth rates based on a Poisson regression using the last 7 days of data for each region. Because reporting is lower on weekends, we adjust for whether the reporting day is a weekend. Response rates vary during the week; 77-85 percent of hospitals typically respond on weekends compared to 86-92 percent during the week. Response rates have generally declined since early May. The declining response rate could lead to estimated growth rates that are lower than the actual growth rates.

We explored alternative methods for a variety of the inputs. For example, in the previous brief, we used simple arithmetic using the last day of data and 7 days prior (to account, again, for rate of reporting). This simple method, although highly intuitive, led to less stable estimates — the percentage growth might vary from 23 percent one day to 2 percent the next. The regression approach provides a smoother, more stable estimate. The trend over the next few weeks is the key driver of the number of weeks of capacity, and as that varies, the projection varies.

■ **Regions:** For the regional analysis, we used customized data runs provided by the State with hospitalizations aggregated to the PHRST regions based on the hospital location. Due to occasional updating of reports by hospitals over time, the regional data used here do not always align with the statewide data published daily, although differences are small and inconsequential to the primary conclusions. Note that patients may reside in a different region than where they are hospitalized.