Productivity and Adaptability: Why COVID-19 Has Not Overrun American Hospitals

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Introduction

Early in the COVID-19 epidemic, many gloomy images emerged of what might be ahead. In one, hospitals would be overrun by more COVID-19 patients than they could treat. Models developed at the Institute for Health Metrics and Evaluation (IHME) provided numbers that supported the image. For the most part, overrun hospitals did not happen. Things turned out better because America’s hospitals did better than the IHME model thought they could.

Hospital productivity has proved to be greater than anticipated in the IHME model. Productivity determines how many patients hospitals can serve. Productivity reflects how many beds a hospital has and how many days each patient stays in a bed. The most common pattern in hospitals, patients who are discharged alive and do not require time in an intensive care unit (ICU), provide an example. Length of stay for that group has been a third shorter than assumed in the IHME model.

The data required to tell the adaptability story in detail is not yet available. Only a qualitative assessment is possible at this point. Hospitals adapted in ways not anticipated in the IHME model. For example, they delayed elective surgical procedures, freeing up beds. The story will become more detailed as data about hospital admissions and the clinical course of COVID-19 patients becomes available.

More Productivity Means More Patients Can Be Treated

Greater productivity makes it possible to treat more patients with the same number of hospital beds. Many COVID-19 patients have moved from admission to discharge in fewer days than the IHME model assumed. As a result, hospitals can treat more COVID-19 patients with a given number of beds than the IHME model projects.

Length of stay determines how many patients a hospital can treat in a period of time. If a hospital has 200 beds and the average patient stays for 10 days, that hospital would be overrun if more than 20 new patients got admitted every day. But if the average patient only needed to stay in the hospital for 5 days, the hospital would have twice as much capacity – 40 new patients each day.

At the outset of the epidemic, no one knew how many hospital beds or ICU beds or ventilators patients COVID-19 patients would need. In a world of great uncertainty, models allowed the few facts that were known to become a look into the future. Mortality was the most timely and accurately measured fact. IHME used observations about the relationship between the number of deaths and number of people hospitalized with COVID-19 to turn estimates of deaths into estimates of how many people would need a hospital bed.

The IHME assumption about length of stay in its initial model run released to the public on March 26 used data from recent experience in China, Italy, and the US. That initial iteration used the assumption that the average length of stay would be 10 days among those less than 75 and 8 days among those age 75 and older.

Even if there were enough hospital beds, there might not be enough beds in ICUs or invasive ventilators. To estimate ICU bed need, the IHME team found data showing 122 out of 509 patients hospitalized in the US required ICU care. The estimate for ventilator need reflected reports from China that 54% of cases with ICU stays required mechanical ventilation. A paper based on patients admitted to two hospitals in China before January 31 provided the assumption that admissions with ICU stays would have a median length of 8 days.

Additional changes (described in the appendix at the end of this document) in assumptions were part of an April 5 update from IHME. The assumptions from both IHME papers are on the following page.
Those assumptions from early in the epidemic can now be compared to what has happened since (see table 1). Reports about the largest number of COVID-19 patients in US hospital patients comes from the customers of Epic Systems, an electronic health record provider. Epic has reported length of stay data among 94,875 people admitted to 526 hospitals in 21 states through July 29. This sample represents 31.4% of COVID-19 hospital admissions through that date in a non-random set of hospitals.

Hospital stays in the US have been shorter than the assumptions used in the IHME forecasts. Those who were discharged alive and did not require time in the ICU are 66.1% of the Epic sample. In this group, the 5 day median length of stay was 37.5% shorter than 8 days assumed in the IHME forecasts. Patients discharged alive and who had an ICU stay were 18.0% of the sample. In this group, the median overall length of stay was 11 days, of which 6 were spent in the ICU. These lengths are 45% and 43.8% shorter, respectively, than the IHME assumptions. Those who died but spent no time in the ICU had a median stay of 5 days, shorter than the IHME assumption of 6 days. These patients were 7.0% of the Epic Systems sample.

One group of patients had a longer median length of stay in the Epic Systems sample than the IHME assumption: those who spent time in the ICU but ultimately died. These are the patients who doctors and nurses worked the longest to help before their efforts could do no more. This group was 8.9% of the Epic sample. The median length of stay was 11 days, of which 8 were ICU days. This is 83.3% longer than the assumption of 6 days in the IHME model.

Table 1. Hospital Length of Stay, COVID-19 Patients
(median number of days)

<table>
<thead>
<tr>
<th></th>
<th>IHME, 3/26 ASSUMPTIONS</th>
<th>IHME, 4/5 ASSUMPTIONS</th>
<th>EPIC, DATA THROUGH 7/29</th>
</tr>
</thead>
<tbody>
<tr>
<td>Discharged alive, no ICU stay</td>
<td>12</td>
<td>8</td>
<td>5</td>
</tr>
<tr>
<td>Discharged alive, with ICU stay</td>
<td>8</td>
<td>20 (of these, 13 in ICU)</td>
<td>11 (6 in ICU)</td>
</tr>
<tr>
<td>Died, with ICU stay</td>
<td>10 days if age &lt;75 8 days if age 75+</td>
<td>6 (all 6 in ICU)</td>
<td>11 days (8 in ICU)</td>
</tr>
<tr>
<td>Died, no ICU stay</td>
<td></td>
<td></td>
<td>5</td>
</tr>
</tbody>
</table>

Sources: IHME COVID-19 health services utilization team and Christopher J. L. Murray, “Forecasting COVID-19 hospital bed-days, ICU-days, ventilator days and deaths by US state in the next four months.” Publication date: March 26, 2020; version posted to MedRxiv March 30, 2020; Accessed September 30, 2020: https://www.medrxiv.org/content/10.1101/2020.03.27.20043752v1;


The groups with shorter lengths of stay in the Epic Systems data are together much larger than the group with a longer length of stay than the IHME assumption (91.1% of patients in groups with shorter lengths of stay and 8.9% in the group with a longer length of stay.)

Whether hospitals did better than forecasts from the IHME model expected depends on the relative size of the patient groups whose stays are shorter in the Epic data than in the IHME assumptions compared to the patient group with stays that are longer in the Epic data than the IHME assumptions. The 10:1 ratio between the sizes of the two groups makes it more likely than not that hospitals produced more discharges with fewer beds than the IHME assumptions expected.

The strongest caveat to the assertion that hospitals did better than expected comes from variability in length of stay. Day by day, patients with shorter stays get discharged while those whose stays will be the longest continue to stay. Over time those with very long stays become a larger and larger share of the current COVID-19-related patient census. Patients who stay a very long time in the hospital reduce measured productivity. The willingness of hospitals and doctors to continue to fight for those patients is a feature, applauded by some, of the American health care system.

In both the IHME assumptions and what Epic Systems reports about a large number of patients, the summary statistic is median (50th percentile) length of stay. Epic Systems also reports how long patients at the 75th percentile of stay length were in the hospital. While the median stay among those who died and spent time in the ICU was 11 days overall, it was 19 days at the 75th percentile. The ICU portion of the stay had a median length of 8 days, but at the 75th percentile, it was 12 days. The 75th percentile of ICU days among those who spent time in the ICU but lived was also 12 days.

These patients who have very long stays influence how many beds are available and the average length of stay, but they do not change the median length. The IHME model uses assumptions about median length of stay.

Hospitals Have Adapted as the Epidemic Unfolded

Adaptability may have played a larger role than productivity in how hospitals avoided the bleak outcomes foretold in early forecasts from the IHME model. The length of stay assumptions in the IHME can be compared to data from large numbers of patients. Adaptability leads to other aspects of the IHME model where the issue is clear but the data that can be compared to assumptions is not yet available.

Are more beds available than the IHME approach assumes?

Hospitals adapted to the potential onslaught of COVID-19 patients. They canceled elective procedures. That made more beds available for COVID-19 patients.

When the results from the IHME model appeared, the results were strikingly different from other models that forecast much higher death rates. As the IHME modeling team explained, their model was different because it allowed for behavior to change as governments introduced policies to promote social distancing. The gap between the “do nothing” models and IHME’s “do something” model could be explained through the phrase “flattening the curve.” The scale of the epidemic has turned out to be closer to the IHME model’s forecast than the forecast of models that did not include behavior change.

It is ironic, then, that those who developed the hospital portion of the IHME model appear not to have anticipated behavior change by those who run hospitals. These behaviors have included postponing elective procedures and converting non-ICU spaces, such as surgical suites, to ICU rooms.

Instead, the explanation the modelers provided suggests that they assumed hospitals would continue to have the same
non-COVID-19 utilization of hospitals beds and that historic data about the number of ICU rooms would capture hospital capacity in an epidemic.\textsuperscript{8}

Changes in non-COVID-19 related care and better care for COVID-19 patients

Treatment patterns, how patients seek care and what care is available changed after the first COVID-19 cases began to appear at hospitals. Non-COVID demand factors influence how many hospital beds are available for COVID-19 patients. Would-be patients have behaved differently. Individuals who in other times had symptoms that would have brought them to the hospital came in fewer numbers. Patients become admitted to hospitals either on a scheduled basis or by admission through the emergency department. Both types of admissions declined, making available even more beds. Even patients with the least discretionary timing for their health care needs, such as those with heart attacks and strokes, appeared in fewer numbers.\textsuperscript{9}

Improved treatment may be another form of adaptation and productivity growth. Clinicians and hospitals have experienced what economists call "learning by doing." In the early days of the epidemic, no COVID-19 patients had been seen before. Each new patient provided an opportunity to put to work the experience gained from treating earlier patients. Evidence unknown at the beginning of the epidemic has demonstrated the effectiveness of technologies. The steroid dexamethasone has been shown to reduce mortality among those on mechanical ventilation or receiving oxygen. Remdesivir has been shown to reduce the length of hospital stays among some COVID-19 patients.\textsuperscript{10}

Changes in practice patterns and patient behavior meant more hospital beds have been available than in the IHME assumptions. Going forward into future phases of the COVID-19 epidemic, similar responses could again mean more beds available at epidemic peaks than in the IHME forecasts.

The Potential for Future Hospital Bed Shortages

The COVID-19 epidemic has not had a phase that overran American hospitals. Could that happen in the future?

In July IHME offered a set of scenarios for the COVID epidemic through the end of the year. In the IHME model, winter will bring more infections and deaths.\textsuperscript{11} In the IHME model, hospital resource need follows from the number of deaths. In the IHME reference scenario, deaths will peak in early December at 5.6 deaths per day per million Americans (95% uncertainty interval: 2.7 to 10.9).

As the epidemic has unfolded since July, the IHME data visualization at the end of September for the reference scenario showed peak hospital bed demand occurring in early December, at 113,407 beds (a point estimate accompanied by a 95% uncertainty interval of 73,757 to 182,923 beds.\textsuperscript{12} This level of hospital need is a forecast of a phase of the epidemic that will require more hospital resources than at any point in the epidemic to date.\textsuperscript{13}

Like all the IHME hospital resource forecasts, it is the result of a model that builds from assumptions about how death rates drive hospitalizations. While the IHME death rate model does use data about actual numbers of deaths, the hospital resource model does not incorporate data about how many beds COVID-19 patients use.\textsuperscript{14}

The IHME hospital resource forecast shows shortages of ICU beds that will be more widespread than non-ICU beds. The early days of the epidemic showed that hospitals can be nimble, converting non-ICU beds to ICU beds. This adaptability has not been reflected in the IHME estimates of ICU capacity. As with beds overall, if there are shortages, they are likely to be local rather than statewide, regional, or nationwide.

The IHME approach considers each US state as an autonomous unit. This notion of geography leaves the potential
for local shortages understated. While all of Rhode Island
be described by statewide data, New York (or California or
Texas) cannot. Only with great difficulty can a hospital bed
available in Buffalo help someone who needs a bed in New
York City. A bed across the Hudson River in New Jersey is far
closer. One approach to the difference between states and
hospital markets divides the United States into “hospital referral
regions,” an approach that divides the country into more than
300 regions and allows for regions that cross state lines. An
assessment based on these units would detect “false negatives”
in projections of bed adequacy as statewide estimates combine
areas that may be stressed and areas that are not into a single
overall number that says supply will exceed demand.

Variability in length of stay could also make for higher utilization
than the IHME approach anticipates. Hospital resources will
be taxed less by how high the peak need is than how long
it takes for peak need to recede. A small share of patients
will eventually have very long hospital stays. If the number of
new admissions peaks and drops, the long-stayers will not
push a hospital to crisis. But if an area reaches a peak and
stays there, then the accumulation of long-stayers could leave
hospitals with no beds for newly-admitted patients.

Finally, there is a relationship between hospital capacity and
the state of the epidemic in the area the hospital serves.
Those who work at hospitals live in the communities those
hospitals serve. When hospital staff become infected or must
quarantine because they have been identified as a close
contact in the contact tracing process, they cannot work. The
hospital industry has a long-established practice of sourcing
workers to meet critical needs for a short period. Locum
tenens physicians and travel nurses can take the place of staff
who cannot work. Mobile health care workers can only be in
one place at a time. They can meet regional shortages but not
shortages across many regions.

Bed shortages that would require nationwide steps to
postpone elective care as took place in March and April 2020
are unlikely but not impossible. The COVID-19 epidemic would
have to reach a far larger scale than it has to date. If shortages
occur, they will be in particular areas. The assumptions that
undergird the IHME forecast overstate bed demand at any
particular scale of the epidemic and underestimate bed availability.
While they help thinking about the future scale of the epidemic,
the forecasts of hospital resource utilization are not a useful
tool for emergency managers.
Appendix: The Evolution of the IHME Forecasts for Peak Demand for Hospital Beds, ICU Beds, and Ventilators

IHME released a March 26 paper on hospital, ICU, and ventilator demand and capacity through the end of July. The IHME team said that across each state’s peak demand date, maximum need would be 64,175 beds more than the difference between licensed beds and average annual occupancy, with a 95% uncertainty interval (the IHME-preferred term often referred to as a confidence interval) between 7,977 and 251,059 beds. The 64,175 bed point estimate was 7 percent more beds than American hospitals had. The peak need date would vary by state, ranging from April 10 to May 22. The outlook was bleaker for ICU beds, 17,380 beds, with the 95% uncertainty interval running from 2,432 to 57,955 beds. The 17,380 ICU bed need would be about 25 percent of the number of ICU beds IHME believed hospitals had. IHME provided estimates of ventilator need, 19,481 at the peak (with a 95% uncertainty interval of 9,767 to 39,674 ventilators.) IHME did not find data about how many ventilators hospitals had and thus did not compare need with availability at that time. The IHME authors did say there would be “large gaps in availability of ventilators.”

The shortfall would be geographically concentrated. Twenty-six states faced very little risk of a shortage. These states had a point estimate for peak demand that was less than the number of available beds and no days with a 95% uncertainty interval running between 7,977 and 251,059 beds. Nine had some risk (with a point estimate of peak bed demand that did not exceed available beds a 95% uncertainty interval around the peak demand estimate that exceeded available beds. Thirteen had peak demand that would exceed the available number of beds but the 95% uncertainty interval around the peak estimate included the number of available beds. In only three states (New Jersey, New York, and Vermont) did the entire 95% uncertainty interval around the peak bed number estimate exceed the number of beds that IHME thought would be available. The outlook for ICU beds was much worse. In only one state, Arkansas, was there little risk of demand exceeding what IHME estimated supply to be (point estimate of zero and the upper bound of the 95% uncertainty interval not exceeding zero (Table 1 in the March 26 paper.)

In an update posted on March 30, IHME said that the experience in Seattle suggested a larger share of patients would require mechanical ventilation. Before that the estimate for ventilator need reflected reports from China that 54% of cases with ICU stays required mechanical ventilation. The IHME team said that Seattle-area hospitals told them that 80% of patients who went to the ICU required mechanical ventilation. As a result, the peak ventilator need would be 26,753 (with a 95% uncertainty interval of 12,934 to 43,183.) The peak need for hospital beds was described in total number, 224,321 beds, not the excess of beds needed over beds available.

In an update posted on April 2, additional days of data increased the forecast hospital use peak. The number of beds needed would be 262,092, a shortage of 87,674 beds. ICU bed need would be 39,727, a 19,863 bed shortage. And 31,782 ventilators would be needed.

The outlook quickly improved. In the next update, posted on April 5, the forecast for peak need for hospital beds was 140,823 (95% uncertainty interval of 73,390 to 284,569), a 37.2% decline since the April 2 forecast. Peak ICU bed need was forecast to be 29,210 (16,149 to 55,869) and peak ventilator need 18,992 (10,553 to 36,318).

Both policy and modeling changes contributed to the decline in peak need. On the policy side, additional states had implemented policies that the model anticipated would reduce deaths and thus hospitalizations.
Changes in assumptions also reduced future hospital demand. The key variable in the IHME model for hospital bed need has been the ratio of COVID-19-related hospital admissions and deaths. In earlier model runs, that variable was seen as 11.5 hospitalizations for each person who experienced a COVID-19-related death. That number came from a CDC report presenting data about 508 hospitalizations through March 16. In that data, there were 11.5 hospitalizations for each COVID-19-related death. IHME said it had been able to obtain more data from state governments since the CDC report covering 16,352 admissions and 2,908 deaths. In the larger sample that IHME considered, there were 5.6 admissions for each death – about half as many as the earlier CDC-gathered data showed. IHME also used the additional data to develop some state-specific ratios that would feed into state-specific bed need calculations that would be compared to the bed availability number (a number based on annual state-level bed occupancy and licensed bed numbers.)

There were enough observations to develop state-specific ratios for seven states that ranged from 4.22 for New York to 10.61 for California. After removing deaths in state-specific states, the national average, used for states without a state-specific number, was 7.1 hospitalizations per death.

The IHME team also said it had new data about length of stay that showed that patients who needed an ICU stay were hospitalized longer than the IHME team had earlier assumed and those who did not had shorter stays than the IHME team had assumed. The update provided assumptions for three types of patients: those discharged alive and who spent no time in an ICU (8 days); discharged alive with time spent in an ICU (20 days total, of which 13 were in an ICU); and patients who died (6 days, with no distinction made between those who did and those who did not spend time in an ICU.)

The next announced change came with the update posted on April 13. More data allowed using more state-specific ratios for the number of hospital admissions for each death. Now state-specific ratios were used for 23 states. These ranged from 4.14 for Massachusetts to 9.79 for Maryland. The ratio used for states with no state-specific ratio became 6.6.

An update posted on April 26 again provided a comprehensive statement of the situation in static tables as well as the ongoing feed of forecasts into a data visualization on the IHME website. In terms of shortfall, the excess of beds needed over beds available during the current phase of the epidemic would peak at 9,079 beds with a 95% uncertainty interval of 253 to 61,937 beds. The ICU shortfall had a point estimate of 9,356 beds and a 95% uncertainty interval of 3,526 to 29,714 beds. The ventilator peak would be 16,545 above the number available, with a 95% uncertainty interval of 8,083 to 41,991.

The geographic extent of shortage shrank. The state-specific estimates were 41 states with a zero bed shortfall and a 95% uncertainty interval that was not above zero; 7 states had point estimates of zero with a 95% uncertainty interval that had an upper bound above zero; and the three states with a point estimate above zero were Connecticut, New Jersey, and New York. Five states with estimates of zero bed shortfall were still forecast to have peak ICU demand that would exceed supply: Massachusetts, Michigan, Rhode Island and Wyoming.

The update reflected several factors. First, the day with projected peak deaths had passed in many states, including those with the most deaths. Fewer deaths meant fewer hospitalizations. Second, new data lead to revised assumptions. Based on reports from New York City, the assumption about the share of those who were admitted to the ICU who would require mechanical ventilation increased to 85%.

A document with additional detail about how the IHME team approached hospital utilization and capacity accompanied the April 26 paper. Those who died were assigned to an ICU bed for the entire period of their hospital stay. Data from New York State covering the period through March 31 showed ICU bed counts
as 25% of hospital census, presumably among those admitted for COVID-19-related treatment. That relationship, together assumptions about total length of stay and ICU stay, said that 6.3% of those admitted and ultimately discharged alive spent time in the ICU. (The 6.3% transfer assumption, along with the length of stay assumption, was the numerical value that would lead to ICU beds for COVID-19 patients amounting to 25% of the number of non-ICU beds with COVID-19 patients.) Finally, data from New York State supported the assumption that 85% of individuals in the ICU required mechanical ventilation.

On May 4, IHME launched an update to its framework: a multi-stage hybrid model that gave a role to positive test numbers. Beginning with this update, the IHME modeling endeavor moved beyond predicting deaths to events that preceded death in the SEIR framework (susceptible to exposed; exposed to infected; infected to recovered.) Including assumptions about the infection to fatality ratio (IFR) also allowed using age-specific mortality data to estimate the number of infections. This broadening of the scope of IHME COVID-19 modeling did not change the process for estimating the number of hospitalizations and whether demand for hospital services was within the capacity of the hospital system.

Refinements since May 4 have altered forecasts of the number and geographic distribution of deaths. Because the number and distribution of deaths drive hospital resource use (beds, ICU beds, ventilators) estimates, the refinements have changed hospital resource estimates. The updates (12 from May 29 to September 18) show no further changes to the assumptions and modeling approach for hospital resource use.

All these changes help understand how the forecasts from the model changed. Bed need forecasts from before the mid-April peak in the first phase of the epidemic relied on forecasts of the future number of deaths each day. Months later, the values used to estimate the hospital resource simulation at the peak are actual rather than forecast numbers of deaths. In the IHME data visualization, updated September 24, the hospital resource need in mid-April was lower than forecast in the April 5 update. The overall hospital bed need peaked on April 18 at 79,208. That number, reflecting the effect of model changes and actual data replacing forecast values, is 56.2% of the 140,823 bed need forecast released on April 5. For ICU beds, the data in the September 24 update showed peak need of 22,251 beds (76.2% of the April 5 forecast.) For invasive ventilators, peak need was 20,223 (106.5% of the April 5 forecast.) While the September view of need at the April peak is lower than the point estimates in the early-April forecast, the September values are within the 95% uncertainty interval of the April forecasts.
The IHME projections provided the data analysis behind the “flatten the curve” message. A presentation made by the White House Coronavirus Task Force on March 31 portrayed the IHME’s forecast of what could happen if policymakers took actions to reduce SARS-CoV-2 transmission as a contrast to models that projected many more deaths but did not take into account actions to slow the spread of SARS-CoV-2. The bad news of the IHMEs was that hospital resources were insufficient for the first peak of the epidemic. The appendix describes how the IHME estimates for bed needs and bed shortfalls evolved from the release of the first estimates on March 26, 2020, through September 18.

2 The IHME March 26 paper describes how hospitals might adapt. The paper explains that the IHME hospital utilization model came into existence to help UW [University of Washington] Medicine understand what might be ahead. UW Medicine responded to the possibility of so many patients infected with COVID-19. “Strategies to [adapt] included the suspension of elective and non-urgent surgeries...” The paper reports that utilization fell by 14% in two weeks after UW Medicine took steps to delay care. The paper also says that hospitals could adapt by moving to a crisis care model, using unused operating rooms, pre- and post-surgery areas, procedures rooms and hallways. In this crisis mode, UW Medicine could increase capacity by 65%. The estimates from the IHME model did not take into account either planful or crisis adaptation. The model viewed hospital capacity available for COVID-19 patients as the difference between the number of licensed beds and the average annual utilization bed utilization. The number of ICU beds and their availability were calculated in a similar manner.

The federal government encouraged planful adaptation by all hospitals. A March 18 statement from the Centers for Medicare & Medicaid Services asked healthcare providers to delay elective procedures and non-essential services.

3 In the Epic sample, 6.3 patients were admitted for each one who died. IHME has used a state-specific ratio for 23 states that range from 4.14 to 9.79 (with an estimate for New York, the state with the largest number of deaths, of 4.23 admissions per death.) For the other states, IHME has assumed 6.6 admissions for each death. Epic Systems provided nationally aggregated data without state-specific breakouts.

Out-of-hospital deaths create another difficulty for comparing the IHME assumptions and the Epic Systems data. The IHME approach uses the total number of deaths from mortality data to estimate total hospital admissions. Epic Systems data reflects what happened to COVID-19 patients who were admitted to a hospital. It allows calculating how many hospital admissions there are for each patient whose hospital stay ends in death. In-hospital deaths are a subset of all COVID-19-related deaths. Deaths that occur in nursing homes or at home are not included.

4 The calculation is based on the number of hospital admissions reported by The Covid Tracking Project. What Epic says about its user community suggests these hospitals are probably more likely to have ties to medical schools or be part of not-for-profit health care systems. Patients treated in smaller, rural, or for-profit hospitals are less likely to appear in the data.

5 The IHME team appears to make a single assumption for all who die, whether or not they have an ICU stay. In “Appendix A: Health Utilization and Capacity” to the April 2 paper, the IHME team says, “We assign the deceased to an ICU bed for their entire admittance period.” This statement appears to preclude the possibility that a patient who ultimately dies spends part of the hospital stay in a non-ICU bed and part in an ICU bed.

6 Craig Smith, MD, chief of Columbia University’s Department of Surgery, and Surgeon-in-Chief, New York-Presbyterian/Columbia University Irving Medical Center, wrote a daily update during the height of the COVID-19 epidemic in New York City. In one of his reports, he described the challenge that developed at his hospital after the peak of new admissions. More and more of those in the ICU and receiving mechanical ventilation were patients who had entered “the long tail of their chronic illness.” Dr. Smith said he hoped some of these patients could be transferred to other facilities (which might include non-hospital facilities that specialize in patients who have a long-term need of ventilator support.)

7 The most detailed description of IHME’s hospital resource simulation is an appendix to the IHME team’s April 26 paper. Nothing in the description of the assumptions addresses variability in length of stay. That implies that the hospital resource simulation assumed that every patient has the median length of stay for his or her group (discharged alive, no ICU stay; discharged alive with ICU stay, etc.)

8 Hospitals expanded ICU capacity by converting other beds into ICU beds. Craig Smith, MD, reported that NewYork Presbyterian converted operating rooms to ICU beds, increasing ICU capacity from 422 to 970 beds over 19 days.

9 Another report from Epic Systems showed how the number of patients who came to hospital emergency departments for heart attacks and strokes fell to 60% of historical averages in late March and early April and did not return to historical norms until June.

10 The IHME modelers have said that the ratio of admissions to fatalities has remained constant since April. This weighs against the argument that treatment has improved. The IHME model for hospital need assumes that all COVID-19 deaths occur in hospitals. In a database assembled by The New York Times, 7 percent of COVID-19-related deaths through mid-September occurred in nursing homes and other congregate care settings for older adults. Deaths may also occur at home or other non-hospital settings. These non-hospital deaths influence the ratio of hospital admissions to death. An increase in the share of deaths that occur in hospitals could offset the reduced mortality from improved care. Thus having an unchanged ratio of admissions...
to deaths between Spring and September could be an artifact of the IHME assumption that all deaths occur in hospitals if a higher share of deaths now occur in hospitals.

In IHME’s “reference scenario,” forces at work include seasonality (respiratory viruses circulate more widely in the winter than summer) and fatigue (lower levels of compliance with public health measures such as staying at home or wearing a face mask.) In this scenario, states decide to reimpose restrictive measures when the state’s death rate reaches 8 daily Covid-19-related deaths per day for each million residents. Eight was the 90th percentile of daily deaths per million at which states acted earlier in 2020. The introduction of those measures leads to a peak followed by a decline. In another scenario, there is no policy response to rising death rates. In that scenario daily death rates continue to rise through the December 31 end of the forecast period.

These values are the September 24, 2020, update to IHME’s data visualization for US hospital resources. The values found on the data visualization will change with subsequent updates.

The relevant magnitude is deaths, not new infections. Deaths track hospital use far more closely than the number of new infections. Thus rising numbers of infections does not necessarily mean more hospitalizations or deaths. In its September 3 update, a chart showed IHME’s new assumptions about how many infections there were for each death. This greatly increased the number of infections for each death among young people. For children about age 10, the assumption moved from approximately 1 death for 2,500 infected individuals to 1 death for 15,000; for young people of about age 20, the assumption moved from 1 death for 2,500 to 1 per 5,000 infected individuals. The ratio increased for all under age 30; it decreased for some parts of the age span over age 30, but those changes were relatively far smaller than for those under age 30. There will be a desire to compare future waves of the SARS-CoV-2 epidemic to earlier peaks. Will the magnitude of these waves crush hospitals? The age distribution among those infected in future waves will be more important than the number newly infected. A phase of the epidemic that has a larger share of young people infected than in earlier phases could be much larger in total infections and make for less hospital burden. A phase that has a larger share of older people infected could overwhelm some hospitals at a lower level of infections than occurred in Spring 2020.

The COVID Tracking Project provides the opposite of the IHME’s model-based view of the past, a data series that shows daily counts of how many Covid-19 patients are currently hospitalized, how many new admissions have taken place, how many are now in the ICU, and how many are on a ventilator. This data comes from a data reporting infrastructure that has come into existence since the Covid-19 epidemic began.

The Dartmouth Atlas Project (DAP) presents the work of the team that developed the concept of the “hospital referral region.” DAP presents data on numbers of positive tests that aggregate counties into Hospital Referral Region.
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Hanns Kuttner is a senior fellow at Hudson Institute. His career spans the policy and research world. During the presidency of George H.W. Bush, he was part of the White House domestic policy staff with responsibility for health and social service programs. Most recently, he was a research associate at the University of Michigan's Economic Research Initiative on the Uninsured. He has also worked for the federal agency which runs the Medicare and Medicaid programs and advised the state of Illinois on restructuring its human service programs.

Mr. Kuttner has written extensively about issues relating to Americans’ health insurance status and the potential for improving the American health care system. With Gail Wilensky and Joseph Antos, he wrote, “The Obama Plan: More Regulation, Unsustainable Spending,” published in Health Affairs, the policy journal of the health sphere, in September 2008. His current research projects look at alternative ways to pay physicians and health insurance decisions by small employers.

Mr. Kuttner has an A.B. from Princeton University. His graduate training was at the University of Chicago, where he received an M.A. degree from the Irving B. Harris Graduate School of Public Policy Studies.

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