COVID Modeling Teams
Funded by Council of State and Territorial Epidemiologists with support from the Centers for Disease Control and Prevention.

22 Dec 2021, To be distributed online and through select media outlets

Summary

Multiple academic teams were selected by the Council of State and Territorial Epidemiologists and the CDC to support decision-making in health jurisdictions. This is a joint statement on the Omicron variant, which can spread in communities very quickly. Results from several modeling groups project that many communities may have hospital systems where demand exceeds capacity, potentially larger than prior peak hospitalizations during the pandemic. The emergence and rapid spread of the Omicron variant of the SARS-CoV-2 virus, the ongoing level of cases associated with the Delta variant, and the timing of social gatherings creates a situation where urgent actions are needed, which can be informed by modeling. Communities where a number of mitigation measures are layered are less likely to experience the catastrophic failures that are feasible in the anticipated wave of the Omicron variant. There is still significant uncertainty about the trajectory of Omicron in the US over the next several weeks.

Omicron variant details

The Omicron variant that was identified in South Africa has many more mutations than previous variants. Real-world data (e.g., South Africa, the UK, etc.) has shown that transmission can be rapid. CDC genomic surveillance shows that Omicron has overtaken Delta in almost every U.S. region as of December 18.

Current estimates for Omicron are that the effective reproductive rate is significantly higher than Delta or any previous strain widely circulating in the US. There is evidence that Omicron's growth advantage is due to a combination of increased transmissibility and immune escape. A significant number of reinfections have occurred in people who previously had COVID-19 disease. In addition, people who were vaccinated can acquire the Omicron variant, especially if vaccination did not occur recently and has not been boosted by a third shot. Vaccinated people who were previously infected appear to maintain higher neutralizing antibodies relative to vaccinated but previously uninfected people.

The severity of disease caused by Omicron is not fully known. The population in South Africa is significantly younger than in the US and has an immunity profile shaped more by previous infection than vaccination, relative to the United States. Hospitalizations are increasing in South Africa and several places with early spread of the virus variant, though early reports suggest a reduced death rate among hospitalized individuals in South Africa. On the other hand, limited data from the United Kingdom suggests no appreciable decrease in hospitalization rates among positive cases. There may also be a higher rate of asymptomatic cases. Even if the severity of Omicron is similar to Delta or somewhat milder, if the transmission rate is higher than Delta then many hospitalizations would result[1]. The likelihood that outbreaks across the US will be temporally synchronous across multiple regions is also much higher with such a transmissible variant.

There is still uncertainty around some aspects of the Omicron variant though increasingly scientists agree that it is more transmissible than the Delta variant, has higher immune escape than previous variants, and that infections can lead to hospitalizations and death. Mathematical modeling is well positioned to explore these uncertainties and support decision making.

Initial projections of Omicron impact on the US

Multiple modeling teams have developed projections for infections, reported cases, hospitalizations, or deaths over the coming weeks within the US along with estimates of disease parameters. Multiple scenarios were considered (e.g., Omicron similar to or more transmissible than the Delta variant, similar to or milder than the Delta variant, and with moderate to high immune escape).

The teams currently believe the more likely scenarios have Omicron as at least as transmissible than Delta or higher (e.g., 36% over the natural reproductive rate without mitigation for Delta or 100% over the ancestral strain) and with immune escape higher than Delta (e.g., 50% or more). The teams assumed that even if Omicron broke through previous immunity, that severe disease resulting in hospitalization was less likely for individuals with prior (natural or vaccine-induced) immunity than for those with no immunity.

Each group made separate assumptions in their model about mitigations such as wearing of masks, social distancing, additional vaccinations including in children age 5-11 and others, and additional boosters. The US modeling teams find that any wave of significant infection will result in another wave of hospitalizations, with a number of deaths also likely. This was true across a wide range of modeling scenarios and assumptions.

In comparison to the previous peak of hospitalizations, teams found that the size of the new surge ranged from 60% of the prior peak to four times or more the prior peak with some usage of boosters and masking–a broad range of outcomes. Compared to 50% uptake of boosters in the eligible population, it was found that hospitalizations could be 2.5 to 6 times higher with no boosters. The scenarios in which Omicron transmissibility was assumed to increase relative to Delta resulted in a surge at least as big as prior peaks, even if previous immunity provided some

[1] A strain that is twice as infectious and doubles every five days could cause 64 times as many cases as a less transmissible one. (Sarah Zhang, The Atlantic, "We Know Enough…"). Even with a ten-fold reduction in hospitalization rate, the more transmissible variant could result in a significantly larger burden on the health system.

protection against hospitalization and some of the population had boosters. If asymptomatic disease is more likely, then hospitalizations could be lower.

For teams that analyzed mitigation scenarios, models consistently show that increases in vaccination including boosters will have an important positive impact on hospitalizations but will not be sufficient to avoid a substantial winter surge without additional mitigation. Modeling suggests that if an effective antiviral therapy is rapidly distributed at a wide scale to recently infected people, then this would further decouple case rates from hospitalization rates, and further limit the burden on medical wards and intensive care units.Fewer hospitalizations also occurred if mask usage was continued (including in school environments), booster uptake was increased, vaccinations among children increased, and isolation and quarantining were used for people who were symptomatic or exposed. Increased social distancing in reaction to higher hospitalization rates also decreased the cumulative numbers of hospitalizations and deaths but was not sufficient to prevent healthcare systems from overheating during Omicron outbreaks.

The timing of the surges was not precisely identified. Estimates depended on when the omicron variant arrived in an area, the number and types of connections locally, vaccination and booster uptake, and other factors. Across multiple models the surge was well underway by early to late January.

Modeling teams determined that areas with lower vaccination rates were at higher risk, regardless of previous immunity. Teams also estimated that areas with low rates of booster uptake were at high risk.

State of the nation in the US

As of 18 December 2021, the CDC estimates that Omicron cases accounts for 73% of new infections in the US. At the same time, the Delta variant is still circulating. The CDC reports that approximately 61% of the US population had received full initial vaccination (65% of those age 5 or older). Many of the vaccinations occurred six months ago or more, and the CDC reports that only 31% of the population 18 and over have received a booster (53% of those 65 and older), leaving a significant number more vulnerable to Omicron. Coverage also varies geographically. The fully vaccinated population as a proportion of all residents ranges from 46% (Idaho) to 76% (Vermont), and variation at county scales is even greater (outside 20-80% with coverage several percentage points lower on average in counties with worse scores on the Social Vulnerability Index). Coverage also tends to be lower in the Southeast and rural areas. For data where race/ethnicity is available, the lowest coverage is among individuals identified as Black Non-Hispanic.

Many locations around the US are seeing high levels of hospitalizations (pre-Omicron), which may be at least partially related to the Thanksgiving holiday in late November.

Hospital systems throughout the country are facing significant current and continuing labor challenges, even with the use of traveling nurses. There is expected to be very little surge capacity available in December and January. When hospital systems are full, it is well documented that all-cause mortality increases, not only for COVID-19 but also for unrelated events such as heart attacks or car accidents.

Mask mandates have been lifted in many cities and states around the nation. Several more national holidays in the upcoming weeks are likely to lead to additional transmission even without the Omicron variant.

Testing capacity in the US has increased relative to one year ago, although the access varies widely within and among states. The use of rapid tests has increased but shortages are occurring in many states. Some rapid tests may not detect Omicron, and the incubation period may be shorter (resulting in more spread before individuals know they have been exposed). A significant increase in infections could result in additional shortages and delays in testing.

The population of susceptible people in the US is not well-known. Previously, the CDC estimated that from February 2020 to September 2021 only 1 in 4 infections were reported (1 in 1.3 deaths), though waning immunity and reinfection risk means many previously recovered individuals are not fully protected. The proportion susceptible is also likely to vary by age group, race/ethnicity, urbanicity, state, status as an essential worker, or other factors.

Implications for Public Health

Given current beliefs about the Omicron variant, modeling teams generally found that multiple types of mitigation or intervention would be needed simultaneously to avoid overwhelming the healthcare system. Some of the areas of intervention would require early action, even before cases have risen significantly. Outcomes also depend greatly on behaviors, including those of individuals, households, schools, workplaces, and communities. Communities where a number of measures are layered are less likely to experience the catastrophic failures that are feasible in the anticipated wave of the Omicron variant. Examples of interventions are listed below, which can be implemented by individuals, households, communities, schools, companies, hospital systems, health jurisdictions, policymakers, etc. There is significant uncertainty about the trajectory of Omicron in the US over the next several weeks. Additional information may adjust projections and corresponding responses.

- Vaccination of eligible people, age 5 up
- Boosters to previously vaccinated who are eligible
- Usage of high-quality masks (e.g. N95, KN95, KF94) rather than cloth or surgical masks in high risk environments
- Risk and mitigation by households, especially if gathering with others (e.g., testing before and/or after, masks)
- Risk management in hospitals (personnel, absenteeism, at-home care with monitoring, triage)
- Utilization of current treatments plus others identified as effective, e.g., oral antiviral therapies if approved by FDA and others
- Increased testing (laboratories, providers, and at-home) with increased stocking of supplies
- Preparations for supply chain disruptions and workforce absenteeism including food and medical supplies, etc.

- Continued encouragement of mask usage (e.g., schools, universities, retail establishments, workplaces, community settings)

Modeling Team Background

Multiple academic teams were selected by the Council of State and Territorial Epidemiologists and the CDC to (a) forecast SARS CoV-2 infections and outcomes; (b) estimate the impact of intervention scenarios; and (c) support state and local decision-makers, for August 2021 - January 2021. Teams represent a diverse set of perspectives including geographical level and locations, types of models and assumptions, and research questions addressed. See list at the end of this document.

The teams have collaborated to create a joint statement of information and recommendations to state, local, and territorial health jurisdictions and other decision makers related to community health, as well as government, industry, and the American public. This initiative mirrors consensus statements available in the UK from the Scientific Advisory Group for Emergencies. Similarly, consensus statements are being prepared for teams affiliated with The Scenario Modeling Hub, which collaborates with the CDC.

CSTE/CDC Supported Teams

- *Heterogenous Forecast and Nowcast of COVID-19 at County Scale – Jeffrey Shaman, Columbia University, jls106@cumc.columbia.edu*
- *Modeling SARS-CoV-2 in King County, WA: Update March 2, 2021 – Dobromir Dimitrov and Joshua T. Schiffer, Fred Hutch, jschiffe@fredhutch.org*
- *COVID-19 Simulation Integrated Model (COVSIM) to Inform State and Local Levels – Julie Swann, NC State University (with Georgia Tech and UNC-Chapel Hill), http://go.ncsu.edu/covsim, jlswann@ncsu.edu*
- *COVMOD-Multiscale modeling and forecast of the COVID-19 Pandemic – A. Vespignani, M. Chinazzi, M. Ajelli (Northeastern University & Indiana University), - mobslab@networkscienceinstitute.org*
- *COVID Modeling and Forecasting Project - Joshua Salomon, Stanford University (with Harvard University and Yale University), salomon1@stanford.edu*