Arkansas Public Health Pandemic Working Group
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COVID-19 Forecasts, Projections, and Impact Assessments

The University of Arkansas for Medical Sciences’ (UAMS) Fay W. Boozman College of Public Health (COPH) faculty conducted five types of assessments for this monthly report: 1) a look at the pandemic in Arkansas from a longer-term perspective; 2) forecasts and projections of cases and maps of community spread; 3) forecast models of hospitalizations and patients needing intensive care; 4) forecast model of COVID-19 deaths; and 5) status of COVID-19 vaccination.

All forecasts and projections were developed using COVID-19 data from the Arkansas Department of Health through July 11.

Summary points are:

- The COVID-19 test positivity rate in the state is over 20%. This is five times the national average. Although testing rates are low, this is a very high positivity rate, suggesting rapid community viral spread.
- The 15-day model forecasts 371,276 cumulative COVID-19 cases in Arkansas by July 26, an increase of 16,000 new cases over what was reported by the Arkansas Department of Health (ADH) on June 18. In the next 15 days, the number is expected to increase by an average of 1,039 cases per day.
- The 30-day model forecasts 392,772 cumulative infections on August 9, an increase of almost 36,000 cases over the number reported by the ADH on June 18, or an average of 1,236 cases per day.
- The 15-day models continue to show Arkansans between ages 35 and 59 have the highest number of COVID-19 diagnoses — forecast to increase by 5,591 cases, and average of 372 cases per day. The model also forecasts an increase of 2,538 cases in children under 17, or a daily average of 169 cases.
- During the most recent two weeks, 25 counties had relative increases in new cases greater than 100%.
- The 15-day models forecast 19,970 cumulative hospitalizations and 5,660 cumulative intensive care patients by July 26. This means a daily average of 37 new patients and 20 new intensive care patients respectively.
- The 30-day model forecasts 20,850 cumulative hospitalizations by August 11, a daily average of 48 new patients.
- The group with the greatest number of hospitalizations continues to be adults ages 60 to 74. However, the 15-day model suggests hospitalizations of adults 35 to 59 will exceed those of patient 60 to 74 in the very near future.
- The 15-day model forecasts 6,043 cumulative COVID-19 deaths by July 26, a daily average of almost three deaths.
- All counties in Arkansas are experiencing low COVID-19 vaccination rates. In the last month, no county has exceeded a 5% increase in the number of persons over 12 who are vaccinated.

The COVID-19 pandemic in Arkansas radically changed in the last two weeks. For this reason, the models we show in this report may already be out of date. In addition to the data presented in this report, our research suggests Arkansas is at the beginning of an exponential surge, which, in the long-term, may exceed the December/January surge in terms of cases and hospitalizations. We base this projection, at least partially, on the course of the Delta variant in the United Kingdom and published reports in the scientific literature. The population of the United Kingdom was far more vaccinated than the population in Arkansas. Nevertheless, the Delta variant caused a surge in all parts of the country, including the less populated areas, such as Scotland and Wales. The character of the surge in the U.K. also differed, affecting young adults and children far more than older adults and increasing the number of hospitalizations. Similar patterns are being observed in many countries around the world, including India,
Australia, France, Indonesia, and others. Our considered opinion is, with low vaccination rates, few Arkansans practicing personal mitigation behaviors, and state policies that seem to discourage protective measures, Arkansas is set to experience increased numbers of COVID-19 infections and hospitalizations.

William Haseltine, writing for *Forbes*, observed the virulence of the Delta variant can be understood by three epidemiological factors: the viral load or the number of particles replicating in the respiratory tract; the time from exposure to the moment of identification via a PCR or antigen test; and, the R naught or how many people an infected person infects. The viral load for the Delta variant is 1,000 times higher than the Alpha variant based on research in Guangzhou China. The much higher viral load allows the Delta variant to spread more quickly, as reflect by its R naught. The R naught of the Delta variant is 6 compared to an R naught of 2.7 of alpha variant, which was considered very high. What this means is that a person infected with the Delta variant can infect, on average, six additional people. The final parameter is our ability to detect the virus of interest. It is detectable within four days or 48 hours earlier than the Alpha variant. Tracking infections in the state, will require widespread testing. Because the Delta variant is more infectious, our opinion is Arkansas may exceed 3,000 new daily infections, the high point of the December/January surge, very quickly. At that point, hospitalizations in the state will begin to challenge the capacity for the system to handle patients.

Arkansas data from the last few days indicate the Delta variant is more virulent. An association we observed in the data is the ratio of daily positive tests to daily hospital census. We observed this ratio is approximately 1 to .55, almost twice the ratio at the peak of the surge in January. Our observation is supported by a study conducted in Scotland published in *Lancet* (Sheikh et al., 2021). As the number of daily cases grows, we can assume the hospital census will keep pace at a rate of .55. For every 1,000 daily COVID-19 cases, the daily hospital census will increase by 550 patients. Of these 550 patients, current data suggest a third will require intensive care. As we approach 3,000 daily cases, the average at the height of the last surge, the daily hospital census will be approximately 1,650, of whom 550 will require intensive care

According to the *Bloomberg Report*, the Delta variant is a serious development because it is the first variant believed to cause more serious disease. More serious disease means greater numbers of hospitalizations. In the United Kingdom, where the Delta variant is dominant, infections and hospitalizations have dramatically increased since the beginning of May. The Delta variant also appears to have a different infection pattern. *The Bloomberg Report* and the *Miami Herald* report most hospitalizations for the Delta variant in the U.K. are in younger people, ages 12 to 20. This is of concern in Arkansas because those least likely to be vaccinated in the state are young people 12 to 20 years old. Equally concerning is a study under review and made available by a preprint service that reports the efficacy of one dose of the Pfizer and AstraZeneca vaccines are far less effective against the Delta variant than with previous variants. On the brighter side, the study also found that two doses of the vaccines remain highly effective.

As we said above, Arkansas is in for a couple very hard months. We base this opinion on, not only the factors already discussed, but also on how vaccines work. Even if every Arkansan was vaccinated today, the effect of that event on the number of new infections and hospitalizations may not be observable for six to eight weeks. As has been widely reported in the scientific and mass medias, one dose of the two-dose COVID vaccines have limited value. The month between the first and second dose, therefore, remains a time of high risk. Even after a second dose, two weeks is needed to achieve full immunity.

We continue to highly encourage proactive measures to increase the rate of COVID-19 vaccinations in the state. The rate at which the state is now vaccinating is too slow. We acknowledge achieving higher vaccination rates is complicated by the relaxed attitude with which the epidemic is now perceived. Outside of metropolitan areas in the state, mask wearing is rare. In almost all areas, local gathering places give little concern to social distancing and large groups of people are gathering. There seems to be a strong feeling in the state that the pandemic is over. We strongly recommend continued mask wearing in public places and continued physical distancing — even for those who are vaccinated. Schools are starting, so we encourage school leaders to promote mask wearing on school campuses and encourage
vaccinations. This can be done to cover a significant proportion of the population at risk of infection and hospitalization. We cannot stand still and witness our children and young adults getting seriously ill at high rates, and perhaps succumb to COVID-19.

The new surge will have both short- and long-term economic consequences. As infections and hospitalizations increase, there will be a natural reaction on the part of the public to self-isolate. We may even see a return to hoarding behaviors exhibited last year. Both self-isolation and hoarding will have a short-term impact. The long-term impact will result from increasing numbers of employees who are seriously ill and unable to work, increasing number of employees who will manifest long-COVID symptoms, and disruptions to the supply chain. There may even be economic consequences if Arkansas is perceived as an unhealthy vacation or conference destination.

As we said in our June report, “COVID-19 is not over in Arkansas. It is, at best, smoldering.” Well, COVID is no longer smoldering. It has broken out into a raging forest fire that will grow in size and strength. We cannot stand still. We must act to reduce the consequences of this new surge to the extent possible.
The Pandemic in Arkansas

Data shown in this section examines the trajectory of the COVID-19 pandemic in Arkansas, changes testing and COVID-19 positivity associated with test results, and the impact COVID-19 has had on Arkansas counties.

In April 2021 the statewide face mask mandate expired, and the state entered a new phase of the pandemic. Figure 1 shows the five phases of the pandemic in state as we have so far identified them. The pandemic in Arkansas did not begin with a significant epidemic curve, and infectious were largely limited to places of employment, such as meat processing plants. Infections did not begin to grow exponentially until September 2020, when there was significant growth in infections in a short period of time. The growth curve in the third phase peaked in mid-January. The fourth phase saw an exponential decline in cases to levels near those of the first phase of the pandemic. The fifth phase saw a stable low level of cases in April 2021 thought June 2021. We are now entering a sixth phase related to a projected surge in new infections. Infections in the latest curve are related to the spread of the Delta variant throughout Arkansas.

Figure 2 is another view of the pandemic, showing the seven-day rolling average of new infections since March 2020. Daily numbers are often considered too “noisy” to accurately reflect an epidemic’s growth. To address this noise, we use a rolling average to smooth out meaningless daily differences in infections.

What is easily discernable from data plotted in Figure 2 is new COVID-19 cases increased over time until early January. February 2021 was the first month in Arkansas in which there was a consistent decline in new COVID-19 infections. The curve flattened somewhat during March, when the state averaged around 385 new infections per day. The average of the seven-day rolling average of infections per day was around 192 in May and 227 in June. In the first 10 days of July, the seven-day rolling average jumped to 554, almost double the number just one month earlier.

As shown in Figure 3A, on the next page, testing for COVID-19 in the state peaked in September/October 2020. Since then, the overall testing rate gradually declined. On July 9, the state performed 1.1 tests per 1,000 persons, equivalent to the rate of testing during late-May 2020. Testing for COVID-19 in the state is almost at par with the national average of 1.54 per 1,000. However, coupled
with the higher positivity rate compared to the national average, relatively low testing rates raises concerns about surveillance. Without regular, large-scale testing, the best data for disease surveillance may be hospitalizations.

Broadly defined, the COVID-19 positivity rate is the number of people who test positive for COVID-19 as a proportion of the number of people who have been tested. The positivity rate is an indicator of viral transmission. A higher positivity rate is indicative of higher transmission relative to the number of tests.

Figure 3B shows the seven-day moving average of the positivity rates for Arkansas and the United States. The positivity rate in Arkansas decreased from December through March. However, during the last month, it consistently increased and is currently almost at par with the rates in early-January, 2021. Currently, the positivity rate is at 21%, equivalent to almost five times the national average of 3.6%.

Community COVID-19 cases.
Map 1 on the next page shows per capita rates of COVID-19 cases in Arkansas by county, from the beginning of the pandemic. These data provide a historical marker of the pandemic burden on Arkansas counties. Presently, all by one county in the state have per capita rates above 700 cases per 10,000 residents, meaning one in 20 residents have been infected with COVID-19 at some point during the pandemic. In the June report, 29 counties showed per capita rates greater than 1,000 per 10,000 residents. In this report that number is 44. Two counties — Sevier and Yell — have per capita rates above 1,500 per 10,000. In these two counties, one in seven residents have had COVID-19 sometime during the pandemic. Of note, all but one county with a per capita case rate greater than 1,200 per 10,000 is adjacent to another county with a rate greater than 1,200 per 100,000, with the same high rate.
Hospitalizations by county. Evaluating the distribution of hospitalizations across counties provides a sense of the burden COVID-19 placed on regional and county hospitals.

Map 2 shows the per capita hospitalization rates per 100,000 residents March 2020. Fourteen counties have rates above 1,000 per 100,000, or one in 100 individuals hospitalized at some point during the pandemic. All Arkansas counties have per capita rates above 300. The highest hospitalization rates have been in eastern counties. Poinsett County has the highest hospitalization rate in the state.

Understanding the percentage of COVID-19 positive patients in a county who have been hospitalized is an important measure of disease spread and an indicator of future hospitalizations when combined with the number of new local cases. Map 3, shown on the next page, provides the percent of COVID-19 cases hospitalized by county. A value of 5%, for example, means five out of 100 COVID-19 cases in a county have been hospitalized. Forty-six counties have hospitalization rates above 5%, meaning one of every 20 COVID-19 cases in these counties were hospitalized. Clay and Phillips County have rates above 10%.

High hospitalization rates may indicate counties that have had less testing capacity or populations less willing to test. In these counties, cases may be identified later in the infection, when patients are asymptomatic or perhaps ill. Areas shaded darkest blue have the highest percentage of positive cases requiring hospitalization. These counties should consider increasing community testing and early access to resources that may aid in preventing a COVID-19 case from requiring hospitalization.

Summary. Examining the COVID-19 pandemic over time can be instructive. As shown above, the pandemic in Arkansas has had at least five discernable phases, each showing different features. Arkansas is now entering a new surge due to the presence of the Delta variant of COVID-19, the summer social gatherings including summer camps, and the lack of mandated prevention measures, such as wearing facemasks and social distancing. In this sixth phase, the positivity rate in
Arkansas is far above national average and is approaching the positivity rate at the height of the December/January surge.

**Map 3** Percent of positive cases hospitalized by county

Per capita case rates and hospitalization rates at the county level show some counties have been disproportionately impacted by the pandemic. Per capita case rates may be indicators of possible problems with long-term COVID. We do not clearly understand the proportion of those infected with COVID-19 that will develop long-term effects of the disease, but we do know a substantial number will. This may be a long-term health problem in counties with high per capita rates, if vaccination rates remain low. Fortunately, although studies are in the first stages, vaccination appears to significantly improve long-term COVID by helping the body clear the virus.

If we directly compare Maps 1 and 2, we can see there is an association between per capita COVID-19 cases and hospitalization rates. Counties with high per capita case rates and percentage of cases hospitalized tend to be located in the eastern half of the state.

COVID-19 per capita hospitalization rates at the county level are also instructive because they provide a sense of how prepared a county is to both prevent and deal with future public health emergencies. Counties with high COVID-19 per capita hospitalization rates tend to be rural and distant from urban centers. These counties tend to have high rates of other chronic and infectious disease and limited health care resources with which to deal with them. We can surmise these are the counties that will have significant problems protecting the health of their populations during future pandemics or the emerging “third wave” of COVID-infections associated with the Delta variant. With respect to planning how to meet future health crises, planning should focus on rural, resource constrained counties in Arkansas with an eye toward developing innovative strategies for providing public health and health care services.
COVID-19 Cases

Confirmed COVID-19 cases are those identified using a PCR test. Probable cases are cases diagnosed using an antigen test. Results of antigen tests have been reported by the Arkansas Department of Health (ADH) since Sept. 2, 2020. ADH continues to distinguish between confirmed and probable cases, but are combined in this report. We refer to confirmed and probable cases as “cases.”

15 & 30-day forecasts of COVID-19 cases in Arkansas. Until recently, 15-day forecasts were calculated using data since the beginning of the pandemic. To provide a better fitting model, we now forecast from May 1.

Figure 4a shows COVID-19 cases in Arkansas forecast through July 26. The 15-day forecast for July 26 shows cases in Arkansas will reach 371,276, or around 15,000 new cases between July 11 and July 26.

Figure 4b shows the forecast of COVID-19 cases in the next 30 days, through August 9. The 30-day forecast shows Arkansas will have a cumulative caseload of just under 400,000 cases. The 30-day model is showing the state will add about 36,000 new cases by early August.
Forecasts by age and race/ethnicity. As shown in Figure 5a, the forecasts indicate increases in new cases for all age groups. The model forecasts the greatest increase in cases will be in adults age 35 to 59. The forecast is for 5,591 new cases, an average of 372 cases per day. Similarly, the monthly forecast till August 11 shows 13,233 new cases in this age group. That translates to over 440 cases within the age group per day.

The group with the second highest growth will be young adults age 18 to 34, as the orange line in the figure. The 15-day model forecasts 108,433 cumulative cases in adults 18 to 34 by July 26, an increase of almost 5,000 cases reported on July 11. The 30-day model forecasts 115,299 cumulative cases in adults age 18 to 34 by August 11.

For children 17 and under, the model forecasts 2,538 new cases, or a 2\% increase by July 26. This is a daily average of 169 new cases. The monthly model forecasts 6,034 cumulative cases for children 17 and under by August 11.

Cases in adults age 60 to 74 are forecast to increase by 1,794 or 1\% compared to the cases reported on July 11. We should expect the number of cases in adults 60 to 74 to increase to 49,987 by July 15 and to 52,373 by August 11.

The age group forecast to have the smallest increase is adults over 75. New cases among adults 75 and older are forecast to increase by a comparatively modest 498 cases.

When we compare percentage increases by race/ethnicity, Blacks, Hispanics, and Whites will have increases essentially the same rates through July 26 and August 11.
Relative change in COVID-19 cases by county. Map 4 shows the relative change in cases for each Arkansas county. Relative change is determined by calculating the percent change between cases during the most recent two-week period, June 28 through July 11, to cases from the prior two-weeks, June 14 through June 27. A number of counties are excluded from this map due to reporting fewer than 10 cases in one of the two-week reporting periods.

During the most recent two weeks, of those counties for which a relative rate could be calculated, all but five had increases in case rates. Twenty-five counties had relative increases above 100%, compared to two in the previous report.

As shown in Map 5, 44 counties in Arkansas had per capita case rates above 20 per 10,000 in the last two weeks. This a huge increase when compared to only two counties in the previous report. There is a clear concentration of high case rates in the central part of the state. Because this includes relatively rural counties the increased rates cannot be explained as an artifact of increased testing availability.

Summary. The 15-day and 30-day models forecast a growing number of new COVID-19 cases between July 26 and Aug. 11, compared to forecasts in our previous reports. All forecasts are exacerbated by the new circulating Delta variant of the SARS-CoV-2 in the state.

The greatest number of new cases will continue to be in adults between 18 and 59. However, all age groups are forecast to have growth.

A large number of counties in the state report relative growth in cases greater than 100% in the past two weeks. This strongly suggests the virus is traveling at a rapid rate throughout the state. There is no apparent difference between rural/urban counties. Given vaccination rates in the state, as shown below, we cannot see a reason this rapid spread of COVID-19 in the state will change in the next two months.
COVID-19 hospitalizations and need for ICU

15 & 30-day forecasts of hospitalizations. Figure 6a shows the 15-day forecast for COVID-19 hospitalizations in the state on July 26. The model forecasts 564 individuals will be newly hospitalized for COVID-19 between July 11 and July 26, an increase of 2% over the previous two weeks. There will be a daily average of 37 new hospitalizations. Hospitalizations in Arkansas are forecast to reach 19,970 cumulative hospitalizations by July 26, and 20,580 by August 11 (Figure 6b).

The estimated trend in hospitalizations shows the early beginnings of an exponential growth rate, as shown in Figure 6a and 6b. Hospitalization lags cases by one to three weeks, so this growth pattern may be indicative of greater growth in the future, particularly given the low rate of testing in the state.

Figure 7, on the next page, shows a similar growth pattern for patients needing intensive care. The 15-day model is forecasting 5,660 cumulative COVID-19 intensive care patients by July 26, an increase of more than 477 over our last report on June 18.

Figures 8 shows the 15-day forecast of hospitalizations by age. The greatest number of hospitalizations will continue to be in adults 60 to 74. Cumulative hospitalizations for adults for this age group will reach 6,396 by July 26, increasing by 3% in the next two weeks.

The second-highest number of hospitalizations will be in adults 35 to 59 in the 15-day forecast. As shown in Figure 8, COVID-19 hospitalizations in this age group are expected to increase by 218 patients, or 4% in the next two weeks. This also is an indication from the figure that hospitalizations in this age group is increasing.
Summary. The conclusion we reach from the 15-day models is that hospitalizations will continue to increase, and the slopes suggest the early beginnings of an exponential growth curve. The 15-day models are forecasting the greatest number of hospitalizations due to COVID-19 will continue to be in adults aged 60 to 74. However, adults 35 to 59 are likely to be the largest group hospitalized in the very near future. This is consistent with the expectation that the Delta variant is having a greater impact on younger adults.

While still early in this surge, we expect to see greater numbers of young adults, 18 to 34 and children under 17 hospitalized. Presently, numbers remain small. However, we believe this is due to the time lag between the entry of the delta variant and hospitalizations rather than accuracy of the models.
COVID-19 Deaths

**15-day forecast of COVID-19 deaths.** The 15-day model was calculated using data through July 11. The 15-day model is forecasting 6,043 cumulative deaths in Arkansas due to COVID-19 by July 26, as shown in Figure 9. The state should expect an increase of 40 deaths in the next 15 days. This is an average 3 death per day over the next 15 days.

**Summary.** Consistent with cases and hospitalizations over the last two weeks, the number of daily deaths from COVID-19 are trending upward. Deaths lag both cases and hospitalizations. Consequently, the beginnings of an exponential growth curve apparent in the other models is not as obvious with death data. However, we expect this to change in the next month.
COVID-19 Vaccination.

Map 6 Percent of the population (12+) fully vaccinated

Map 6 shows the percentage of the fully vaccinated population (age 12+) in each Arkansas county as of July 12. Vaccination data were processed by Haley Hale using data available from the Arkansas Department of Health’s website. There is still close to a five-fold difference between the county with the highest vaccination rate — 45% in Bradley County — and the lowest — 9% in Miller County. Demographically, Miller County looks like many other counties in Arkansas with much higher vaccination rates. It has been anecdotally reported that many Miller County residents receive their vaccinations across the border in Texas. These vaccinations are not being recorded in Arkansas and, consequently, may be skewing the number of adults vaccinated in Miller County. The same could be true for other border counties.

Comparing current vaccination rates with those in the previous report in June, Map 7 shows the counties making the most rapid progress toward vaccinating their populations. The counties with the highest one-month increase were Independence, Washington, and Benton counties, each showing an addition of five percent or more of its population. Even so, the rate of vaccination across the state remains low.
Methodological Notes

**Short-term forecasts.** Time series forecasting is a method that uses observed data to predict future values. The purpose of the models is to fit the best curve to data and extend the curve into the future. To forecast aspects of the pandemic in Arkansans, the models used COVID-19 cases, hospitalizations, ICU admissions, and death data reported to the Arkansas Department of Health. It should be noted the report defines a “case” as a COVID-19 test result reported and posted by the Department of Health. As indicated by recent research, the number of undiagnosed COVID-19 infections in the community may be higher by 40% to 50%. Although an antibody seroprevalence student recently was completed in the state, we have not yet had time to incorporate it into our modeling.
Glossary of Terms

**Active infection** = a positive infection, with or without a COVID-19 test, that has not yet recovered or died

**Case** = a positive COVID-19 test result reported to the Arkansas Department of Health

**Community** = population not in a prison or population not in a prison or nursing home

**Cumulative** = total number of a given outcome (e.g., cases) up to date

**Extended state-space SIR (eSIR) model** = a model based on three components: susceptible (S), infected (I), and removed (R, including both recoveries and deaths)

**Susceptible-Exposed-Infected-Recovered model (SEIR)** = another variant of standard epidemiological model considering exposure as another factor controlling for disease dynamics

**Hospitalization** = a positive infection or case that was admitted to the hospital

**ICU** = intensive care unit admission

**Infection** = a COVID-19 infection, with or without a test and regardless of having recovered or died

**Positivity Rate** = the number of people who test positive for covid-19 as a proportion of people have been tested

**Projections** = long-term predictions

**Recovered** = a positive infection that is no longer symptomatic or shedding virus

**Susceptible** = an individual who can be infected with the disease of interest

**Time series forecast** = short-term forecast of events through a sequence of time