**Modeling Local COVID-19 Disease for Athens-Clarke Hospital Service Area:
Brief Report**

Ishaan Dave, MSPH
Nicholas Mallis, MPH
Megan Bramlett, MPH
Micah Gell-Redman, PhD
Justin Ingels, PhD*
Grace Bagwell Adams, PhD, MPA*

*Corresponding Authors:
ingels@uga.edu
gbagwell@uga.edu

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University of Georgia
College of Public Health
Department of Health Policy & Management
Department of Epidemiology & Biostatistics

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Executive Summary

Overview

On Wednesday, March 23rd, a meeting between the Piedmont Athens Regional Medical Center (PARMC) ICU director, PARMC and St. Mary's Healthcare intensivist physicians, and a University of Georgia College of Public Health research team took place to discuss the need for modeling the effect of COVID-19 on the region served by Athens-Clarke County hospital systems.

The purpose of this document is to provide information regarding current and potential future COVID-19 disease prevalence, as well as estimates of overall hospital burden to prepare as effectively as possible for the community health effects of COVID-19. This report uses publicly-available data from March 2020, when the first Clarke County cases were confirmed. The models presented here have been calibrated to fit the population size; date of the first confirmed case; likely number of exposed but not infectious persons; and infectious persons in the community from when the first case was reported.The simulations reported below, which are calibrated using these data, predict the number of future cases through April 28th.

The region served includes Athens-Clarke and 16 surrounding counties, with a service area population approximating 650,000 individuals. For this reason, the analysis in this report covers 17 counties in the service area. The document contains three main sections of analysis: 1) an overview of how the epidemic has developed in the service area so far; 2) model simulations that predict how the epidemic might develop across the service area over time; and 3) estimates of the number of total hospitalizations and peak hospitalizations between the time this report was written and April 28th, 2020.

Main Findings

Our first set of predictions (Scenario 1) assume that social distancing interventions will not be adopted or will not be maintained throughout the service area. The second set of predictions (Scenario 2) focuses on the alternative, in which these interventions do occur and adherence to them is at an "average" level. For context, we provide a brief timeline of movement restrictions. As of March 27, only two of the 17 service area counties had implemented comprehensive shelter-in-place interventions (Clarke and Oconee). Two additional counties subsequently enacted partial interventions (Barrow and Walton). A statewide shelter-in-place policy was announced on April 1.

Table 1 provides a synopsis of model results of estimated cumulative confirmed cases and expected hospitalizations. **The overall range of estimated cumulative confirmed cases is between 779 and 3,358 by April 28th**.

To make these predictions most useful, we provide additional estimates of the direct effects implied by each scenario on service area health providers. First, we consider the total number of hospitalized patients, which we have estimated and present in Column 3. Second, we present model estimates that show the peak number of simultaneous hospitalizations during the month of April in Column 4. These models take into account the average duration of stay and reflect the fact that while new patients are being admitted, some will be discharged. **The total inpatient admits over the month of April are estimated to range between 175 and 757; the peak simultaneous admits are estimated to range between 98 and 639.**

While we do not estimate the number of patients or cases that might require intensive care services (including ventilator support), we note that a percentage of patients who are admitted to the hospital will need additional respiratory support. There is substantial variation in the data and reports that have been generated on the fraction of inpatient cases that then need to be admitted to the ICU. The latest World Health Organization publication that provides data on this topic estimates that 5% of cumulative cases will need such support.[1] The University of Washington's Institute for Health Metrics and Evaluation suggests that 15% of patients will require an ICU bed.[2]

Limitations
The information presented here summarizes the results of a mathematical model. Like all such models, the one used here is based on simplifying assumptions. Experts in the field have labeled these assumptions plausible, and the predictions made using these assumptions match well with what we know about the epidemic so far. In spite of this, the assumptions underlying this model are necessarily imperfect. Predictions based on these assumptions are subject to uncertainty that cannot be characterized within the framework of the model itself. Moreover, the data that are input into the model, including the number of confirmed cases, are imperfectly measured, which adds another element of uncertainty that cannot easily be quantified.

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[1]https://www.who.int/publications-detail/clinical-management-of-severe-acute-respiratory-infection-when-novel-coronavirus-(ncov)-infection-is-suspected
[2] https://covid19.healthdata.org/projections

Table 1. Range of Estimates from Model Simulations of Confirmed Cases & Hospitalizations through April 28, 2020.

	Cumulative Confirmed Cases	Total Inpatient Admits	Peak Simultaneous Inpatient Admits
Scenario I: Poor Adherence/No Sheltering-In-Place	3,358	757	639
Scenario II: Average Adherence to Sheltering-In-Place	779	175	98

Table Notes: Columns 2 and 3 present the upper bound (or largest) estimates from the range of total inpatient admits and the range of peak cases that are inpatient through April 28, 2020. These estimates do not go beyond the end of April.

Discussion & Summation of Findings
On April 1, Governor Brian Kemp issued a Shelter-In-Place (SIP) order for the state of Georgia, to be implemented through April 13, 2020 (as of the writing of this brief). Given this policy change, if individuals adhere to the mandate, there should be a significant decrease in the number of COVID-19 cases. It will, however, take time for the positive effect of such policy changes to be realized. Given that Athens-Clarke and Oconee counties implemented SIP ordinances earlier, there should be earlier benefits realized in these two counties.

Across the country, communities are trying to understand when the "peak" of the COVID-19 pandemic will occur. In the "average" SIP scenario presented here, the height of cumulative cases is estimated to be April 27, 2020. It is not possible to estimate a peak date for the "poor" SIP scenario presented, because the cases will continue to rise beyond the end date of the model simulation.

It is impossible to predict a specific number of confirmed cases given the shifting public health and public policy landscapes in this region, and the unknown level of adherence to SIP policies. For this reason, two sets of models are presented based on a set of assumptions which allow us to introduce varying levels of SIP interventions. The range of these findings are presented above in Table 1. For hospital planning purposes, it is recommended that both PARMC and St. Mary's hospitals prepare for greater rather than fewer cumulative cases and hospitalizations in order to be as prepared as possible for the coming surge.

Finally, data on confirmed cases and the rationing of tests across the state severely inhibit accurate case counts. This context is important for community, hospital, and government preparedness efforts. Widespread testing and the return of results to patients in a timely manner will improve our ability to understand virus prevalence.

Full Model Results
Section I: Epidemic Curve for Hospital Service Area Counties

FIgure 1 below shows the current epidemic curve for Clarke and surrounding primary and secondary counties from which our two hospitals serve. See Appendix A for a map and list of all counties served. **As of April 2, 2020, the Georgia Department of Public Health daily brief reported there have been a total of 154 confirmed COVID-19 cases in the ACC Hospital Service Area.**

Growth of Confirmed Cases in the ACC Hospital Service Area
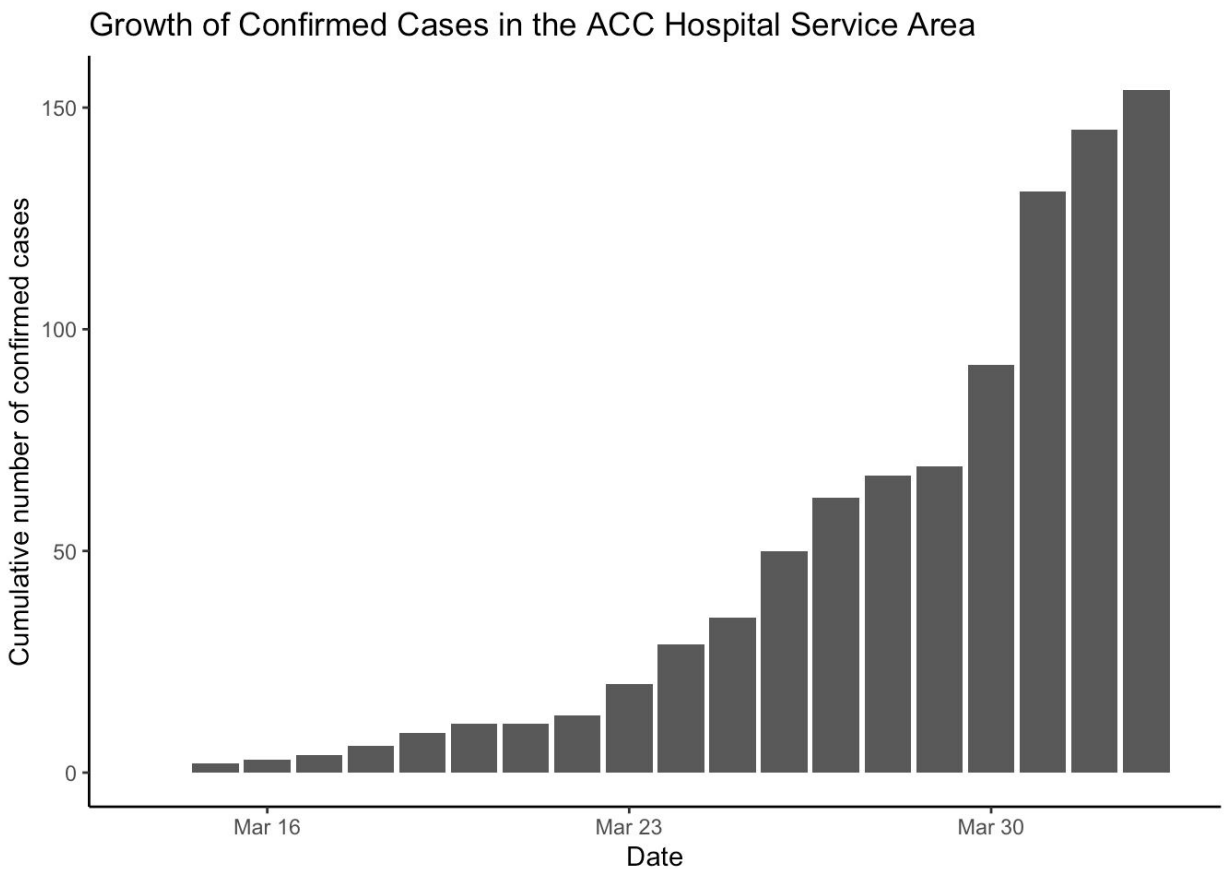
Section II: Estimate of Total Confirmed Cases: Athens Clarke County Hospitals' Service Area

In order to predict the total number of confirmed cases expected in Clarke and surrounding counties, we modified a simulation model developed by Dr. John Drake (infectious disease ecologist) and Dr. Andreas Handel (epidemiologist) and colleagues at the University of Georgia. This model was originally designed to simulate the number of aggregate cases from the original outbreak in Wuhan, China and was then adapted to predict cases across the state of Georgia. Dr. Drake, Dr. Handel and colleagues shared data, programming, and output to assist and expedite the process of local modeling. Details regarding their Georgia state-level analysis may be found here.

For the purposes of the local analysis presented in this report, the model was recalibrated to local conditions in Athens-Clarke County (ACC) hospital service area counties. The initial number of reported cases from the 17-county region was included as a parameter in the models. We present two scenarios in the following results.
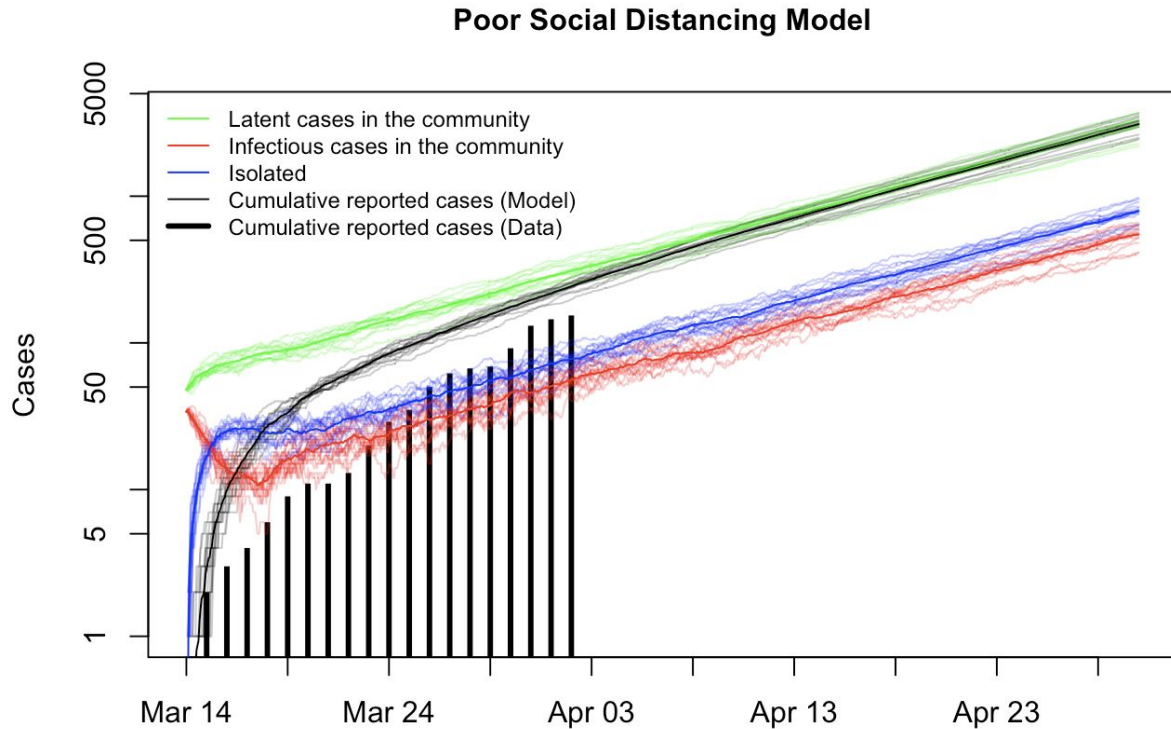
Scenario 1 is the upper bound prediction (highest cumulative reported confirmed cases we might expect) when social distancing and shelter-in-place interventions **are not** being implemented and/or adhered to across the service area.

Scenario 2 includes results from the upper bound prediction of cumulative reported confirmed cases when social distancing and shelter-in-place interventions **are** widely implemented and are adhered to at an "average" level--this model is calibrated to reduce transmission by 33%.

In each of these models, there are some implicit assumptions. For example, as a result of state and local policy changes and public health efforts, it is assumed that there is some reduction in transmission of the disease over time (*e.g.* isolation of symptomatic individuals that have been told by providers to quarantine at home).

Taken together, these models provide a range of estimates. For planning purposes, it is suggested to prepare for the scenario that will allow for an adequate amount of Personal Protective Equipment (PPE) and enough healthcare providers, among other resources that might be needed, should the confirmed cases follow the time trend of the larger estimates presented. Another reason to consider the estimates from Scenario 1, where poor adherence to shelter-in-place occurs, is because only two of the 17 counties in the hospital service area implemented comprehensive shelter-in-place ordinances before the April 1st statewide policy was announced by Georgia Governor Brian Kemp.

Scenario 1: Poor Social Distancing/Shelter-in-Place Intervention Adherence
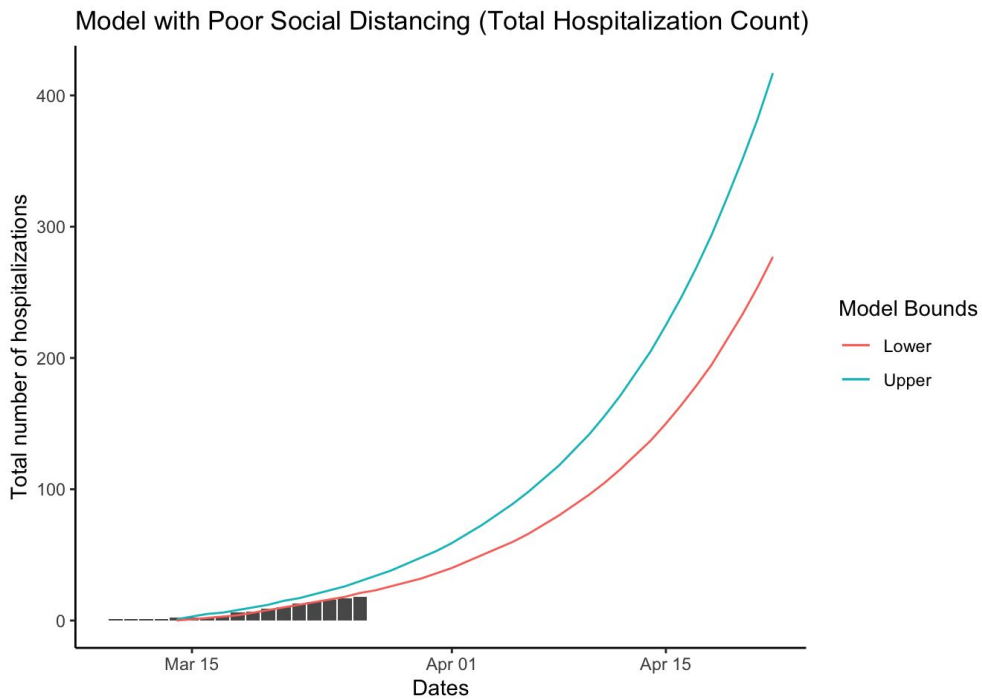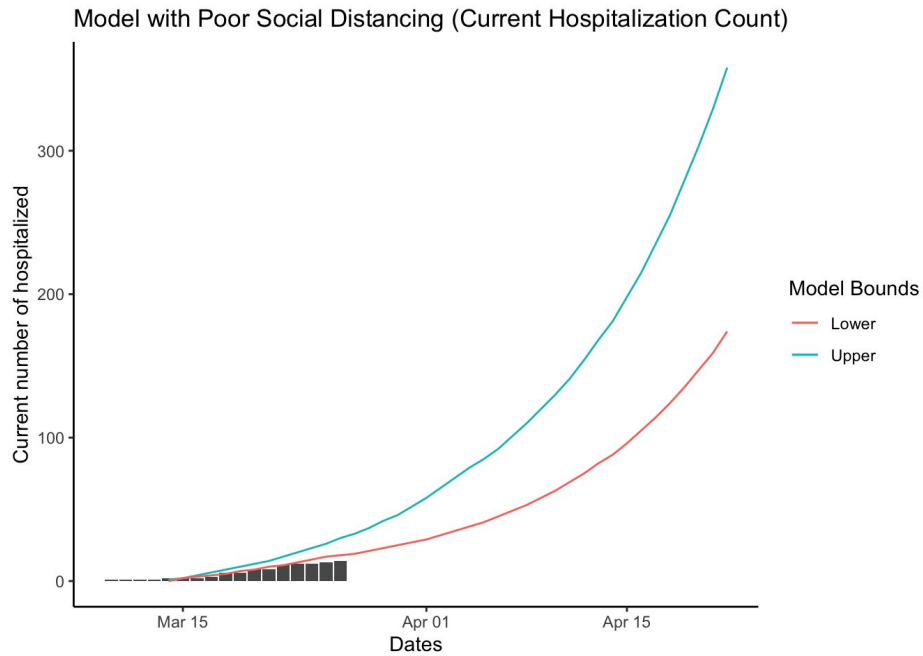
Poor Social Distancing Model

This scenario shows the upper bound (highest cumulative reported cases we might expect) in Clarke and surrounding counties through April 28th when social distancing and shelter-in-place interventions are poorly adhered to across all counties. The black curve (labeled Cumulative reported cases (Model)) represents model estimates on the cumulative reported cases in Athens and surrounding counties. The vertical black lines represent the current epidemic curve.[3] Based on this scenario, the upper bound estimate of cumulative reported cases through April 28 is predicted to be 3,358.

Hospitalizations would continue to rise at a steady rate over the time period, as shown in the second figure below. The current hospitalization count, or simultaneous inpatient cases, would also continue to rise. The rate of current hospitalizations rises slower than total given that there will be some discharges over the time period.

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[3] The y-axis (Cases) on the following three plots are on the log scale, not continuous values. This is true for all disease curves presented on cumulative cases.

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In the following graphs, using the poor distancing model simulation of cases, the total and current number of hospitalizations are plotted over the same time period. The vertical black lines are reported hospitalizations at one of the two local hospitals and, therefore, only represent a portion of the total hospitalizations in the ACC service area.
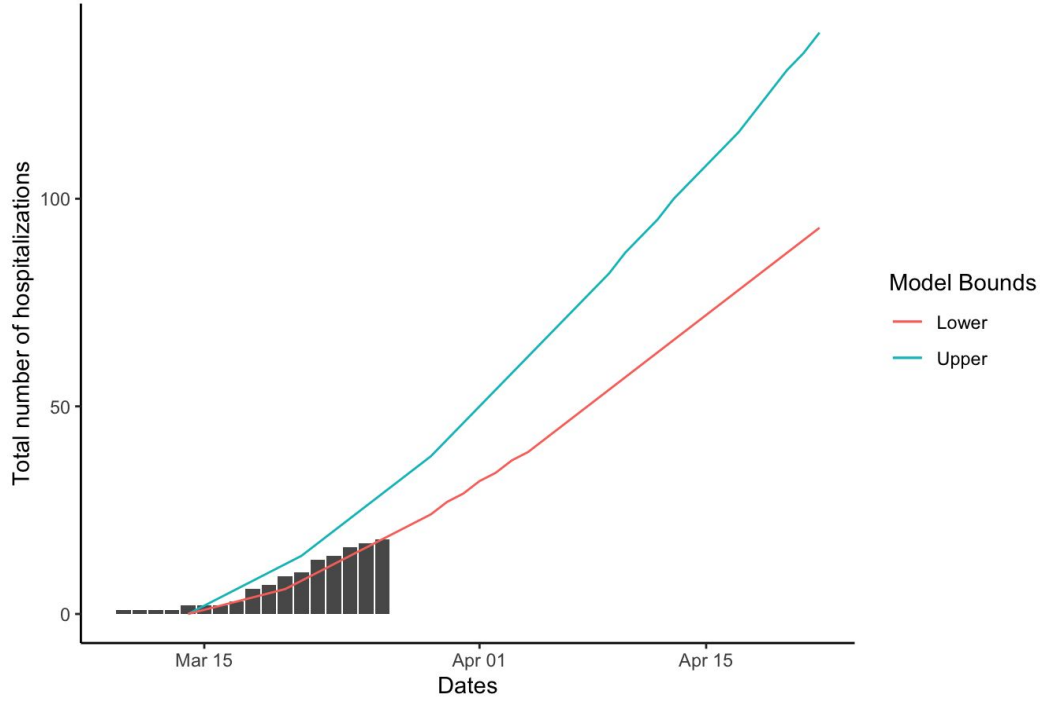

Model with Poor Social Distancing (Current Hospitalization Count)

Model with Poor Social Distancing (Total Hospitalization Count)

Scenario 2: Average Social Distancing and Shelter-In-Place Adherence

**Model with Average Social Distancing**
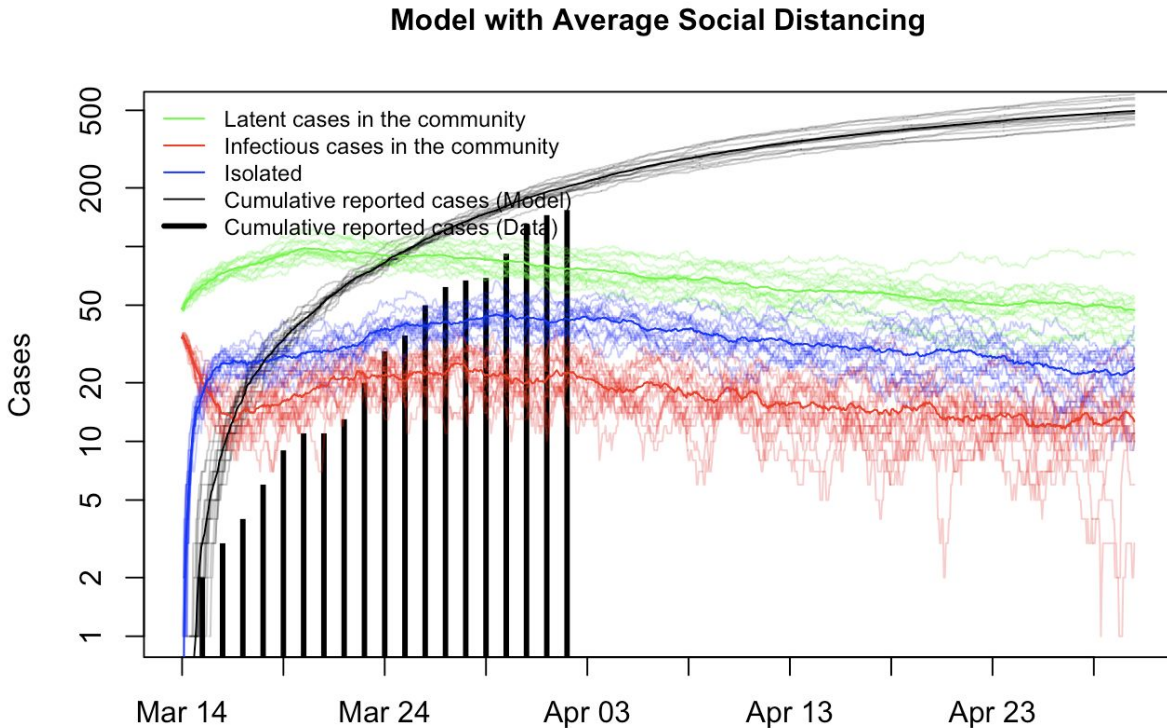
The second scenario shows the estimates for total cases in Clarke and surrounding counties through April 28 when social distancing and shelter-in-place interventions are being implemented and adhered to at an average level. The black curve (labeled Cumulative reported cases (Model)) represents our predictions on the cumulative reported cases in Athens and surrounding counties. The vertical black lines represent the current epidemic curve. In this scenario, 779 cases are estimated by April 28th with average social distancing and shelter-in-place implementation and adherence. In this scenario, the total hospitalization count ends up a little over half of what would be expected with the natural epidemic.

In the following graphs, using the average distancing model simulation of cases, the total and current number of hospitalizations are plotted over the same time period. The vertical black lines are reported hospitalizations at one of the two local hospitals and, therefore, only represent a portion of the total hospitalizations in the ACC service area.

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Model with Average Social Distancing(Total Hospitalization Count)

Model with Average Social Distancing (Current Hospitalization Count)
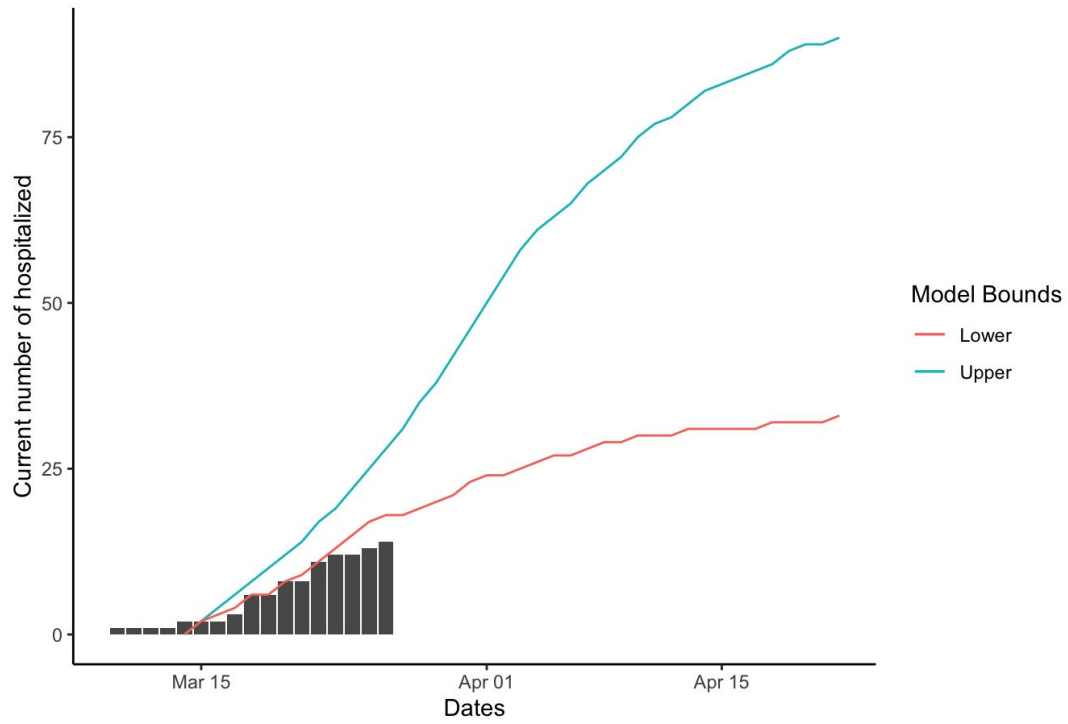
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References

Drake, J.M. & P. Rohani.*[4] *Scenario Analysis for the Transmission of COVID-19 in Georgia.* Retrieved March 24, 2020 from
http://2019-coronavirus-tracker.com/stochastic-GA.html

Georgia Department of Public Health, DPH COVID-19 Daily Status Report. Retrieved April 2, 2020 from https://dph.georgia.gov/covid-19-daily-status-report

Institute for Health Metrics and Evaluation (2020). University of Washington IHME COVID-19 Projections. Retrieved April 2, 2020 from https://covid19.healthdata.org/projections.

United States Census Bureau (2019). *Quickfacts*. Retrieved March 15, 2020 from https://www.census.gov/quickfacts/fact/table/US/PST045219

World Health Organization. (2020). *Clinical management of severe acute respiratory infection (SARI) when COVID-19 disease is suspected: Interim guidance*. WHO Reference Number: WHO/2019-nCoV/clinical/2020.4

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[4] Additional Contributors: Lewis Bartlett, Ana Bento, Rebecca Borchering, John Drake, Yang Ge, Andreas Handel, Drew Kramer, Culzean Kennedy, Brian McKay, Eric Marty, Rachel Mercaldo, Paige Miller, Tierney O'Sullivan, Chloe Parker, Robbie Richards, Trippe Ross, Kate Sabey, Liliana Salvador, Cecilia Sanchez, JP Schmidt, Patrick Stephens, Chao Song, Daniel Suh, Benjamin Taylor, David Vasquez, Joy Vaz, Jessica Wenclawiak, Anna Willoughby, Cali Wilson

Appendix A: Service Area Overview
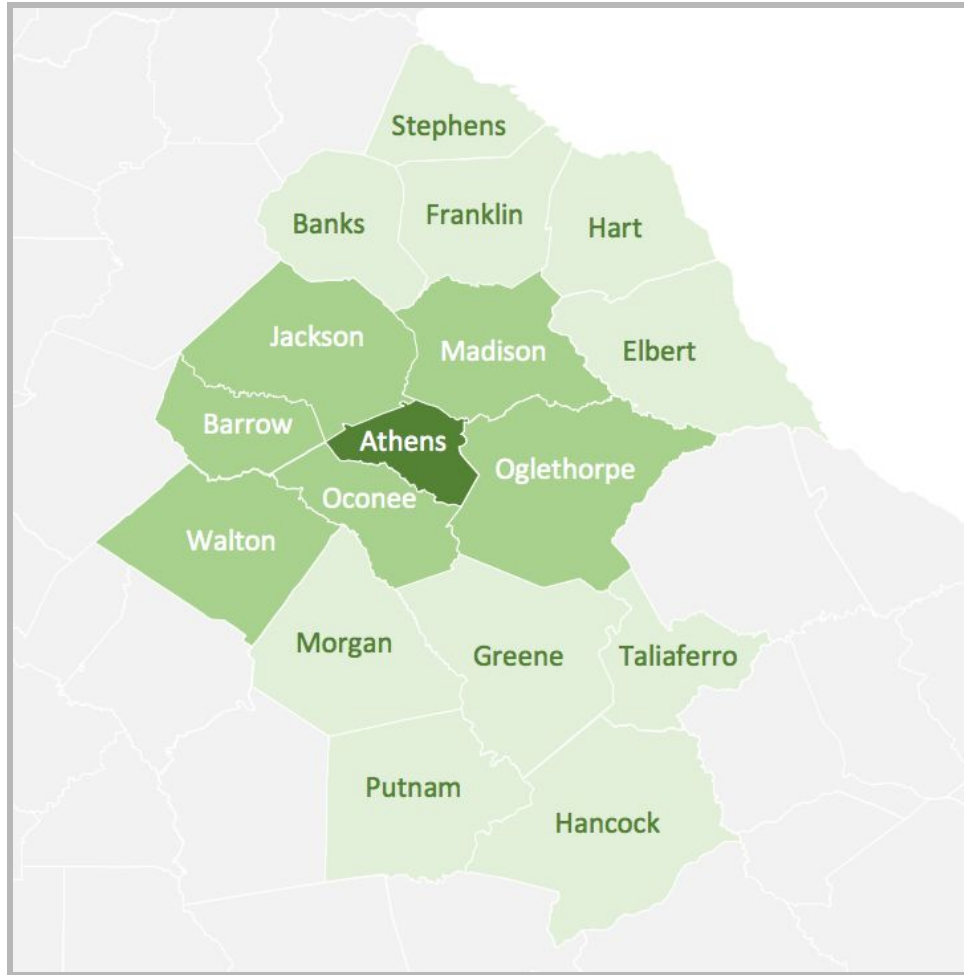
Athens-Clarke County
Population: 127,064
Area: 119.2 sq mi

Primary Counties
Counties: Athens-Clarke, Barrow,
Jackson, Madison, Oconee, Oglethorpe,
Walton
Population: 471,602
Area: 1,850.5 sq mi

Secondary Counties
Counties: Banks, Elbert, Franklin,
Greene, Hancock, Hart, Morgan,
Putnam, Stephens, Taliaferro
Population: 179,859
Area: 3,002 sq mi

17-County Service Area Total
Population: 651,461
Area: 4,842.5 sq mi