Modeling COVID Hospitalization During the Early COVID Pandemic in St. Louis

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During the COVID-19 pandemic in the United States, great focus was placed on how well hospital systems were able to handle the increased patient load. The dual aims of statistical process monitoring are (1) early event detection and (2) situational awareness. When we monitor the spread of a disease like COVID, the focus is on situational awareness. In this study, we develop a time series model to estimate the current state of the disease across the various zip (postal) codes in St. Louis County, Missouri. We use this model to forecast hospitalization counts up to 14 days ahead using individual data gathered from St. Louis County in Missouri. We evaluated the utility of lagged case counts on the weekly scale as regressor variables. For forecasts at longer horizons, the lagged case data were not yet observed. Auxiliary time series models for lagged cases were developed, and forecasts from that model were used to forecast the hospitalization counts. Model performance was evaluated with time series cross-validation, using mean absolute error as the primary metric. Models incorporating lagged case data outperformed baseline models that did not include lagged case data. Additional predictors, such as vaccination coverage, day of the week, and holidays, were also examined. These results highlight the importance of robust time series modeling and the inclusion of lagged cases in forecasting hospitalization counts. Such models could be used by public health departments to inform hospital systems of incoming surges in patient load, giving hospitals time to prepare with staffing, space, and supplies to decrease overall mortality.

Keywords: Time series, Autoregressive moving average model, Prediction error