

A Multivariate Forecasting Model for the COVID-19 Hospital Census Based on Local Infection Incidence

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Abstract: COVID-19 has been one of the most serious global health crises in world history. During the pandemic, healthcare systems require accurate forecasts for key resources to guide preparation for patient surges. Forecasting the COVID-19 hospital census is among the most important planning decisions to ensure adequate staffing, number of beds, intensive care units, and vital equipment. In the literature, only a few papers have approached this problem from a multivariate time-series approach incorporating leading indicators for the hospital census. In this paper, we propose to use a leading indicator, the local COVID-19 infection incidence, together with the COVID-19 hospital census in a multivariate framework using a Vector Error Correction model (VECM) and aim to forecast the COVID-19 hospital census for the next 7 days. The model is also applied to produce scenario-based 60-day forecasts based on different trajectories of the pandemic. With several hypothesis tests and model diagnostics, we confirm that the two time-series have a cointegration relationship, which serves as an important predictor. Other diagnostics demonstrate the goodness-of-fit of the model. Using timeseries cross-validation, we can estimate the out-of-sample Mean Absolute Percentage Error (MAPE). The model has a median MAPE of 5.9%, which is lower than the 6.6% median MAPE from a univariate Autoregressive Integrated Moving Average model. In the application of scenario-based long-term forecasting, future census exhibits concave trajectories with peaks lagging 2-3 weeks later than the peak infection incidence. Our findings show that the local COVID-19 infection incidence can be successfully incorporated into a VECM with the COVID-19 hospital census to improve upon existing forecast models, and to deliver accurate short-term forecasts and realistic scenario-based long-term trajectories to help healthcare systems leaders in their decision making.