A model to predict ceiling of care in COVID-19 hospitalized patients

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Background and objective: Therapeutic ceiling of care is the maximum therapeutic effort to be offered to a subject based on age, comorbidities, and the expected clinical benefit in relation to the availability of resources. According to previous data, COVID-19 subjects with a ceiling of care assigned at hospital admission are mainly older, have more comorbidities, and fewer clinical symptoms at baseline than patients without a ceiling of care. The incidence of death, severe pneumonia, and complications is higher in patients with a ceiling of care. Therefore, analysis of hospitalized subjects with SARS-CoV-2 infection should be stratified by ceiling of care to avoid bias and overestimation of outcomes. The ceiling of care decision is not reported in most published COVID-19 cohorts. Our aim is to develop and validate a model to predict the ceiling of care for hospitalized subjects with COVID-19 using information on the demographic and clinical profile of the patients available at the time of hospital admission.

Methods: The data used to develop the model came from an observational study conducted during four waves of COVID-19 (March 2020-August 2021) in 5 centers in Catalonia. Data were sampled 1000 times by bootstrapping. A logistic regression model with ceiling/no ceiling as outcome was fitted for each sample using backward elimination. Variables retained in more than 95% of the models were candidates for the final model. Alternative variable selection methods such as Lasso, CART, and Boruta were also performed to increase the robustness of the final set of selected variables. Discrimination was assessed by estimating the area under the ROC curve (AUC) and calibration by comparing observed versus expected probabilities of ceiling of care by deciles of predicted risk. Validation was performed in the whole cohort and in subgroups of interest. A cohort of patients diagnosed with COVID-19 in the Basque Country will be used to externally validate the results.

Results: A model including age, COVID-19 wave, chronic kidney disease, dementia, hypertension, heart failure, metastasis, peripheral vascular disease, COPD, and ictus had excellent discrimination (AUC=0.89 [95% CI 0.88; 0.90]) and the observed probabilities agreed well with the predicted probabilities. Patients with relevant comorbidities and by deciles of age also showed excellent figures for calibration and discrimination. External validation of the model in a cohort of patients with COVID-19 is ongoing.

Conclusions: Ceiling of care can be predicted from information on the subject's demographic and clinical profile available at hospital admission. Cohorts without information on ceiling of care can use this model to report outcomes in accordance with it and avoid bias, particularly in overestimating the incidence of outcomes in patients without ceiling of care.

Keywords: COVID-19, Therapeutic ceiling of care, Prediction model, Variable selection.