MAYO CLINIC

A Call to Action: Modeling Hospital Capacity in a Pandemic

Lindsey Lehman, MPH, MHA, Kassie King, MA, Jesse Andrist, M.S., Mary Bany, MA, Jake Beckel, MBA

Objective

Employ a predictive hospital capacity model to facilitate operational planning and response to the unprecedented demand for beds brought on by the COVID-19 pandemic. Specifically to: facilitate proactive bed capacity management to ensure patients can continue to be cared for in the right place at the right time, plan for a responsible return to pre-pandemic surgical scheduling volumes and enable operations at record peak capacity rates reaching above 95 percent.

Planning/research methods

A prediction model was requested by hospital leaders to assist in decision making in anticipation of COVID-19 hospitalizations. Historical demand trends for beds, largely driven by surgical and procedural practices, were no longer sufficient. Hospital leaders wanted to incorporate community COVID-19 trends and develop additional precision from other sources of bed demand, which had also been altered by the pandemic. The anticipated surge did not materialize, however the need for a predictive model was amplified by subsequent COVID-19 surges and staffing constraints.

Implementation methods

A COVID-19 model, which included national and community spread information, was produced to assist in a ramp up plan to bring elective surgeries and procedures back up while also accommodating the prediction of COVID-19 cases through the end of year. The COVID-19 model subsequently led to a Bed Census Model which took the COVID-19 model along with other hospital inputs (Emergency Department arrivals and admits, Surgical and Procedural Schedules, Appointment and Hospital to Hospital conversion rates) to assist in predicting capacity needs.

Utilizing a multidisciplinary teamwork approach, the two models were developed in partnership between highly technical teams and the operational consumers of the models. The technical teams managed the model build and evolution under an Agile framework. Technical team members included a data scientist, data engineers, and business intelligence experts to visualize the outputs of the model. Implementation of the model into daily huddles and its use in hospital bed capacity decision making was managed by operational leaders through an iterative process. Short PDSA cycles were utilized to evaluate success, provide awareness and ensure safe patient care during higher occupancy rates. These two models initially assisted in managing 1,053 adult acute beds within a two-hospital service area. Later iterations of the models expanded to include 94 pediatric beds, 73 behavioral health beds and integration of 19 other locations within the hospital system.

Results (e.g., cost savings, increased productivity, improved quality of care)

The model served as a call to action, highlighting the need to intervene and avoid the predicted outcome. Proactive decisions were made for bed capacity management utilizing prospective data allowing for appropriate capacity to be made available (right type of bed at the right time). This included both the unpredictable COVID-19 volumes as well as the planned increase in elective surgical scheduling. As a result, hospital leaders were able to effectively manage the re-establishment of elective surgical case volume to a level near pre-pandemic case volumes while facilitating care for the fluctuating COVID-19 population. COVID-19 census varied between 0.11% and 14.09% in 2020 and between 0.27% and 10.37% in 2021.

Lessons Learned

Modeling is an iterative process and facilitating successful iteration is key. Regular touchpoints that allow for review by team members with diverse perspectives adds tremendous value. Robust performance evaluation is one way to increase stakeholder buy-in, particularly for those relying on but not helping to manage the model. Mean Absolute Deviation was chosen as the key performance metric for its explainability and meaningfulness to the practice. Its interpretation can be stated as “on average how many beds is the model projection away from actual.” Adaptability is a must in a new modeling effort to improve upon the inevitable inaccuracies that arise from unexpected changes in a system.

Contact: Lehman.Lindsey@mayo.edu