# Predicting Behavioral Emergencies in the Hospital

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## Background

Nearly half of all hospitalized patients in U.S. have comorbid psychiatric disorders[1]. Behavioral health crises are implicated in a vast majority of patient-perpetrated assaults and physical threats[2]. However, the current practice for patients experiencing a behavioral emergency is reactive, rather than proactive, and focuses more so on containing the patient and suppressing violence rather than improving treatment and outcomes. Containment-focused responses to behavioral emergencies use chemical sedation and physical restraints, which contribute to longer length of stay as well as increased rates of injury and nosocomial infections for patients[3]. There is a call to health systems to progress the standard of care for behavioral emergencies through the formation of trained behavioral emergency response teams (BERTs)[4]. Duke University's Departments of Medicine and Psychiatry, along with the Duke Institute for Health Innovation (DIHI), formed a transdisciplinary team to develop a machine learning model for the real-time detection of behavioral emergencies using electronic health record (EHR) data. Our goal is to support an established Behavioral Emergency Response Team's proactive monitoring of and intervention on patients' psychiatric destabilizations to improve care for patients and safety for clinicians.

## Methods

We used data collected from 310873 inpatient encounters for 179416 unique adult patients at three Duke University Health System (DUHS) hospitals from 1/1/2017 to 12/31/2021. We excluded patients who were less than 18 years old at time of admission. A behavioral emergency outcome was defined as the occurrence of any of three interventions during the encounter while the patient was on an intermediate or stepdown unit (excluding emergency and perioperative units): a violent restraint order placed, a medical hold order placed, or a non-violent restraint order placed plus the ordering or administration of an antipsychotic medication. The outcome was compared to a limited data set of ground truth clinical note documentation of a behavioral emergency or consultation, or dual physician adjudication. The machine learning model was designed to predict the first occurrence of a behavioral emergency up to 12 hours prior to the event. Model inputs included historical event data as well as 31 temporal data inputs related to patient assessment scores, ordering and administration of medications, and toxicology screening labs. The model was trained using light gradient boosting machine (lgbm) with 70% of the data used for training, and 15% each for validation and testing. We are evaluating the model performance based on sensitivity, specificity, positive predictive value (PPV), area under the curve (AUC) of the receiver operating characteristic (ROC) curve.

## Results and conclusion

Of the 310873 encounters for 179416 patients, 5261 encounters (1.69%) for 4759 patients (2.65%) met the behavioral emergency outcome definition during the encounter. A May-November 2022 comparison of the behavioral emergency outcome (n=203) with behavioral emergency clinical note documentation (n=506) and dual physician adjudication (n=31) yielded precision of 90% and sensitivity of 36% for the behavioral emergency outcome. Model results are pending. The clinical workflow applies the real-time behavioral emergency outcome, the predictive model, and secure paging technology to alert the BERT nurse, prompting a chart review and bedside assessment as needed to identify and intervene on imminent behavioral emergencies. The behavioral emergency outcome label is currently set up to run in real-time, with a bed view visualization tool and event paging system in place. Our next steps are to complete training and evaluation of the model, and integrate it into the BERT team workflow. We aim to evaluate the solution's potential to decrease use of violent restraints, antipsychotic medications, physician hold and suicide precautions, length of stay, and incidence of patient violence.

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