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TOWARDS A HYBRID DISCRETE EVENT SIMULATION AGENT-BASED MODEL FOR THE TEXAS STATE MENTAL HOSPITAL SYSTEM

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ABSTRACT

State mental health hospitals provide a vital service to individuals who pose a threat to themselves or others. However, in recent years, these facilities have struggled to meet demand, resulting in a waitlist of over one thousand patients. Despite legislative efforts to address this issue, waitlist lengths persist and continue to grow. This study employs a hybrid discrete event simulation agent-based model (DES-ABM), trained on publicly available aggregate data, to model waitlists for state mental health hospitals in Texas. Once trained, the model enables projections of the impact of various policy interventions and resource allocation strategies on the waitlist. The model successfully approximated waitlist lengths from 2020-2022, and we tested two interventions involving the expansion of available beds, recording their effects on the waitlists.

1 INTRODUCTION

The state mental hospitals of Texas play a critical role in both the public health and criminal justice systems. These hospitals treat two primary populations: forensic patients, who are defendants charged with a crime but found incompetent to stand trial or individuals who have been found not guilty by reason of insanity; and civil admits, who have not been charged with a crime but may be seeking mental health services on their own or due to a court order.

In recent years, staffing issues have led to beds being taken offline. An increase in long-term stay patients and a growing demand from the forensic system have, in turn, contributed to an expanding waitlist that patients must navigate before accessing services. For forensic patients found incompetent to stand trial, this means they often wait in county jails where their condition may deteriorate further. For civil patients, long wait times without sufficient mental health care may lead to escalation of symptoms.

This work aims to address the waitlist crisis in the state mental healthcare system by (1) building an hybrid DES-ABM model of the system and training it with real data to ensure it is reasonably representative of reality; and (2) using the model to test the effects of capacity expansion on the waitlists.

2 METHODS

A DES-ABM model is constructed in which patients and treatment centers are treated as agents. The state forensic mental health system has two waitlists: one for maximum security patients, another for standard forensic admits who may be housed with civil admits. To simplify the model, we focus on standard forensic admits and civil admits only, excluding maximum security waitlists or beds. Geography is also not considered in the model, and patients are placed on the waitlist for the treatment center with the shortest expected wait at the time. Data available to train the model is limited to publicly available aggregate counts, including partial quarterly data on number of patients added to, removed from, and on the waitlist from 2020-2022. Additionally, the proportion of civil and forensic admits is available, although standard and

maximum security forensic patients are not distinguished. The total number of beds and online number of beds per facility was reported in June 2022, but is it not clear when the measurements were taken or what the breakdown is for standard versus maximum security beds. The average length of stay (LOS) for civil and long-term forensic patients is roughly known, but the average LOS for short-term standard security forensic patients is unclear due to aggregate reporting with maximum security patients. Timesteps in the model represent 5 days of real time and a simple multilayer perceptron is used to impute the number of patients admitted to the waitlist at each timestep based on the reported quarterly data. Approximate Bayesian computation (ABC) is employed to tune the LOS parameters, which are assumed to follow three distinct normal distributions for civil, short-term forensic, and long-term forensic admits. Since mean LOS is roughly known for civil and long-term forensic admits, the ABC searches for the mean LOS of short-term forensic admits and the variances for each distribution. Success in training the model is ascertained by comparing the waitlist lengths in the model with the actual waitlist times reported from 2020-2022.

3 RESULTS

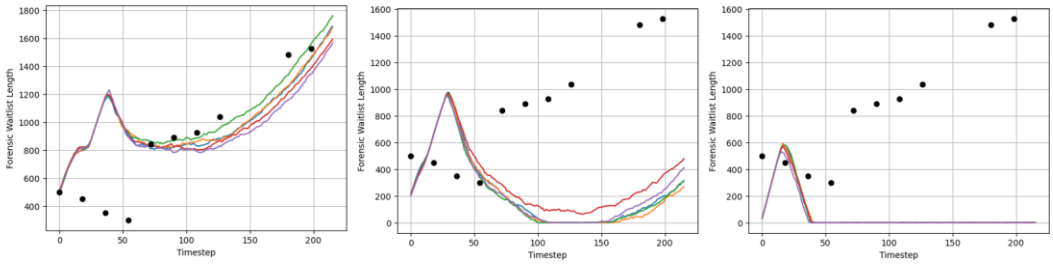

Figure 1: The forensic waitlist lengths for 5 runs of the tuned model are shown under 3 scenarios: (left) online number of beds per facility is as reported in June, 2022; (middle) each facility uses 80% of their total beds or the percentage reported in June, 2022, whichever is higher; (3) each facility uses all available beds.

After the ABC procedure, the mean LOS for short-term patients was determined to be 30.1 timesteps and the variances for civil, short-term forensic, and long-term forensic patients were found to be 11.3, 16.4, and 10.5 timesteps respectively. Figure 1 shows the effects of increasing the available beds on the waitlist.

4 CONCLUSION

As Texas grapples with inflated wait times, DES-ABM modeling, in collaboration with legal and psychiatric experts, provides an avenue to predict demand on the state mental health system and test the effect of resource allocation strategies on simulated waitlists.

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