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EVALUATING THE IMPACT OF PSYCHIATRIC EMERGENCY UNITS ON PEDIATRIC MENTAL AND BEHAVIORAL HEALTH OUTCOMES

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ABSTRACT

The increasing prevalence of pediatric mental and behavioral health (MBH) conditions has driven a rise in emergency department (ED) visits, often worsening crowding and straining resources. Psychiatric Emergency Units (PEUs) have emerged as a potential solution to address these challenges by diverting medically stable MBH patients into a calm, specialized setting. We developed a discrete-event simulation of a pediatric ED setting in South Carolina to evaluate the impact of implementing a PEU. Times across various patient journey segments and resource utilization were assessed under varying patient arrival rates and unit capacities. Results showed a shorter length of stay, faster time to disposition and psychiatric evaluation times, and improved room and hallway bed utilization. These findings suggest that PEUs can help hospitals manage increasing MBH volumes more effectively, mitigate system overload, and enhance the quality of pediatric MBH care.

1 INTRODUCTION

In the United States, the rise in mental and behavioral health (MBH) conditions among children has become a public health concern, leading to a growing number of Emergency Department (ED) visits (Tkacz and Brady 2021; Radhakrishnan et al. 2023). The past decade has seen a significant increase in the number of patients presenting with psychiatric diagnoses, with an estimated prevalence of 10.9% in 2017 rising to 21.9% in 2020 (Theriault et al. 2020). Between 2011 and 2020, the proportion of pediatric ED visits related to mental health increased from 7.7% of all pediatric visits to 13.1%, with an alarming 5-fold rise in visits for suicide-related symptoms (Bommersbach et al. 2023). This trend has been further exacerbated by the COVID-19 pandemic, with reports indicating a 24% and 31% increase in mental health-related ED visits for children aged 5-11 and 12-17 years old, respectively, compared to pre-pandemic levels (Leeb et al. 2020).

While ED settings are well-equipped to handle medical emergencies, many of them, particularly those in rural areas, are poorly designed to address the needs of MBH patients (Hoge et al. 2022; Saidinejad et al. 2023). The environment within a standard ED can be chaotic and stressful, potentially exacerbating the distress of individuals in a mental health crisis. Children and their families not only encounter inadequate and inequitable mental health care but also often experience prolonged length of stay (LOS) and excessive boarding times in ED hallways (Nash et al. 2021; O'Donnell et al. 2020). A study by Case et al. (2011) found that MBH visits in pediatric EDs have a median length of stay of 169 minutes, significantly longer than the 108 minutes for other visits. Recent evidence highlights that the increasing volume of pediatric MBH is associated with increased ED crowding, reduced throughput, and compromised care quality for both psychiatric and non-psychiatric patients, particularly due to prolonged boarding times (Hudgins et al. 2025; Hoffmann 2025). Additionally, ED staff are exposed to workplace violence when patients, especially

MBH patients who might pose risks to themselves and others, experience lengthy stays in the ED (Lee et al. 2023).

To address these challenges, implementing system-level interventions to improve the quality of MBH visits for both patients and staff is essential. Multiple studies have investigated the benefits of psychiatric emergency models to offer safer and more appropriate environments for MBH patients (Anderson et al. 2022; Kalb et al. 2022). Hasken et al. (2022) demonstrated that opening an on-site pediatric inpatient psychiatric unit reduced ED boarding times and LOS, while Zeller et al. (2014) reported similar improvements after launching regional dedicated psychiatric emergency services. Psychiatric Assessment, Treatment, and Healing (Kim et al. 2022), Crisis Stabilization Units (Barocas et al. 2022), and Psychiatric Observation Unit (Parwani et al. 2018) are examples of such psychiatric emergency models. In this study, PEUs are defined as specialized hospital-based units dedicated to care for mental and behavioral health patients who have stable medical situation. Unlike conventional ED settings, these units provide a dedicated, calming space for psychiatric stabilization, allowing patients to receive timely, specialized care without the need for inpatient admission. Key characteristics facilitate this goal, including rapid evaluation and treatment planning by multidisciplinary teams, continuous observation, and a safe environment for MBH patients.

To model ED workflows and evaluate intervention effects before real-world implementation, researchers have increasingly applied discrete-event simulation (DES). Doudareva and Carter (2022) emphasize DES's critical role in emergency department modeling, particularly in validating patient flow and evaluating resource planning strategies. Baia Medeiros et al. (2019) applied DES to support capacity planning for mental health and addiction (MHA) services in EDs, accounting for forecasted increases in demand and assessing the impact of resource adjustments. Adeyemi et al. (2023) developed a DES model to represent regional psychiatric patient flow, evaluating system-level interventions aimed at reducing treatment delays and ED boarding times. In the outpatient setting, Howells et al. (2022) modeled adult psychology services using DES to identify staffing-related bottlenecks and explore the effects of introducing dedicated care coordination roles. Cerdá et al. (2021), in a systematic review, examined simulation models used to address the opioid crisis, highlighting the importance of model calibration, validation, and transparency. Mistarihi et al. (2023) integrated DES with the Six Sigma DMAIC framework to improve pediatric ED efficiency, demonstrating significant reductions in patient waiting times and process cycle time.

Given the growing demand for MBH patient care and the potential benefits of PEUs, limited research has assessed the impact of PEUs on pediatric MBH patient outcomes and ED operations using simulation modeling. This study aims to fill this gap by applying discrete-event simulation modeling to evaluate the effectiveness of a PEU in improving key ED performance metrics related to time across different segments of the patient journey, resource utilization, and crowding under varying patient arrival rates and unit capacities.

2 DATA COLLECTION

2.1 Study Setting

This study focuses on a large urban pediatric emergency department in South Carolina. The physical layout includes 11 general treatment rooms, 6 hallway beds used for overflow or boarding, 5 fast-track beds for low-acuity patients, and 2 ligature-minimized MBH rooms shared with adult patients. All pediatric patients, regardless of condition, enter through a shared waiting area. The ED operates with a multidisciplinary team. Emergency physicians work in four staggered shifts to provide 24/7 coverage, supported by a core team of six nurses, including a dedicated triage nurse. Psychiatrists are available on-call from 8:00 a.m. to 8:00 p.m., and social workers provide extended coverage, with two counselors available from 7:00 a.m. to 10:00 p.m. and one counselor available overnight.

2.2 Dataset Description

This study was approved by the Institutional Review Board. The research team utilized the dataset from electronic medical record (EMR) data from 11 emergency departments, focusing only on pediatric (under 17 years old) visits between October 2017 and March 2023. The dataset includes 387,842 pediatric encounters from 190,249 unique pediatric patients. To identify MBH-related visits, the research team collaborated with clinicians to review and validate relevant ICD-10 (International Classification of Diseases, Tenth Revision) codes, ultimately identifying 394 unique codes associated with MBH conditions. Using this binary classification, a total of 19,870 MBH-related visits, which accounts for approximately 5.1% of all pediatric ED encounters, were flagged as MBH-related visits. For the development of the simulation model, however, only data collected between February 2021 and March 2023 from the emergency department described in section 2.1 was used. In 2022, the ED setting recorded 34,748 pediatric visits, including 1,119 related to MBH conditions.

2.3 MBH Patient Flow

The patient flow for pediatric mental and behavioral health patients in the emergency department follows a multi-stage process influenced by the mode of arrival and clinical urgency (Soman et al. 2025):

1. Arrival into the ED: EMS patients typically arrive through the ambulance bay and are directed straight to a treatment room by nurses stationed at the triage area. In contrast, walk-in patients enter through the main entrance and register at the front desk before undergoing triage and room assignment. Due to the lack of a dedicated pediatric MBH unit, patients may be placed in pediatric ED rooms, hallway beds, or two ligature-minimized MBH rooms shared with adults.

2. Medical and psychological evaluations: Once in the ED, patients are first assessed by a charge nurse who reviews the triage notes and gathers additional clinical details. The next step is the provider evaluation, where ED physicians determine whether to initiate medical treatment, request a behavioral health consultation, or proceed with disposition planning. Social workers or intake coordinators are engaged for MBH assessments and to help plan appropriate outpatient referrals or admissions. For safety, high-risk patients often undergo precautionary measures such as being changed into hospital scrubs, having belongings removed, and receiving one-on-one observation.

3. Disposition and treatment plan: For an MBH patient that is medically cleared by a physician, either the ED attending or psychiatrist always make the disposition decision. While dispositioning patients, providers determine whether the patient should be discharged with a resource plan for outpatient MBH care, admitted into the hospital for further medical treatment, or transferred to a psychiatric facility for inpatient care.

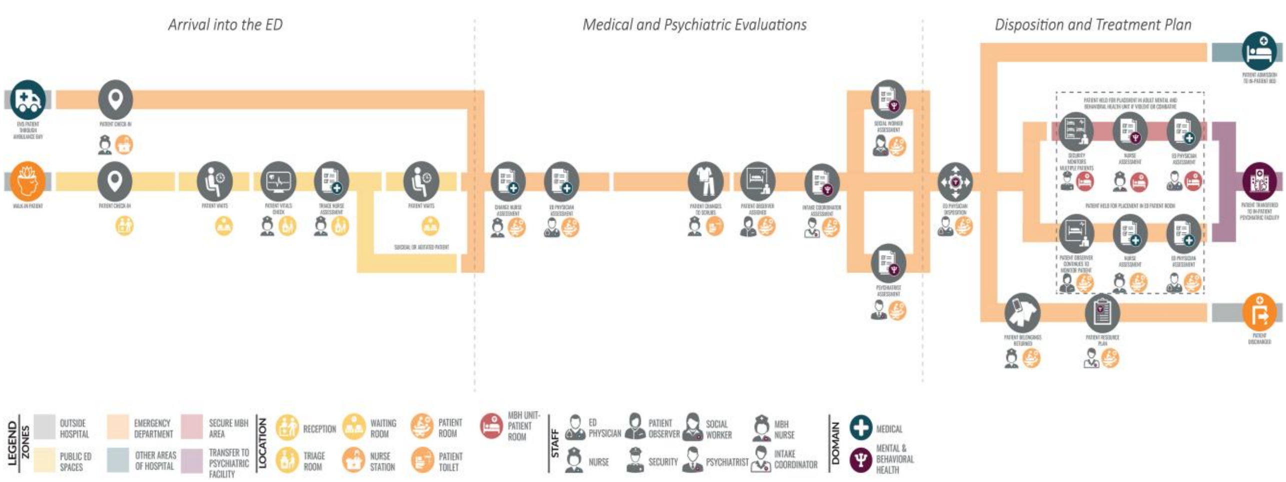

Figure 1. Pediatric patient journey map in the ED (Soman et al. 2025).

2.4 Pediatric Visit Characteristics

The arrival rate for walk-in pediatric patients (Figure 2) shows a steady increase beginning around 7 a.m., peaking between 6 p.m. and 8 p.m., and then declining during late-night hours. EMS arrivals remain relatively low and stable throughout the day, with a slight increase in the late afternoon and early evening. The total average arrival rate peaks around 8 p.m. with nearly six patients per hour.

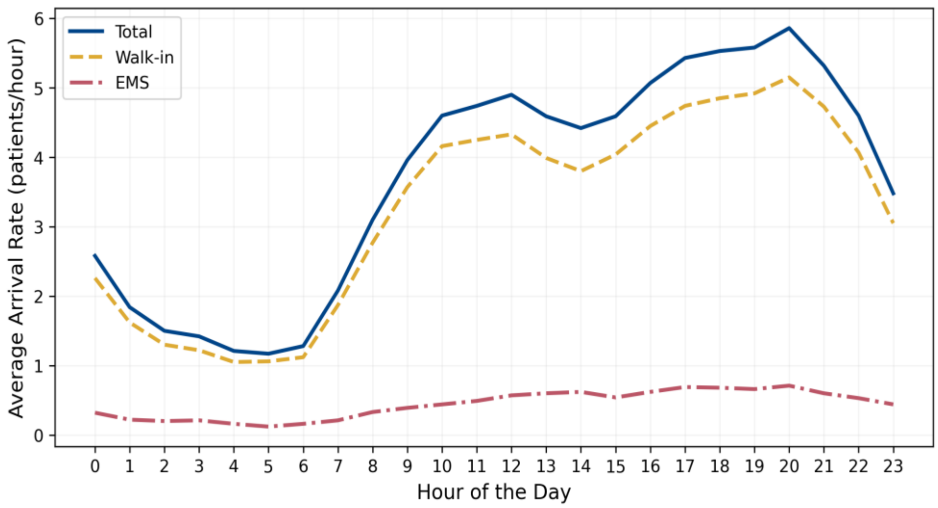

Figure 2. Average hourly arrival pattern of pediatric patient by arrival mode.

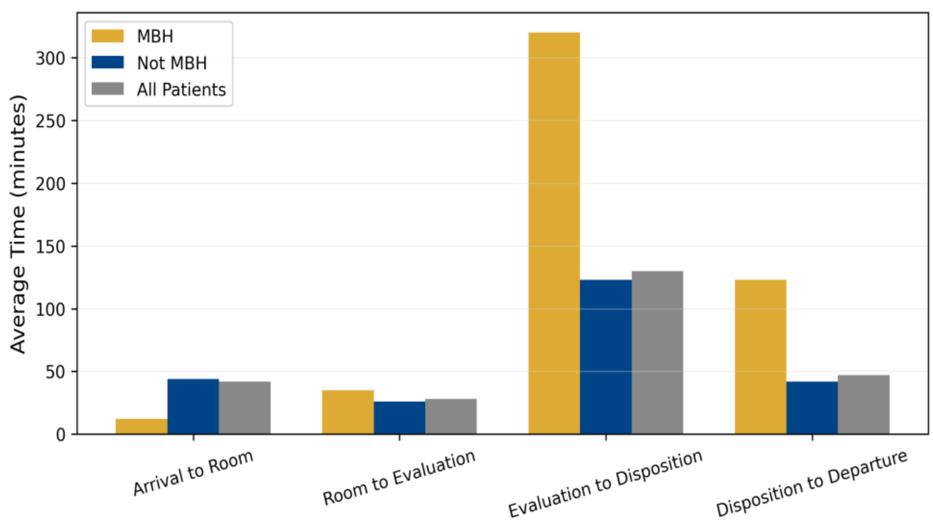

Figure 3. Patient journey time segments of pediatric patients.

Figure 3 illustrates the average time (in minutes) spent in each stage of the ED care process for pediatric patients presenting with MBH conditions, compared to non-MBH and the combined patient population. As shown, MBH patients experience significantly longer stays during the "Evaluation to Disposition" and "Disposition to Departure" phases, with averages of 320 and 123 minutes, respectively. These extended durations are largely attributed to the complexity of psychiatric evaluations and the subsequent challenges in securing appropriate disposition pathways due to limited psychiatric bed availability, delays in coordination with outside facilities, and the involvement of external agencies like social services.

2.5 Service Durations

To support model input assumptions, a survey was conducted to estimate the time spent by different provider types (including physicians, nurses, psychiatrists, and social workers) during patient assessments. These estimates were used to inform service time distributions within the simulation model. The Arena Input Analyzer was used to fit appropriate probability distributions to the collected estimates. Table 1 summarizes the key task durations per patient and the corresponding fitted distribution used in the model. It is important to note that these values were not obtained through direct time-motion studies but are based on providers' best approximations from their clinical experience, which provided a baseline for testing and refining simulation logic.

Table 1. Service durations per patient.

Task	Condition	Distribution
Physician or resident Assessment	Primary	Triangular (4.5, 20, 30.5)
	Primary in Fast Track	Triangular (5, 10, 15)
	Follow-up	Triangular (5, 10, 12)
Psychiatrist Assessment	Primary	Triangular (30, 45, 60)
	Follow-up	Triangular (5, 10, 15)
Triage by ED Nurse	Walk-in Patients	Triangular (5, 10, 15)
	EMS Patients	Triangular (1, 5, 10)
Social Worker Assessment	Primary	Triangular (9.5, 30, 60.5)
Lab Tests, Imaging or Consultation Delay	ESI 1	Triangular (5, 10, 15)
	ESI 2	Triangular (10, 15, 20)
	ESI 3	Triangular (25, 30, 35)
ED Room Sweep for MBH with no Medical Need	Medically Stable	Triangular (5, 10, 15)
Room/Hallway Bed Prep after Patient Leaves	Last Patient = MBH	Triangular (5, 10, 15)
	Last Patient = not-MBH	Triangular (1, 5, 9)
	Hallway Bed	Triangular (1, 2, 3)

2.6 Psychiatric Emergency Unit Patient Flow

PEU unit patient flow differs from standard ED processes. Patients typically go to the PEU after an initial presentation at the emergency department and after medical clearance. Here's a more detailed breakdown of the workflow (Kim et al. 2022b; Garces et al. 2025):

1. Initial Presentation at the ED: Individuals experiencing a mental health crisis first arrive at the general emergency department. This can occur through self-referral, law enforcement, emergency medical services, or transfers from other facilities.
2. Triage in the ED: Upon arrival, patients go through an initial triage to determine the appropriate level of care. This initial assessment helps identify individuals who may benefit from the specialized services of the PEU.
3. Medical Clearance: Before being transferred to the PEU unit, patients typically undergo a medical evaluation in the main ED to ensure they are medically stable. This step ensures that any immediate medical needs are addressed before focusing on their behavioral health crisis.
4. Transfer to the PEU: Once medically cleared, patients experiencing a mental health crisis are then transitioned or transferred to the PEU.

3 SIMULATION MODEL DEVELOPMENT

By integrating the gathered data, we developed a DES model using Arena Simulation Software (Version 16.20.00) to evaluate pediatric MBH patient flow in the emergency department. This modeling environment enables the testing of system-level interventions and their potential to improve patient outcomes, resource utilization, and operational efficiency. To ensure model tractability and reflect practical limitations, we applied the following assumptions based on operational observations and expert input:

1. Residents, patient observers, receptionists, and security staff were excluded from the model scope.
2. Reception staff can find patients after they are placed in a room, so patients don't wait for reception and registration.
3. Room assignment and assessment order were assumed independent of ESI for ESI 1–3 patients.
4. ESI 4-5 patients typically follow a provider-in-triage (usually seen by a resident) pathway and are often discharged before assigning to main ED rooms. Approximately 20% are reclassified as ESI 3 and routed to the main ED.
5. Patients assigned to hallway beds remain there for the duration of their stay.
6. Service times for all modeled processes were derived from clinician-reported estimates or the teams' assumptions.

3.1 Model setup

The simulation model was executed for 60 days per replication, with a 200-hour warm-up period to eliminate initialization bias resulting from an initially empty system. A total of 50 replications were conducted to account for system variability and ensure statistical confidence in outcome measures. These parameters were selected to balance computational efficiency with sufficient observation of system dynamics.

3.2 Model Calibration and Validation

Model calibration involved iterative adjustment of input parameters, including task durations, routing logic, and decision ratios. Input estimates were derived from a combination of EMR data, direct observations, clinician feedback, and where necessary, assumptions made by the modeling team. To ensure the model's credibility, a validation process was performed by comparing simulated outputs with historical data extracted from electronic medical records. Due to limitations in data granularity, particularly the lack of precise timestamps for every process segment, validation focused on key performance metrics, specifically length of stay (LOS) and time to disposition (TTD) across patient subgroups. Table 2 presents the average (mean) values from the simulation's base scenario alongside corresponding historical averages.

Table 2. Numerical validation of simulation output.

Performance Metric	Historical Mean (hours)	Simulated Mean (hours)
LOS All Patients	4.00	4.09
LOS EMS Patients	4.81	4.64
LOS Walkin Patients	3.89	4.02
LOS MBH Patients	7.62	7.61
LOS not MBH Patients	3.87	3.97
TTD All Patients	3.35	3.39
TTD MBH Patients	5.67	5.45
TTD not MBH Patients	3.26	3.27

The close alignment in mean values across most patient categories suggests that the model reliably reflects real-world system behavior. The small differences observed between the simulated mean and historical values are expected due to random variation in simulation runs and assumptions made during model design.

3.3 Scenarios and Key Changes

To evaluate the potential impact of implementing a PEU on pediatric MBH care, two sets of intervention scenarios were developed. Each scenario group explores a different operational question related to their effectiveness, patient flow, and future capacity planning. The simulation model replicates patient journeys under each intervention, and performance outcomes are compared using key indicators such as length of stay (LOS), time to disposition (TTD), time to psychiatric evaluation, ED room utilization, and hallway bed occupancy. A full summary of all 50 simulation runs is presented in Appendix A. The simulation model incorporates several changes in ED workflow following PEU implementation:

1. Shift in MBH patient distribution: A portion of medically stable MBH patients is redirected from the ED to the PEU.
2. Elimination of ED room sweeping: Since medically stable MBH patients transferred to the PEU, there is no need to perform ED room sweeping.
3. Reduced room preparation times: The time required for room preparation after MBH patient discharge is reduced.
4. Reallocation of MBH rooms: The proportion of MBH patients placed in ligature-minimized rooms decreases from 10% to 0%, since all medically stable patients go to PEU. MBH rooms are ligature-safe rooms and contain little or no fixed medical equipment. If the patient still needs active medical care the workflow keeps them in a standard ED room or hallway bed until they are stable and the medical issues are addressed, then they can be transferred to the MBH area.

3.3.1 Scenario Group 1: PEU Admission Criteria

This scenario group explores the effect of varying patient eligibility thresholds for PEU transfer by adjusting the proportion of MBH patients routed to the unit. This scenario group helps identify optimal patient selection strategies for PEU utilization. It compares baseline operations to interventions where 15%, 35%, 55%, and 75% of MBH patients are considered as medically cleared and transferred to a PEU.

3.3.2 Scenario Group 2: Increased All Patient Volume

To assess the ED's resilience under rising demand, this group of scenarios simulates increasing patient arrival volumes by 10% to 50%. For each volume level, comparisons are made between models with and without PEU integration.

4 RESULTS AND DISCUSSION

To assess the effect of PEU implementation, simulation outputs from 50 replications were evaluated across multiple scenarios. The model's results were analyzed using key performance indicators, including average Length of Stay (LOS), Time to Disposition (TTD), ED room utilization, hallway bed use, and psychiatric evaluation time. Graphs include 95% confidence intervals using half-width values.

4.1 Results

Across the two metrics, LOS and Time to Psychiatric Evaluation, a noticeable improvement occurs between ED with no PEU and an ED with 15% PEU admission rates. This initial drop reflects the structural changes in workflow and patient management described in Section 3.3. However, from 15% to 75%, the patterns differ based on volume levels. For lower volume increases (0%, 10%, 20%), the curves tend to level off, especially for LOS. This is likely because MBH patients make up only 5.1% of all ED patients. Therefore, even at 75% PEU utilization, the absolute number of routed patients remains small. In contrast, for higher volume increases (30%, 40%, 50%), all three metrics consistently decline as PEU utilization rises. This suggests that under conditions of ED crowding, even marginal reductions in resource usage from high resource utilizer MBH patients can significantly improve overall throughput and resource availability. The steeper declines observed for Time to Psychiatric Evaluation reflect the simulation model assumption that

PEU bypasses room assignment and physician evaluation, accelerating access to psychiatric consultation more than it reduces LOS.

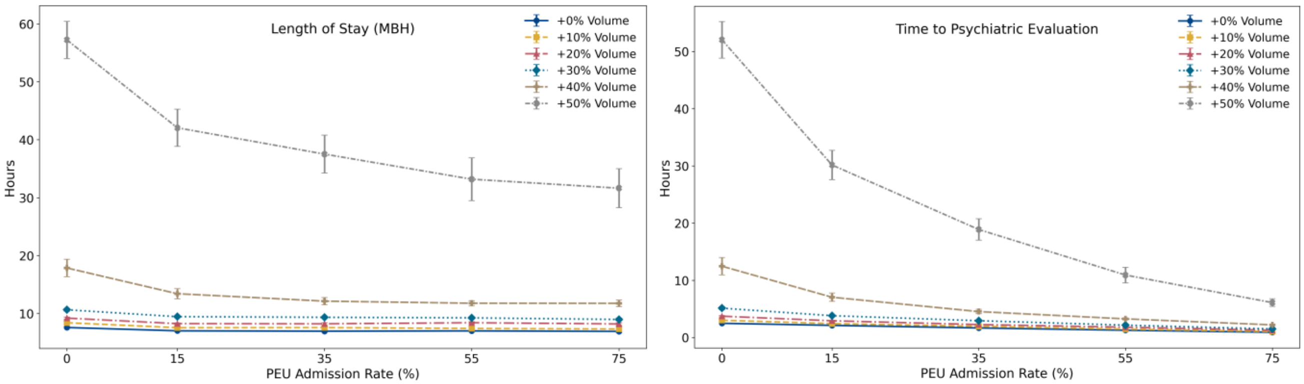

Figure 4. Effect of PEU admission rate and ED volume increase on MBH patients.

Figure 5 illustrates the impact of a 35% PEU admission rate on key performance metrics across increasing ED volume scenarios. In all metrics, the baseline (solid lines) demonstrates significantly sharper rises beyond the 30% volume increase threshold, suggesting system strain. In contrast, the 35% PEU scenarios (dashed lines) show slower growth, indicating improved system resilience. This improvement is achieved by directing only a small number of patients (less than 2% of all patients), suggesting that pediatric MBH patients are high resource utilizers in the ED.

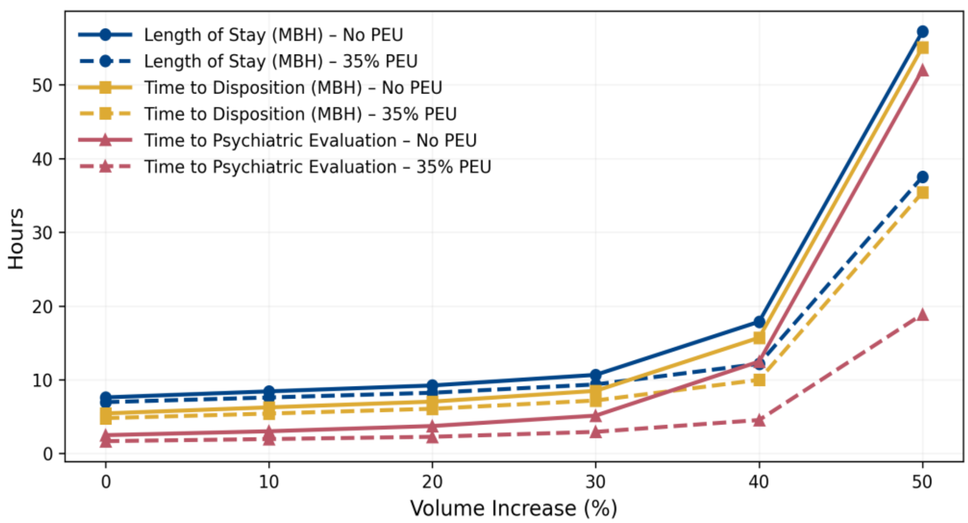

Figure 5. ED performance under volume increase (with and without 35% PEU implementation).

Figure 6 illustrates the relationship between increasing patient volumes and average rate of rooms (at the top) and hallway beds (at the bottom) utilization, under varying PEU admission rates. As overall ED volume increases from 0% to 50%, both room and hallway bed utilization rise across all scenarios. However, higher PEU admission rates are associated with consistently lower utilization levels. As volume increases to 30% and beyond, differences in utilization become more pronounced. These trends suggest that even though MBH patients make up a small percentage of total ED visits, they contribute significantly to space usage due to their longer length of stay and higher resource needs. Redirecting a larger proportion of medically stable MBH patients to a dedicated PEU offloads pressure from the main ED, frees up rooms and reduces hallway bed needs.

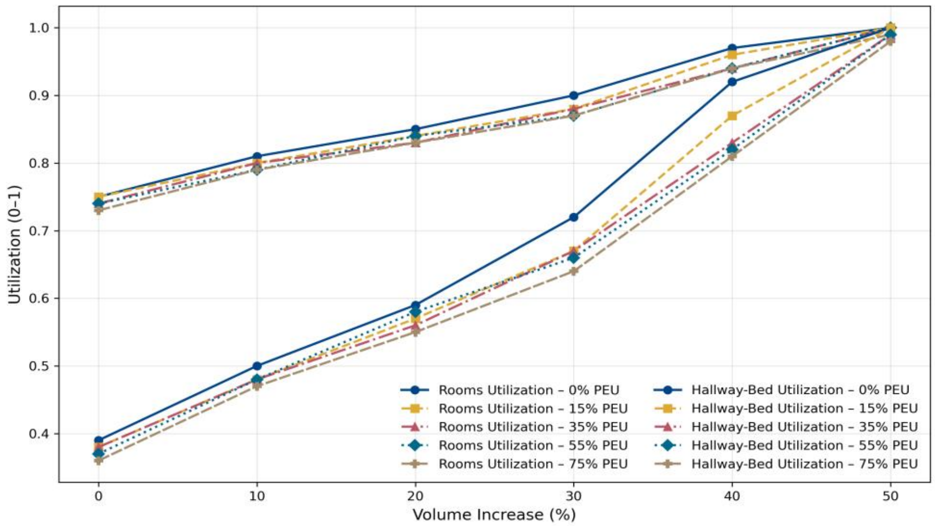

Figure 6. ED room & hallway bed utilization across different PEU admission rates and volume.

4.2 Limitations

Although PEUs can remarkably improve MBH patients' safety and care quality, several practical constraints may hinder their adoption. These include potential constraints in workflow changes, dedicated physical space, and the availability of qualified providers. Ensuring patient and staff safety and overcoming cultural resistance to deviating from traditional care models can also be challenging. Integration with other mental health services and community-based resources is a vital aspect of the PEU model. Finally, cost-effectiveness in the short term is an additional concern. Recent studies indicate that the revenue generated by PEUs does not cover the costs of establishing and operating these units in the short term. Stamy et al. (2021) estimated an increase of approximately $0.86 million in annual ED revenue against about $4 million in combined first year costs ($1.38 planning and construction costs plus $2.63 operating costs) following EmPATH unit implementation. A regional Crisis Stabilization Unit study reported total annual costs of $1.64 million without accompanying revenue streams large enough to offset these expenses (Barocas et al. 2022). An evaluation of psychiatric decision units across four mental health National Health Service trusts in England similarly concluded that any cost savings were marginal and do not offset the cost of units especially within the first two years of operation (Gillard et al. 2023).

5 CONCLUSION

This study demonstrates the potential of PEUs to improve care delivery for pediatric MBH patients in ED settings. Using discrete-event simulation, we evaluated the impact of PEU implementation on key performance metrics, including length of stay, time to disposition, psychiatric evaluation times, and resource utilization. The results show that redirecting medically stable MBH patients to a PEU can significantly reduce delays and alleviate ED congestion, especially under higher patient volume scenarios. While the absolute number of MBH patients is relatively small, their disproportionately high resource usage makes PEUs a highly effective intervention to improve system throughput and efficiency.

Future work could explore several extensions to enhance the applicability of the PEU model. These include simulating patient pathways beyond ED discharge, analyzing staffing levels and bed capacity in both the ED and PEU, expanding the set of performance metrics, and assessing sensitivity to key input assumptions such as workflow logic. Additionally, incorporating psychiatric bed availability across regional facilities, evaluating the economic impact of PEUs, as well as their influence on clinical outcomes and staff well-being presents an important avenue for future research.

APPENDIX A

Table 3. Summary of simulation results.

Scenario	Title	LOS All	Half width	LOS MBH	Half width	LOS not-MBH	Half width	TTD All	Half width	TTD MBH	Half width	TTD not-MBH	Half width	TTPsych eval.	Half width	Rooms utilization	Hallway bed utilization
S0	Baseline (Current ED)	4.09	0.05	7.60	0.13	3.97	0.05	3.38	0.08	5.43	0.13	3.27	0.08	2.48	0.06	75%	39%
S1	+0% Volume, 15% PEU	4.03	0.05	7.03	0.13	3.94	0.05	3.31	0.08	4.86	0.13	3.23	0.08	2.12	0.05	75%	38%
S2	+0% Volume, 35% PEU (suggested based on data)	4.00	0.05	6.96	0.15	3.94	0.05	3.25	0.08	4.79	0.15	3.19	0.08	1.67	0.05	74%	38%
S3	+0% Volume, 55% PEU	3.97	0.06	7.02	0.17	3.93	0.06	3.21	0.10	4.85	0.17	3.17	0.1	1.27	0.03	74%	37%
S4	+0% Volume, 75% PEU	3.92	0.06	6.93	0.23	3.90	0.06	3.14	0.09	4.75	0.23	3.12	0.09	0.91	0.02	73%	36%
S5	+10% Volume, 0% PEU	4.52	0.08	8.42	0.15	4.39	0.08	4.02	0.12	6.25	0.15	3.90	0.12	3.01	0.10	81%	50%
S6	+10% Volume, 15% PEU	4.40	0.06	7.57	0.12	4.31	0.06	3.84	0.09	5.40	0.12	3.77	0.09	2.43	0.06	80%	48%
S7	+10% Volume, 35% PEU	4.40	0.07	7.59	0.16	4.32	0.07	3.83	0.10	5.41	0.15	3.78	0.10	1.95	0.06	80%	48%
S8	+10% Volume, 55% PEU	4.37	0.07	7.44	0.16	4.31	0.07	3.79	0.11	5.26	0.16	3.75	0.11	1.46	0.04	79%	48%
S9	+10% Volume, 75% PEU	4.29	0.07	7.35	0.19	4.26	0.07	3.68	0.10	5.16	0.19	3.66	0.10	1.04	0.03	79%	47%
S10	+20% Volume, 0% PEU	5.12	0.09	9.22	0.17	4.98	0.08	4.89	0.13	7.03	0.17	4.78	0.13	3.72	0.12	85%	59%
S11	+20% Volume, 15% PEU	4.90	0.08	8.26	0.13	4.80	0.08	4.57	0.12	6.09	0.13	4.50	0.12	2.92	0.09	84%	57%
S12	+20% Volume, 35% PEU	4.85	0.08	8.23	0.18	4.77	0.08	4.50	0.12	6.06	0.17	4.45	0.12	2.26	0.07	83%	56%
S13	+20% Volume, 55% PEU	4.91	0.06	8.42	0.20	4.86	0.06	4.60	0.09	6.24	0.19	4.56	0.09	1.80	0.04	84%	58%
S14	+20% Volume, 75% PEU	4.81	0.07	8.21	0.22	4.78	0.07	4.44	0.10	6.04	0.21	4.42	0.10	1.26	0.04	83%	55%
S15	+30% Volume, 0% PEU	6.16	0.16	10.66	0.23	6.01	0.16	6.44	0.24	8.49	0.23	6.33	0.24	5.13	0.23	90%	72%
S16	+30% Volume, 15% PEU	5.69	0.09	9.47	0.17	5.58	0.09	5.75	0.14	7.30	0.16	5.67	0.14	3.81	0.11	88%	67%
S17	+30% Volume, 35% PEU	5.69	0.09	9.36	0.15	5.61	0.09	5.73	0.13	7.18	0.15	5.68	0.13	2.93	0.09	88%	67%
S18	+30% Volume, 55% PEU	5.60	0.12	9.26	0.20	5.54	0.12	5.60	0.17	7.09	0.20	5.57	0.17	2.16	0.07	87%	66%
S19	+30% Volume, 75% PEU	5.47	0.09	8.99	0.23	5.44	0.09	5.40	0.13	6.80	0.23	5.39	0.13	1.50	0.04	87%	64%
S20	+40% Volume, 0% PEU	11.05	0.97	17.87	1.50	10.82	0.95	14.00	1.49	15.70	1.51	13.90	1.49	12.46	1.53	97%	92%
S21	+40% Volume, 15% PEU	8.45	0.57	13.43	0.88	8.30	0.56	9.94	0.87	11.25	0.88	9.88	0.87	7.04	0.72	96%	87%
S22	+40% Volume, 35% PEU	7.56	0.39	12.15	0.63	7.46	0.38	8.56	0.59	9.98	0.62	8.51	0.59	4.53	0.38	94%	83%
S23	+40% Volume, 55% PEU	7.39	0.29	11.79	0.46	7.32	0.29	8.29	0.44	9.61	0.46	8.25	0.44	3.25	0.18	94%	82%
S24	+40% Volume, 75% PEU	7.39	0.34	11.77	0.57	7.35	0.34	8.28	0.52	9.60	0.57	8.27	0.52	2.21	0.13	94%	81%
S25	+50% Volume, 0% PEU	36.03	2.09	57.22	3.21	35.31	2.05	53.74	3.31	55.09	3.21	53.67	3.31	52.04	3.19	100%	100%
S26	+50% Volume, 15% PEU	26.75	1.98	42.06	3.22	26.32	1.95	39.02	3.15	39.94	3.22	38.98	3.15	30.16	2.56	100%	100%
S27	+50% Volume, 35% PEU	23.95	2.09	37.52	3.26	23.66	2.07	34.46	3.30	35.39	3.27	34.43	3.30	18.88	1.86	100%	99%
S28	+50% Volume, 55% PEU	21.04	2.30	33.19	3.70	20.86	2.28	29.81	3.63	31.03	3.69	29.78	3.63	10.92	1.36	100%	99%
S29	+50% Volume, 75% PEU	20.28	2.17	31.64	3.36	20.18	2.16	28.56	3.43	29.47	3.36	28.54	3.43	6.10	0.66	99%	98%

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REFERENCES

Adeyemi, N. O., K. L. Maass, A. M. Graham, and K. S. Pasupathy. 2023. "Policy Interventions to Improve Inpatient Mental Healthcare Access: A Discrete Event Simulation Study". *arXiv preprint arXiv:2304.13849*.

Anderson, K., L. P. Goldsmith, J. Lomani, et al. 2022. "Short-Stay Crisis Units for Mental Health Patients on Crisis Care Pathways: Systematic Review and Meta-Analysis". BJPsych Open 8(4):e144.

Baia Medeiros, D. T., S. Hahn-Goldberg, D. M. Aleman, and E. O'Connor. 2019. "Planning Capacity for Mental Health and Addiction Services in the Emergency Department: A Discrete-Event Simulation Approach". Journal of Healthcare Engineering 2019(June):1–11.

Barocas, J. A., I. Umar, A. Praseuth, L. Evans, N. D. Zaller, and M. J. Zielinski. 2022. "An Economic Analysis of the Cost of a Regional Crisis Stabilization Unit". Journal of Correctional Health Care 28(1):54–58.

Bommersbach, T. J., A. J. McKean, M. Olfson, and T. G. Rhee. 2023. "National Trends in Mental Health–Related Emergency Department Visits Among Youth, 2011–2020". JAMA 329(17):1469.

Case, S. D., B. G. Case, M. Olfson, J. G. Linakis, and E. M. Laska. 2011. "Length of Stay of Pediatric Mental Health Emergency Department Visits in the United States". Journal of the American Academy of Child & Adolescent Psychiatry 50(11):1110–19.

Cerdá, M., M. S. Jalali, A. D. Hamilton, et al. 2021. "A Systematic Review of Simulation Models to Track and Address the Opioid Crisis". Epidemiologic Reviews 43(1):147–65.

Doudareva, E. and M. Carter. 2022. "Discrete Event Simulation for Emergency Department Modelling: A Systematic Review of Validation Methods". Operations Research for Health Care 33(June):100340.

Garces, J. D., M. L. McElroy, L. L. Salmond, and D. A. Taylor. 2025. "Review of EmPATH Units for Behavioral Health Casualties in Prolonged Field Care Environments". Military Medicine 190(3–4):e510–14.

Gillard, S., K. Anderson, G. Clarke, et al. 2023. "Evaluating Mental Health Decision Units in Acute Care Pathways (DECISION): A Quasi-Experimental, Qualitative and Health Economic Evaluation". Health and Social Care Delivery Research 11(39):1–221.

Hasken, C., B. Wagers, J. Sondhi, J. Miller, and J. Kanis. 2022. "The Impact of a New On-Site Inpatient Psychiatric Unit in an Urban Pediatric Emergency Department". Pediatric Emergency Care 38(1):e12–16.

Hoffmann, J. A. 2025. "It's Time to Get on Board: Solutions to the Pediatric Behavioral Health Boarding Crisis". Annals of Emergency Medicine 85(5):393–96.

Hoge, M. A., J. Vanderploeg, M. Paris, J. M. Lang, and C. Olezeski. 2022. "Emergency Department Use by Children and Youth with Mental Health Conditions: A Health Equity Agenda". Community Mental Health Journal 58(7):1225–39.

Howells, M., L. Andrew, and D. Gartner. 2022. "Modelling the Accessibility of Adult Psychology Services Using Discrete Event Simulation". Hawaii International Conference on System Sciences (HICSS), January 4–7, Maui, Hawaii.

Hudgins, J. D., M. C. Monuteaux, C. Kent, et al. 2025. "Changes in Behavioral Health Visits, Operations, and Boarding in a Pediatric Emergency Department". Annals of Emergency Medicine 85(5):381–92.

Kalb, L. G., C. Holingue, E. K. Stapp, K. Van Eck, and J. Thrul. 2022. "Trends and Geographic Availability of Emergency Psychiatric Walk-In and Crisis Services in the United States". Psychiatric Services 73(1):26–31.

Kim, A. K., J. P. Vakkalanka, P. Van Heukelom, J. Tate, and S. Lee. 2022. "Emergency Psychiatric Assessment, Treatment, and Healing (EmPATH) Unit Decreases Hospital Admission for Patients Presenting with Suicidal Ideation in Rural America". Academic Emergency Medicine 29(2):142–49.

Lee, H., H. Yun, M. Choi, and H. Kim. 2023. "Predicting Workplace Violence in the Emergency Department Based on Electronic Health Record Data". Journal of Emergency Nursing 49(3):415–24.

Leeb, R. T., R. H. Bitsko, L. Radhakrishnan, P. Martinez, R. Njai, and K. M. Holland. 2020. "Mental Health–Related Emergency Department Visits Among Children Aged <18 Years During the COVID-19 Pandemic — United States, January 1–October 17, 2020". MMWR. Morbidity and Mortality Weekly Report 69(45):1675–80.

Mistarihi, M. Z., M. D. AL-Tahat, and S. H. AL-Nimer. 2023. "Improving Process Efficiency at Pediatric Hospital Emergency Department Using an Integrated Six-Sigma Simulation Methodology". Processes 11(2):399.

Nash, K. A., B. T. Zima, C. Rothenberg, et al. 2021. "Prolonged Emergency Department Length of Stay for US Pediatric Mental Health Visits (2005–2015)". Pediatrics 147(5):e2020030692.

O'Donnell, E. P., L. Yanek, E. Reynolds, L. M. Ryan, and T. L. Ngo. 2020. "Characteristics of Mental Health Patients Boarding for Longer Than 24 Hours in a Pediatric Emergency Department". JAMA Pediatrics 174(12):1206.

Parwani, V., B. Tinloy, A. Ulrich, et al. 2018. "Opening of Psychiatric Observation Unit Eases Boarding Crisis". Academic Emergency Medicine 25(4):456–60.

Radhakrishnan, L., K. Carey, D. Pell, et al. 2023. "Seasonal Trends in Emergency Department Visits for Mental and Behavioral Health Conditions Among Children and Adolescents Aged 5–17 Years — United States, January 2018–June 2023". MMWR. Morbidity and Mortality Weekly Report 72(38):1032–40.

Saidinejad, M., S. Duffy, D. Wallin, et al. 2023. "The Management of Children and Youth With Pediatric Mental and Behavioral Health Emergencies". Pediatrics 152(3):e2023063256.

Soman, D. A., S. N. Koscelny, D. Neyens, et al. 2025. "Using Patient Journey Mapping and Provider Workflows to Understand Process Barriers to Pediatric Mental and Behavioral Health Care in Emergency Departments". Applied Ergonomics 126(July):104512.

Stamy, C., D. M. Shane, L. Kannedy, et al. 2021. "Economic Evaluation of the Emergency Department After Implementation of an Emergency Psychiatric Assessment, Treatment, and Healing Unit". Academic Emergency Medicine 28(1):82–91.

Theriault, K. M., R. A. Rosenheck, and T. G. Rhee. 2020. "Increasing Emergency Department Visits for Mental Health Conditions in the United States". The Journal of Clinical Psychiatry 81(5):20m13241.

Tkacz, J. and B. L. Brady. 2021. "Increasing Rate of Diagnosed Childhood Mental Illness in the United States: Incidence, Prevalence and Costs". Public Health in Practice 2(November):100204.

Zeller, S., N. Calma, and A. Stone. 2014. "Effect of a Regional Dedicated Psychiatric Emergency Service on Boarding and Hospitalization of Psychiatric Patients in Area Emergency Departments". Western Journal of Emergency Medicine 15(1):1–6.

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