



REVIEW ARTICLE (NARRATIVE REVIEW)

# Maintaining Emergency Department Operational Efficiency and Capacity Management in the Era of Emergency Department Overcrowding and Inpatient Boarding

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## ABSTRACT

Boarding of admitted patients in the emergency department is widely recognized as a significant threat to both departmental function and hospital operations and has been associated with decreased patient satisfaction, prolonged length of stay, and increased risk of adverse events. Although the consequences of boarding are most apparent within the emergency department, the underlying drivers are rooted in hospital wide capacity constraints and broader health system dynamics. As a result, effective mitigation strategies extend beyond the emergency department and require coordinated interventions across multiple levels of care delivery. This review examines interventions aimed at improving emergency department boarding and patient throughput at the departmental, hospital, and healthcare system levels. Additionally, we highlight examples of coordinated, multi level strategies implemented within a large healthcare system to illustrate how integrated approaches to capacity management and patient flow may reduce boarding and improve overall operational performance.

## Introduction

Emergency departments (EDs) across the United States are experiencing persistent challenges related to inpatient boarding. Boarding occurs when an admitted patient remains in the ED while awaiting transfer to an inpatient bed. Boarding times increased sharply during the COVID-19 pandemic and have remained at historically elevated levels. Median boarding times rose from 121 minutes in 2020 to 192 minutes in 2022 across more than 1,000 EDs nationally<sup>1</sup>. These trends reflect a growing mismatch between patient care needs and inpatient capacity, driven by population aging, increasing medical complexity, limited access to outpatient services, and consolidation of hospital care. As a result, EDs have increasingly assumed the role of holding admitted patients for prolonged periods rather than serving solely as sites for rapid evaluation and stabilization, placing sustained strain on emergency care delivery and hospital operations.

Recognizing the patient safety risks associated with prolonged boarding, The Joint Commission established a recommended four-hour boarding limit in 2012. Despite this guidance, boarding durations frequently exceed this threshold. National data demonstrate that the proportion of patients boarding for 24 hours or longer more than doubled between 2018 and 2020, underscoring the widening gap between policy expectations and operational reality<sup>2,3</sup>.

The impacts of ED boarding on quality of care and patient safety are well documented. Boarding has been associated with increased mortality, higher rates of medical errors, and prolonged hospitalizations<sup>4-6</sup>. A systematic review further demonstrated that ED boarding leads to delays in assessment and treatment, decreased compliance with established care standards, increased medication errors and adverse events, higher morbidity, longer inpatient lengths of stay (LOS), and increased readmission rates<sup>7,8</sup>. These findings highlight that boarding is not merely an operational inconvenience but a significant threat to patient safety.

Emergency Department boarding significantly degrades operational efficiency, increasing average provider wait times. Furthermore, boarding patients often require intensive resources,

including one-on-one nursing and continuous monitoring, which limits the ED capacity needed to treat incoming emergencies<sup>9</sup>. This resource strain creates a vicious cycle of worsening crowding, increased left-without-being-seen (LWBS) rates, and declining patient satisfaction<sup>9,10</sup>.

In response to the growing severity of ED boarding, policymakers and quality organizations have increased their focus on system-level solutions. In October 2024, the Agency for Healthcare Research and Quality convened a national summit specifically to address ED boarding, reflecting increased federal recognition of boarding as a hospital-wide capacity problem rather than an ED-specific issue.<sup>2</sup> Similarly, The Leapfrog Group, who assigns letter grades to hospitals based on several quality and patient safety data, has added survey questions assessing the percentage of admitted ED patients boarding longer than four hours, the median ED LOS for admitted patients, and the 90th percentile ED LOS for admitted patients.

This review outlines various examples and methodologies in which EDs, hospitals, and healthcare systems can intervene on the burden of ED boarding, and therefore improve patient safety and satisfaction. We highlight the importance of multi-faceted approaches to these interventions, particularly at the hospital and healthcare system levels. Additionally, we will provide insight via examples of similar interventions that have been implemented at Brown University Health, a large and expanding healthcare system in the United States.

## Approaches to Mitigate Inpatient Boarding in the Emergency Department

### I. THE EMERGENCY DEPARTMENT

While a myriad of hospital-wide operational shifts influence ED efficiency, internal interventions can optimize patient throughput in an attempt to mitigate the deleterious effect of boarding<sup>11</sup>. Although these ED specific measures do not directly alleviate inpatient boarding, they significantly enhance the flow of non-admitted patients, thereby improving the total LOS for those utilizing acute care beds not yet occupied by boarders. These strategies aim to efficiently move

patients through different stages of care, from arrival to discharge.

Physical space to provide patient care is limited in the majority of emergency departments. While building a bigger ED may be the optimal solution, it is rarely possible. While ED expansion alone has not been shown to improve throughput<sup>12</sup>, many EDs, given no other choice, have attempted to increase their functional bed capacity by utilizing all space available such as hallways and nontraditional patient care areas such as expanded internal waiting rooms to maximize their existing space<sup>13</sup>.

Compounding these spatial limitations is a national nursing shortage leading to chronic understaffing and high nurse to patient ratios. Minor staffing deficits in the morning frequently cascade into systemic bottlenecks later in the day. Advanced computer analytics and IT technologies can anticipate call outs, predict surges in patient volume and help optimize staffing to avoid closures of entire assignments<sup>14</sup>. To mitigate nursing shortage, multidisciplinary resources, including Licensed Practical Nurses (LPNs), phlebotomists, and Emergency Medical Technicians (EMTs), can also be utilized to perform clinical tasks. However, the lack of adequate nursing staffing remains a key limiting factor in an ED's ability to increase its functional bed capacity to adequately offset boarding.

Emergency Department flow can be broadly divided into 3 phases: intake, throughput and output<sup>15</sup>. Implementing data-driven modifications within each of these domains can collectively enhance departmental capacity and preserve clinical functionality during periods of high census. The intake phase—encompassing arrival, registration, triage, bed placement, and initial medical assessment—represents a significant portion of a patient's total LOS. To optimize front-end operations<sup>16</sup>, many EDs have transitioned to parallel patient processing models, such as immediate bedding. This strategy bypasses the traditional, linear triage queue by placing patients directly into available clinical rooms, where triage, registration, and initial provider assessments occur simultaneously at the bedside. While this model is different from the traditional ED triage system, it has been shown to reduce LOS and door to room time, and increase patient satisfaction<sup>17-20</sup>.

Traditionally, nurses serve as the primary triage providers, utilizing standardized systems such as the Emergency Severity Index (ESI) to rapidly categorize patients based on clinical urgency and resource requirements. The addition of a "provider in triage" (PIT) is another way to decrease the time a patient waits to be seen and to have their care initiated. In this model, a physician or advanced practice provider (APP) performs rapid initial assessments and initiates diagnostic workups directly from the waiting area when bed capacity is reached.

This intervention facilitates a split-flow care model: critically ill patients are prioritized for high-acuity beds, low-acuity patients are often discharged directly from triage, and mid-acuity patients are transitioned to "vertical care" areas utilizing recliners rather than traditional stretchers and higher nursing ratios. The PIT model offers substantial advantages, including reduced wait times, and time to medical evaluations and initial orders<sup>11,21-23</sup>, which can significantly decrease total LOS<sup>24</sup>. By expediting care for both ends of the acuity spectrum, this approach minimizes LWBS rates, and enhances overall patient satisfaction<sup>25</sup>. Early provider involvement also helps identify critically ill patients more expeditiously, improving safety and outcomes.

In our operational model, patients are initially evaluated in triage by an attending physician who immediately initiates diagnostic workups and therapeutic interventions. Following this initial assessment, clinically appropriate patients are transitioned to a specialized vertical care area where they wait for results in recliners rather than traditional stretchers with an increased nursing ratio, thereby maximizing limited functional bed capacity and accelerating throughput. This area is managed by APPs who oversee patient care, including follow up of diagnostic testing, specialist consultation, and the performance of necessary bedside procedures. By utilizing APPs to manage mid-stream clinical tasks and finalize dispositions, the model allows the front-end physician to maintain focus on the rapid intake of high-volume undifferentiated patients, effectively optimizing both intake efficiency and departmental capacity.

Integrating senior physicians into the triage process significantly enhances emergency department efficiency by ordering tests more judiciously than

more junior providers while still enhancing patient safety<sup>25</sup>. These physicians leverage advanced expertise to initiate targeted workups and therapeutic interventions immediately upon patient arrival, thereby reducing total wait times and LOS. Beyond operational throughput, senior physicians provide a critical safety net; their ability to identify subtle but life-threatening symptoms contributes to more accurate initial risk stratification compared to less experienced staff.

Despite these benefits, the deployment of senior medical personnel in triage requires careful consideration of resource management and costs. While this model streamlines care for medium- and low-acuity patients, it may inadvertently deplete the senior physician pool available for critically ill patients within the main treatment areas. Ultimately the selection of a triage provider involves a strategic balance between traditional nursing expertise and advanced clinical leadership to optimize patient flow and safety.

A multiprofessional team triage approach consisting of a physician, nurse, and auxiliary support staff is often regarded as the gold standard, as it significantly enhances operational efficiency and patient satisfaction compared to traditional, single-provider models. In environments where the PIT model is not feasible, protocol-driven nursing orders serve as an alternative to accelerate care initiation. These institution-specific pathways permit the immediate ordering of laboratory tests, imaging, and basic therapeutic interventions based on chief complaints during periods of peak census. Although nursing protocols have not consistently demonstrated a reduction in total ED LOS, they do improve patient care by reducing time to testing and pain management<sup>26–28</sup>.

Split flow model, strategic segregation of patients into distinct clinical pathways based on acuity and resource requirements, has also been shown to improve ED LOS, patient satisfaction and ED wait time<sup>21,29,30</sup>. By implementing a fast-track system, facilities can divert low-acuity patients with minor injuries or illnesses to dedicated treatment zones, ensuring they receive expedited care without competing for the specialized resources required by critically ill populations or beds more typically blocked by inpatient boarding. The fast-track

system in the emergency department provides significant benefits by improving patient flow, reducing wait times, and enhancing overall efficiency. Additionally, fast-track care improves patient satisfaction by providing quicker evaluation and treatment, while allowing emergency physicians and nurses to focus more effectively on high-acuity cases, ultimately supporting safer and more efficient ED operations.

Another way to improve front end operations is to integrate novel technologies such as self-check-in and self-triage kiosks. These systems permit patients to enter demographic, insurance, and chief complaint data immediately upon arrival<sup>31,32</sup>, shifting the burden of manual data entry from staff to automated interfaces thus reducing administrative bottlenecks. This transition not only accelerates the registration process and reduces wait times but also liberates registration personnel to manage more complex cases<sup>33</sup>.

While there is limited data on accuracy, self-triage kiosks can improve efficiency by enabling patients to report symptoms and basic health information upon arrival, facilitating more rapid risk stratification<sup>34</sup>. By streamlining the initial data collection phase, these technologies significantly decrease waiting room congestion and allow nursing staff to dedicate their focus to direct patient care<sup>31</sup>. When utilized as a support tool rather than a replacement for clinical judgment, self-triage kiosks have potential to enhance intake efficiency, and contribute to more timely care in the ED.

Since the COVID-19 pandemic, telehealth integration has expanded significantly enhancing patient access to medical services and improving overall patient experience. While data is limited, a study from 2019 found that teletriage in the ED decreased LWBS and improved door to provider time<sup>35</sup>. By shifting initial assessment to remote specialists, this model liberates on-site nursing and clinician resources to prioritize direct patient care and bedside interventions during periods of peak demand while allowing a single teletriage provider to be more efficiently utilized at multiple sites based on demand.

Following initial intake, the majority of a patient's stay is traditionally spent awaiting diagnostic results and specialist consultations. With 71% of ED patients requiring at least one diagnostic test<sup>36</sup>, the

integration of point-of-care (POC) testing offers a significant opportunity to enhance throughput. Multiple studies demonstrate that POC testing for high-volume presentations—such as chest pain, which accounts for over 10 million annual visits<sup>36</sup> can drastically reduce turnaround times (TAT) for troponin and D-dimer, thereby shortening total LOS<sup>37–41</sup>. The barriers to the widespread adoption of POC testing primarily involve unfavorable cost-benefit ratios, concerns regarding clinical workforce burden, and technical integration challenges<sup>42</sup>. Specifically, the higher per-test expenditure often conflicts with institutional budgets, while the additional labor required from already strained nursing staff can exacerbate burnout as while faster overall; POC testing often places increased burden on the frontline ED staff. Similarly, because over half of all ED visits include imaging, dedicated ED radiologists and prompt outpatient imaging scheduling are critical for reducing imaging TAT and prioritizing emergent cases<sup>43–45</sup>.

The critical shortage of outpatient mental health resources continues to drive a steady increase in the volume of psychiatric presentations to ED. The number of mental health related visits to the ED has been steadily increasing over the years<sup>46,47</sup>. These patients frequently experience disproportionately long wait times and prolonged LOS<sup>47</sup>. To mitigate these disparities, two well studied models have emerged: Emergency Psychiatric Assessment, Treatment, and Healing (EmPATH) model and integration of telepsychiatry for more prompt patient evaluation and disposition.

The EmPATH model represents a paradigm shift from traditional triage toward rapid, multidisciplinary stabilization for behavioral health (BH) patients. Under this framework, patients transition from the high-stimulation, often chaotic environment of the main ED into a calm, specialized behavioral health unit immediately following an initial medical screening exam. The care team is led by psychiatrists who initiate active therapeutic interventions upon arrival rather than waiting for a consult. Supported by psychiatric nurses, social workers, and peer support specialists, the model emphasizes a non-coercive, open-concept environment that prioritizes de-escalation. Recognized as a national best practice in 2025, the EmPATH model has been shown to decrease inpatient psychiatric admissions,

reducing ED LOS, ED boarding times, and lowering readmission rates and use of restraints<sup>48–51</sup>.

The scarcity of on-site psychiatric specialists has made telepsychiatry an indispensable tool for accelerating BH evaluations and reducing consultation turnaround times<sup>52</sup>. While approximately 55% of EDs have integrated telepsychiatry by 2019<sup>53</sup>, data on ED throughput is more limited. Results do appear mixed with some studies reporting decreases in wait time to initial consultation, while a few others describe an overall increased LOS for patients utilizing telepsychiatry. However, most studies do suggest a decreased admission rate when telepsychiatry services are utilized<sup>54</sup>. Furthermore, telepsychiatry platforms frequently bridge the gap to outpatient follow-up, with potential to further decrease ED use for BH related complaints<sup>55</sup>.

Similarly, integration of interdisciplinary teams—comprising social workers, case managers, and physical therapists—is essential for optimizing the care of patients with complex medical and psychosocial needs. Early intervention by ED-based case managers has been shown to reduce hospital utilization, admission rates, and diagnostic resource consumption, particularly among high-utilizer populations<sup>56,57</sup>. Likewise, social workers provide a critical safety net by addressing the social determinants of health that drive repeat visits<sup>58,59</sup>; while community health workers address issues - such as housing instability, food insecurity, or lack of transportation - that often prompt emergency room visits. ED-embedded physical therapy has proven effective in reducing wait times and LOS for patients presenting with musculoskeletal complaints<sup>60</sup>.

Emergency Department Observation Units (EDOUs) have also become a way to improve ED throughput by functioning as a "pressure valve" for overcrowded hospitals. As the utilization of observation care has expanded<sup>61</sup>, these units have become essential for managing patients who require extended diagnostic testing, monitoring, or stabilization but are expected to reach disposition within a 24-to-48-hour window. Data indicates that use of ED OU can decrease ED LOS<sup>62</sup>, inpatient admission rates, and LWBS<sup>63</sup>.

The implementation of protocol-driven observation care also yields profound hospital-wide advantages, particularly regarding bed capacity and cost management<sup>64,65</sup>. By diverting short-stay

patients from acute care beds, EDOUs optimize resource allocation and improve institutional efficiency. While likely multifactorial, emerging evidence suggests that the presence of an EDOU can decrease the aggregate LOS for the entire hospital, effectively streamlining the trajectory of both emergent and admitted patient population<sup>66</sup>.

Discharge lounges have emerged as another structural solution for mitigating ED boarding by decoupling clinical care from discharge logistics. These lounges serve as a transition zone for medically cleared patients awaiting final needs thereby freeing up acute care beds hours earlier than traditional models, effectively shifting the bed availability curve earlier in the day without the heavier lift of moving discharges themselves earlier. Multidisciplinary dedicated teams are often involved in coordinating the final steps of discharge, such as medication delivery, durable medical equipment and transportation. This shift allows clinical staff to practice at the top of their license; by utilizing LPNs, EMTs, and ancillary staff to manage the lounge, hospitals can redirect RN resources toward high-acuity patient care.

While much of the literature focuses on inpatient lounges<sup>67</sup>, recent data and computer-simulated modeling suggest that ED-specific discharge lounges significantly enhance departmental efficiency<sup>68</sup>. Patients who are medically cleared often remain in ED treatment spaces while waiting for transportation, medications, or final paperwork. By removing the bottleneck that occurs after medical stabilization but prior to physical departure, these units ensure that ED treatment spaces are prioritized for incoming patients. This rapid bed turnover reduces waiting room congestion, improves door-to-provider time, and lowers LWBS rates. Furthermore, relocating non-clinical waiting time out of active treatment areas allows emergency clinicians to focus exclusively on undifferentiated, acutely ill patients, supporting a more focused and therapeutically efficient environment. Furthermore, cohorting stable, low nursing need patients that are close to discharge is an effective and safe way to stretch nursing ratios, allowing for higher intensity care for sicker, undifferentiated patients.

In addition to discharge optimization, geographic cohorting—the practice of grouping boarding

patients or those with anticipated prolonged stays into dedicated zones—is another strategy to help improve operational efficiency. By localizing patients with similar needs, EDs can concentrate specialized resources, such as case managers, physical therapists, and inpatient consultants, to increase team efficiency. While traditionally validated in inpatient settings<sup>69</sup>, cohorting in the ED offers significant safety benefits. This model facilitates superior communication and allows for the integration of inpatient nursing staff into the ED to care for boarded patients, thereby preserving emergency nurses for the high-intensity tasks of resuscitation and stabilization.

While the ED can operationalize various fixes to mitigate boarding, ED-based interventions alone are insufficient and cannot solve the boarding crisis in isolation. Ultimately, ED boarding is a direct manifestation of hospital overcrowding<sup>3</sup>, thus frontline improvements must be coupled with synchronized, hospital-led throughput initiatives to achieve lasting impact<sup>70</sup>.

## II. THE HOSPITAL

As previously mentioned, studies have suggested that ED boarding is a byproduct of hospitals providing patient care beyond their functional capacity. A particular metric widely identified by hospitals that impacts hospital throughput and therefore ED overcrowding is inpatient LOS. It has been found to not only have a direct impact on ED boarding, but is also associated with patient mortality<sup>71–73</sup>. Influence on LOS is multifactorial, leading to ample opportunities for hospital-based interventions to optimize efficiency of patient throughput. For example, a pilot program showed that a multifaceted hospital-based approach to decreasing LOS targeting multiple components of the clinical care continuum (decreasing diagnostic testing TAT, establishing a hospitalist proceduralist team, implementing workflows to optimize care progression for common patient presentations [i.e. diuresis in heart failure], and cohorting patients and workflows to optimize care coordination and patient throughput) could lead to associated improvements in LOS metrics<sup>74</sup>.

As the frequency of specialty consultations has doubled over time<sup>75</sup>, it is crucial to not only improve access to specialty services but to also improve efficiency of these consults. Waiting for a

specialist to arrive and provide a disposition decision accounts for 33% of the total time in the ED for patients who are eventually admitted and 54% for those who are discharged<sup>76,77</sup>. To mitigate these delays, hospitals in 2026 are leveraging secure text messaging and EMR-integrated alerts to improve responsiveness<sup>78</sup>. Furthermore, establishing evidence-based pathways allows emergency physicians to bypass certain consultations through protocol-driven admissions or prompt outpatient follow-up, ensuring that specialist resources are reserved for the most complex clinical decisions.

Implementation of expedited outpatient follow-up pathways for high-volume presentations - such as chest pain, atrial fibrillation, and transient ischemic attacks (TIA) – is another strategy to reduce hospital crowding and unnecessary admissions. These pathways utilize validated risk-stratification tools, such as the HEART score, to identify low-to-intermediate risk patients who can be safely discharged with reliable follow up. By securing specialist consultations or diagnostic testing within an expedited time frame, these models eliminate the need for defensive admissions while maintaining clinical safety and protecting physicians from potential liability by linking efficient practice to validated clinical guidelines. Operationally, these pathways shorten ED LOS by transferring complex diagnostic workups—such as advanced cardiac imaging and formal neurology evaluations—to the ambulatory setting. This shift not only optimizes inpatient capacity for high-acuity cases but also reduces the total cost of care and prevents "bounce-back" visits by ensuring patients receive definitive, long-term management outside the acute care environment<sup>79,80</sup>.

From a patient perspective, structured follow-up reduces clinical uncertainty and improves adherence to care plans by providing a clear, reliable trajectory for continued follow up. Furthermore, addressing the barrier of limited outpatient access is essential for meeting current performance metrics, such as the CMS readmission reduction mandates. By establishing robust, coordinated links between the ED and community specialists, hospitals and healthcare systems can shift the diagnostic burden to more cost-effective ambulatory settings. Ultimately, these high-value care pathways promote systemic efficiency and resource

conservation while ensuring that diagnostic evaluations and treatment adjustments occur before conditions escalate into secondary crises.

At the hospital level, efforts to optimize inpatient capacity can alleviate strain associated with ED boarding. This could include initiatives focused on even distribution of elective admissions throughout the week, implementing processes for direct admission that allow appropriate patients to bypass the ED, and optimizing staffing throughout the hospital so that all patient care spaces can be utilized<sup>71,81</sup>. Surgical smoothing is a recognized example, which distributes elective surgeries more evenly throughout the week, reduces peaks in inpatient bed demand and allows admitted ED patients to move to inpatient units more rapidly. Hospitals implementing surgical smoothing have demonstrated increased revenue, fewer elective surgery cancellations, decreased costs, and improved bed occupancy<sup>82</sup>.

Interventions aimed at improving the efficiency of workflows to discharge admitted patients have also been found to be correlated with decreased ED boarding<sup>83</sup>. Additionally, various hospitals have implemented designated physical spaces where patients that are medically cleared for discharge can await further coordination of additional disposition logistics (i.e. transportation), in order to expedite turnaround of inpatient beds<sup>67</sup>. Hospitals can improve ED boarding not only by looking at processes involved with discharging admitted patients, but also the timing of these discharges. Studies have suggested that interventions that promote timely discharge, particularly those that emphasize discharges occurring prior to anticipated surges in ED patient arrivals, can effectively decrease ED boarding<sup>84,85</sup>. Streamlined discharge processes further improve inpatient capacity by making beds available earlier and more predictably. Effective approaches include targeting early-day discharges, planning weekend discharges, and using discharge lounges to allow patients to vacate inpatient beds while awaiting final departure. Supporting inpatient care teams through expanded evening access to imaging and diagnostic services, rather than limiting these resources to traditional daytime hours, also accelerates clinical decision-making and patient flow<sup>2</sup>.

**Table 1.** Interventions aimed at maintaining efficiency by Emergency Department phase of care.

Phase of Care	Intervention	Impact	References	
Intake	Expansion of bed capacity	Increases usable space despite fixed footprint	12, 13	
	Predictive Analytics	Anticipates surge, callouts, optimizes staffing	14	
	Multidisciplinary staffing (LPN, EMT, etc)	Mitigates nursing shortages, redistribute work		
	Parallel processing/immediate bedding	Reduces door to room time and LOS	16-20	
	Provider in Triage (PIT)	Reduces wait times, LWBS and LOS.	11, 21-25	
	Vertical care model (recliners for mid acuity care)	Maximizes bed capacity		
	Senior physician led triage	Improves diagnostic accuracy, safety, LOS	25	
	Protocol-driven nursing orders	Reduces time to testing and analgesia	26-28	
	Split-flow/fast track systems	Improves LOS, wait time, and patient experience	21, 29, 30	
	Self check-in and self triage kiosks	Reduces registration time, decrease wait time	31-34	
	Teletriage	Decreases LWBS, improves door-provider-time	35	
	Throughput	Point-of-care testing	Shortens diagnostic TAT and LOS	36-42
		Dedicated ED radiology and ED imaging pathways	Reduces imaging delays	43-45
EmPATH behavioral health model		Reduces LOS, boarding, admissions, restraints	48-51	
Telepsychiatry		Accelerates BH evaluations, reduces admissions	52-55	
Case management, social work, PT		Reduces admissions, LOS, return visits	58-60	
Output		ED observation units	Decreases ED LOS, LWBS, admissions	61-68
	Discharge lounges (ED-specific)	Improves bed turnover, reduces LWBS	67, 68	
	Geographic cohorting of patients	Improves efficiency, communication and safety	69	

A multifaceted and targeted approach to optimizing hospital capacity and decreasing LOS, such as the examples highlighted above, often requires direct support and coordination from not only hospital leadership, but the healthcare system itself. Active bed management has emerged as another critical intervention. The use of dedicated inpatient bed managers to coordinate real-time bed assignment has been shown to significantly reduce boarding time<sup>2</sup>. One study demonstrated that reducing bed downtime (the interval between bed vacancy and assignment to an ED patient) from 254 minutes to 129 minutes resulted in substantial improvements in patient flow<sup>86</sup>. Key interventions included real-time provider notification of empty beds and the use of weekly performance dashboards to track performance<sup>86</sup>.

Leadership engagement and accountability are consistently associated with successful boarding reduction. A leadership-driven program that actively intervened in real time to move ED

patients to inpatient beds within 60 minutes reduced boarding time by 46 minutes and decreased overall ED LOS by 34 minutes<sup>87</sup>. Hospitals with executive leadership involvement, hospital-wide coordinated strategies, data-driven management, and formal accountability systems are more likely to achieve sustained reductions in ED LOS and boarding duration<sup>88</sup>. Over the past several years, there have been various advancements to the coordination of the complexities around hospital bed management, one of which is the development of hospital and/or healthcare system based capacity command centers<sup>81,89-91</sup>.

### III. THE HEALTHCARE SYSTEM

In the early 2010s, academic medical centers began recognizing that fragmented communication—where bed management, transport, surge management, and transfers operated in silos—contributed to severe issues related to hospital capacity, boarding of admitted patients in ED, increased LOS and delayed care. Key literature,

such as studies by Kane et al. (2019), highlights that centralized hubs utilize real-time data to synchronize patient flow, effectively turning a hospital from a collection of departments into a cohesive system. A functional healthcare system can be thought of as one large hospital with various wings that are geographically far apart.

Brown University Health is a large, integrated, multi-hospital health system that serves a diverse regional population in two different states, with consistently high ED volumes and a broad spectrum of clinical acuity. The system is anchored by a major tertiary care academic medical center and includes a dedicated pediatric hospital, two academic community hospitals, two additional community hospitals, and a pediatric psychiatric hospital. In addition to its inpatient facilities, Brown University Health encompasses an extensive network of outpatient primary care practices, specialty clinics, and ambulatory care centers.

As it has grown, Brown University Health is an example of a large healthcare system that has undergone significant transformation in how it manages patient movement through the development of a centralized command center. What began as a traditional Transfer Call Center serving a single hospital in 2009 has evolved to include other functions over more than a decade, and as of 2025, evolved into the current Brown University Health Capacity Management and Access Center (CMAC).

The CMAC is led by a collaborative structure including a system Chief Medical Officer, A Vice President of Operations, Medical Directors, and Clinical Managers. Its mission and vision are to provide seamless access and optimal patient flow across the Brown University Health system and to ensure the right patient gets the right bed at the right hospital without delay. Guiding principles include transparency, system-first thinking, and data-driven accountability.

Collectively, the system's emergency departments evaluate and treat more than 1,000 patients each day, spanning all ages, socioeconomic backgrounds, and levels of medical and behavioral complexity. Some of these hospitals receive nearly half of their arrival volume via EMS, placing them in the 99th percentile nationally. The size, diversity, and operational complexity of the system require real-

time situational awareness, coordinated decision-making, and centralized operational oversight. CMAC fulfills this critical role by serving as the system-wide command center, supporting patient flow, resource allocation, and operational coordination across all facilities. Its integrated functions include several key pieces: 1) Integrated Transport Services, 2) transfer and access, 3) patient placement and discharge planning, 4) surge management, 5) load balancing, and 6) a system physician administrator (SPA)

Integrated Transport Services: Integrated transport services is comprised of four distinct entities including: a.) An internal critical care transport service, b.) Community paramedicine to see patients in the community and prevent unnecessary hospital visits, c.) Medical communications to interface with state and regional emergency services. d.) An electronic service that coordinates non-emergent medical transportation for patients.

Transfer and Access: The CMAC functions as a centralized single point of entry for referral sources across the continuum of care, including primary care physicians, urgent care centers, ambulatory surgery centers, specialty clinics, and external hospitals. In the first month of FY26 alone, Transfer and Access received over 3500 calls. This included over 900 accepted transfer requests. Transfer Navigators are experienced, nurse-level clinicians who manage incoming referral and transfer requests, facilitate appropriate triage, and coordinate direct admission pathways when clinically appropriate, thereby bypassing the Emergency Department. By centralizing access and coordination, the CMAC reduces variability in admission processes, shortens time to definitive care, reduces unnecessary Emergency Department utilization, and optimizes system-wide capacity. This coordinated approach enables Brown University Health to accept a greater number of patients while improving timely access to care across our region and reducing boarding of admitted patients in the ED.

Patient Placement and Discharge Expediting: Patient placement and discharge expediting is championed by two distinct roles. First, bed navigators strategically place patients across all system hospitals. This represents a system-first

level of thinking; improving overall occupancy balance and reducing ED boarding of admitted patients. Second, discharge expeditors are experienced nurse managers who identify and remove barriers (e.g., pending radiology studies, procedures, case management needs, care coordination, durable medical equipment needs, etc). They assist with tasks such as moving studies to the outpatient setting to free up inpatient capacity when appropriate.

Surge Management: CMAC provides oversight of surge management and the hospital surge grid; a centralized electronic system that provides real-time visibility into operational capacity across the health system. The surge grid categorizes hospital status along a defined continuum from green to black, with each escalation level triggering clearly defined, accountable action items for every service line and facility within the system. These action items include, but are not limited to, activation of designated surge care areas, deployment of additional clinical and support staff, utilization of hallway or overflow beds when appropriate, staging of discharged patients in alternative care locations, and adjustment of nursing staffing ratios. Through structured escalation and standardized response, the Surge Grid enables proactive capacity management and supports the delivery of safe, high-quality care for all patients during periods of increased demand.

When the system escalates into "Red" or "Black" status, the organization shifts into high gear by convening urgent surge huddles. This process begins with critical data inputs: departmental leaders complete pre-prepared grids and update electronic logs of discharge delays to provide a clear picture of current bottlenecks. Armed with this data, a diverse group of participants—including hospital leadership, physicians, nurse leaders, ancillary services, and the System Physician Administrator—gather to assess the situation. Together, they forge real-time mitigation plans designed to resolve immediate obstacles and expand hospital capacity, ultimately relieving the intense strain on the Emergency Departments. Surge huddles are deliberately brief, structured and focused on actionable items emphasizing real-time problem solving rather than simply serving as a forum for report-out on current status. The brief nature of these huddles is designed to allow

attendees to return to their work as quickly as possible. The surge huddles are run by a member of the CMAC team.

Load Balancing: In addition, the CMAC plays a critical role in ensuring patients are appropriately placed across all hospitals and inpatient units throughout the system, even during periods of constrained capacity. Through active, system-wide bed management and real-time coordination, CMAC balances patient distribution to optimize unit-level and hospital-level capacity. This level-loading approach maximizes the system's ability to accept transfers while simultaneously reducing Emergency Department boarding and improving overall patient flow. Algorithm development and implementation is another key function of the CMAC. The CMAC uses sophisticated algorithms to distribute patients across the system. One example of a key innovation is the ICU Placement Algorithm and Capability Matrix. A large healthcare system may have over a dozen ICUs of varying types and capabilities. By identifying preferred, secondary and tertiary ICUs capable of handling specific pathologies, the system avoids bottlenecks while waiting for specific ICU beds to open when others across the system may have available capacity.

System Physician Administrator: During the evolution of the CMAC, a position of System Physician Administrator (SPA) was developed. The SPAs are sourced from a pool of experienced physician leaders across a variety of service lines including, but not limited to Emergency Medicine, Internal Medicine and surgical specialties. The SPA is a pivotal leadership role that serves as an escalation pathway for discharge delays and transfer disputes. Crucially, the SPA acts as a surrogate accepting physician for some inpatient services. This allows the system to "accept" a patient before a specific bed is identified, preventing the "call back later" response that often leads to patients being sent to competitors. By working closely with the transfer and bed navigators, this position allows for patients to have access to the care they need, at the time they need it and in the facility with the best capacity.

The SPA also serves as a physician resource for transfer navigators, supporting the review and coordination of transfer requests to ensure patients

receive the right care, in the right location, at the right time. In addition, the SPA functions as a point of escalation for the discharge expediter when physician input is required regarding potential barriers to discharge.

The CMAC maintains a rigorous focus on both regulatory standards and performance metrics including acceptance volume/percentage, Emergency Department to inpatient transfer percentage, total call volume, on-time transport performance, clinical quality metrics, Left Without Being Seen (LWBS), average hourly boarders, bed requested to assigned time, bed requested to depart time and both Emergency Department and inpatient LOS.

It is not enough to simply report out these Key Performance Indicators (KPIs). An institution must establish an accurate baseline, set goals using SMART framework, (Specific, Measurable, Achievable, Relevant and Time-bound). For example, Brown University Health found itself to be an outlier when it came to transfers accepted to the Emergency Department rather than directly to inpatient units. This results in potentially avoidable unnecessary second ED visits, excess resource utilization, crowding and a poor patient experience. In its first year, CMAC established a goal of increasing transfers accepted directly to inpatient units to 50% over this fiscal year. After 2 months, this has improved from an established baseline of 31% to 38.5%.

Transitioning to a centralized CMAC model represents a profound cultural shift that extends far beyond technical implementation. To navigate this evolution, leadership embarked on a "Road Show," engaging stakeholders across the system to secure early buy-in. These sessions were vital for explaining the strategic benefits of a command center, the mechanics of "level loading," the logic behind new algorithms, and the nuances of preliminary transfer acceptances while beds are pending. A core component of this change involves reshaping long-standing habits, specifically moving away from traditional "ED to ED" transfers in favor of direct inpatient admissions. This shift is essential for system decompression; by redirecting lower-acuity patients to community hospitals, the system preserves critical capacity at large tertiary centers

for specialized services that only they can provide. However, redirecting patients requires overcoming significant hesitation from families who may expect admission to the specific hospital where they first presented. To address this, clear communication and public awareness campaigns—often in partnership with other regional healthcare organizations—help patients understand the benefits of being admitted to the most appropriate facility within the system. Finally, the human element of transfer coordination demands a proactive approach to financial considerations. Addressing the costs of transportation early in the process is essential for patient-centered care. Because the system spans multiple states and various insurance products, the CMAC relies on close collaboration with financial services, case management, and legal teams. Together, they develop the standardized policies and transparent communication necessary to manage the regulatory and financial complexities of interstate transfers, ultimately ensuring a smoother experience for every patient.

The experiences related to the development and evolution of our system command center are not only technical solutions but represent a cultural transformation within the organization. As health systems grow in size and complexity, centralized command centers similar to the Brown University Health CMAC represent a critical evolution in hospital operations. Success depends as much on trust, communication, and shared accountability as it does on the data tracking and care algorithms. Other health systems considering similar command center structures must invest early in the engagement of all stakeholders in order to get buy-in to true system-level thinking.

## Conclusion

Healthcare faces a crisis of inadequate capacity to meet the demand for patients seeking access to care. As populations age and grow, this supply and demand mismatch will worsen. It is critical that access to unscheduled care be a priority. Maintaining emergency department operations during periods of high boarding and limited hospital capacity is a complex challenge that requires a coordinated, multifaceted approach. Sustainable solutions must be implemented at the ED, individual hospital, and broader healthcare

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system levels, with shared accountability across all stakeholders. Such alignment is essential to safeguarding patient safety, optimizing efficiency, delivering high-quality care, and supporting both patient and staff experience, while preserving access to emergency services across the region. Meaningful improvement depends on leadership engagement and frontline buy-in, coupled with the consistent measurement and longitudinal tracking of KPIs to guide data-driven, actionable quality improvement initiatives.

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## References:

1. Augustine J. A Sobering Year for Emergency Departments and Their Patients. ACEP Now. 2023. Accessed December 16, 2025. <https://www.acepnow.com/article/a-sobering-year-for-emergency-departments-and-their-patients/>
2. Weinick RM, Bruna S, Boicourt RM, Michael SS, Sessums LL. *AHRQ Summit to Address Emergency Department Boarding*. Agency for Healthcare Research and Quality; 2025.
3. Janke AT, Melnick ER, Venkatesh AK. Hospital Occupancy and Emergency Department Boarding During the COVID-19 Pandemic. *JAMA Netw Open*. 2022;5(9):e2233964. doi:10.1001/jamanetworkopen.2022.33964
4. Roussel M, Teissandier D, Yordanov Y, et al. Overnight Stay in the Emergency Department and Mortality in Older Patients. *JAMA Intern Med*. 2023;183(12):1378-1385. doi:10.1001/jamainternmed.2023.5961
5. Mathews KS, Durst MS, Vargas-Torres C, Olson AD, Mazumdar M, Richardson LD. Effect of Emergency Department and ICU Occupancy on Admission Decisions and Outcomes for Critically Ill Patients. *Crit Care Med*. 2018;46(5):720-727. doi:10.1097/CCM.0000000000002993
6. Singer AJ, Thode HC, Viccellio P, Pines JM. The association between length of emergency department boarding and mortality. *Acad Emerg Med Off J Soc Acad Emerg Med*. 2011;18(12):1324-1329. doi:10.1111/j.1553-2712.2011.01236.x
7. Rasouli HR, Esfahani AA, Nobakht M, et al. Outcomes of Crowding in Emergency Departments; a Systematic Review. *Arch Acad Emerg Med*. 2019;7(1):e52.
8. do Nascimento Rocha HM, da Costa Farre AGM, de Santana Filho VJ. Adverse Events in Emergency Department Boarding: A Systematic Review. *J Nurs Scholarsh Off Publ Sigma Theta Tau Int Honor Soc Nurs*. 2021;53(4):458-467. doi:10.1111/jnu.12653
9. Gross TK, Lane NE, Timm NL, COMMITTEE ON PEDIATRIC EMERGENCY MEDICINE. Crowding in the Emergency Department: Challenges and Best Practices for the Care of Children. *Pediatrics*. 2023;151(3):e2022060972. doi:10.1542/peds.2022-060972
10. Olson RM, Fleurant A, Beauparlant SG, et al. Prolonged Boarding and Racial Discrimination and Dissatisfaction Among Emergency Department Patients. *JAMA Netw Open*. 2024;7(9):e2433429. doi:10.1001/jamanetworkopen.2024.33429
11. Farley HL, Kwun R. *Emergency Department Crowding: High Impact Solutions*. ACEP; 2016. [https://www.acep.org/siteassets/sites/acep/media/crowding/empc\\_crowding-ip\\_092016.pdf](https://www.acep.org/siteassets/sites/acep/media/crowding/empc_crowding-ip_092016.pdf)
12. Mumma BE, McCue JY, Li CS, Holmes JF. Effects of emergency department expansion on emergency department patient flow. *Acad Emerg Med Off J Soc Acad Emerg Med*. 2014;21(5):504-509. doi:10.1111/acem.12366
13. Lowie B, Hicks C, Falat C, et al. Overcoming stagnant flow: A scoping review of vertical movement in the emergency department. *Acad Emerg Med*. 2024;31(3):256-262. doi:10.1111/acem.14846
14. Hu Y, Chan CW, Dong J, et al. Implementing a prediction driven framework for emergency department nurse staffing to optimize real time decisions. *Npj Health Syst*. 2025;2(1):16. doi:10.1038/s44401-025-00019-2
15. Yidom MYAB, Napoli A, Granovsky M, et al. Managing and Measuring Emergency Department Care: Results of the Fourth Emergency Department Benchmarking Definitions Summit. *Acad Emerg Med Off J Soc Acad Emerg Med*. 2020;27(7):600-611. doi:10.1111/acem.13978
16. Wiler JL, Gentle C, Halfpenny JM, et al. Optimizing emergency department front-end operations. *Ann Emerg Med*. 2010;55(2):142-160.e1. doi:10.1016/j.annemergmed.2009.05.021
17. Spaite DW, Bartholomeaux F, Guisto J, et al. Rapid process redesign in a university-based emergency department: decreasing waiting time intervals and improving patient satisfaction. *Ann Emerg Med*. 2002;39(2):168-177. doi:10.1067/mem.2002.121215
18. Morgan R. Turning around the turn-arounds: improving ED throughput processes. *J Emerg Nurs*. 2007;33(6):530-536. doi:10.1016/j.jen.2007.04.011
19. Bertoty DA, Kuszajewski ML, Marsh EE. Direct-to-room: one department's approach to improving ED throughput. *J Emerg Nurs*. 2007;33(1):26-30; quiz 93. doi:10.1016/j.jen.2006.09.018
20. Takakuwa KM, Shofer FS, Abbuhl SB. Strategies for dealing with emergency department overcrowding: a one-year study on how bedside registration affects patient throughput times. *J Emerg Med*. 2007;32(4):337-342. doi:10.1016/j.jemermed.2006.07.031

21. Oredsson S, Jonsson H, Rognes J, et al. A systematic review of triage-related interventions to improve patient flow in emergency departments. *Scand J Trauma Resusc Emerg Med.* 2011;19:43. doi:10.1186/1757-7241-19-43
22. Franklin BJ, Li KY, Somand DM, et al. Emergency department provider in triage: assessing site-specific rationale, operational feasibility, and financial impact. *J Am Coll Emerg Physicians Open.* 2021;2(3):e12450. doi:10.1002/emp2.12450
23. Spencer S, Stephens K, Swanson-Biearman B, Whiteman K. Health Care Provider in Triage to Improve Outcomes. *J Emerg Nurs.* 2019;45(5):561-566. doi:10.1016/j.jen.2019.01.008
24. Holroyd BR, Bullard MJ, Latoszek K, et al. Impact of a triage liaison physician on emergency department overcrowding and throughput: a randomized controlled trial. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2007;14(8):702-708. doi:10.1197/j.aem.2007.04.018
25. Abdulwahid MA, Booth A, Kuczawski M, Mason SM. The impact of senior doctor assessment at triage on emergency department performance measures: systematic review and meta-analysis of comparative studies. *Emerg Med J EMJ.* 2016;33(7):504-513. doi:10.1136/emered-2014-204388
26. Campbell P, Dennie M, Dougherty K, Iwaskiw O, Rollo K. Implementation of an ED protocol for pain management at triage at a busy Level I trauma center. *J Emerg Nurs.* 2004;30(5):431-438. doi:10.1016/j.jen.2004.06.013
27. Seguin D. A nurse-initiated pain management advanced triage protocol for ED patients with an extremity injury at a level I trauma center. *J Emerg Nurs.* 2004;30(4):330-335. doi:10.1016/j.jen.2004.06.010
28. Cooper JJ, Datner EM, Pines JM. Effect of an automated chest radiograph at triage protocol on time to antibiotics in patients admitted with pneumonia. *Am J Emerg Med.* 2008;26(3):264-269. doi:10.1016/j.ajem.2007.05.008
29. Ieraci S, Digiusto E, Sonntag P, Dann L, Fox D. Streaming by case complexity: evaluation of a model for emergency department Fast Track. *Emerg Med Australas EMA.* 2008;20(3):241-249. doi:10.1111/j.1742-6723.2008.01087.x
30. Bish PA, McCormick MA, Otegbeye M. Ready-JET-Go: Split Flow Accelerates ED Throughput. *J Emerg Nurs.* 2016;42(2):114-119. doi:10.1016/j.jen.2015.06.003
31. Lammila-Escalera E, Greenfield G, Aldakhil R, et al. Safety and Efficacy of Digital Check-in and Triage Kiosks in Emergency Departments: Systematic Review. *J Med Internet Res.* 2025;27:e69528. doi:10.2196/69528
32. Coyle N, Kennedy A, Schull MJ, et al. The use of a self-check-in kiosk for early patient identification and queuing in the emergency department. *CJEM.* 2019;21(6):789-792. doi:10.1017/cem.2019.349
33. Mahmood A, Wyant DK, Kedia S, et al. Self-Check-In Kiosks Utilization and Their Association With Wait Times in Emergency Departments in the United States. *J Emerg Med.* 2020;58(5):829-840. doi:10.1016/j.jemermed.2019.11.019
34. Joseph MJ, Summerscales M, Yogesan S, Bell A, Genevieve M, Kanagasingam Y. The use of kiosks to improve triage efficiency in the emergency department. *NPJ Digit Med.* 2023;6(1):19. doi:10.1038/s41746-023-00758-2
35. Joshi AU, Randolph FT, Chang AM, et al. Impact of Emergency Department Tele-intake on Left Without Being Seen and Throughput Metrics. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2020;27(2):139-147. doi:10.1111/acem.13890
36. Nawar EW, Niska RW, Xu J. National Hospital Ambulatory Medical Care Survey: 2005 emergency department summary. *Adv Data.* 2007;(386):1-32.
37. Koehler J, Flarity K, Hertner G, et al. Effect of troponin I Point-of-Care testing on emergency department throughput measures and staff satisfaction. *Adv Emerg Nurs J.* 2013;35(3):270-277. doi:10.1097/TME.0b013e31829d2048
38. Singer AJ, Ardise J, Gulla J, Cangro J. Point-of-care testing reduces length of stay in emergency department chest pain patients. *Ann Emerg Med.* 2005;45(6):587-591. doi:10.1016/j.annemergmed.2004.11.020
39. Lee-Lewandrowski E, Nichols J, Van Cott E, et al. Implementation of a rapid whole blood D-dimer test in the emergency department of an urban academic medical center: impact on ED length of stay and ancillary test utilization. *Am J Clin Pathol.* 2009;132(3):326-331. doi:10.1309/AJCP6US3ILGEAREE
40. Storrow AB, Zhou C, Gaddis G, et al. Decreasing lab turnaround time improves emergency department throughput and decreases emergency medical services diversion: a simulation model. *Acad*

*Emerg Med Off J Soc Acad Emerg Med.* 2008;15(11):1130-1135. doi:10.1111/j.1553-2712.2008.00181.x

41. Storrow AB, Lyon JA, Porter MW, Zhou C, Han JH, Lindsell CJ. A Systematic Review of Emergency Department Point-of-Care Cardiac Markers and Efficiency Measures. *Point Care J -Patient Test Technol.* 2009;8(3):121-125. doi:10.1097/POC.0b013e3181b316b9

42. Shaw JLV. Practical challenges related to point of care testing. *Pract Lab Med.* 2016;4:22-29. doi:10.1016/j.plabm.2015.12.002

43. Lamb L, Kashani P, Ryan J, et al. Impact of an in-house emergency radiologist on report turnaround time. *CJEM.* 2015;17(1):21-26. doi:10.2310/8000.2013.131235

44. Abu Mughli R, Baia Medeiros DT, MacDermott R, et al. Overnight emergency radiologist coverage model with preserved resident autonomy: impact on report turnaround times and resident experience. *Emerg Radiol.* 2025;32(2):203-215. doi:10.1007/s10140-025-02330-9

45. Jalal S, Ouellette H, Ante Z, Munk P, Khosa F, Nicolaou S. Impact of 24/7/365 Attending Radiologist Coverage on the Turnaround Time in an Emergency and Trauma Radiology Department. *Can Assoc Radiol J J Assoc Can Radiol.* 2021;72(3):548-556. doi:10.1177/0846537119899321

46. Santo L, Peters Z, DeFrances C. *Emergency Department Visits for Adults with Mental Health Disorders: United States, 2017–2019.* National Center for Health Statistics (U.S.); 2021. doi:10.15620/cdc:112081

47. Baia Medeiros DT, Hahn-Goldberg S, O'Connor E, Aleman DM. Analysis of emergency department length of stay for mental health visits: A case study of a Canadian academic hospital. *CJEM.* 2019;21(3):374-383. doi:10.1017/cem.2018.417

48. Kim AK, Vakkalanka JP, Van Heukelom P, Tate J, Lee S. Emergency psychiatric assessment, treatment, and healing (EmPATH) unit decreases hospital admission for patients presenting with suicidal ideation in rural America. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2022;29(2):142-149. doi:10.1111/acem.14374

49. Parwani V, Tinloy B, Ulrich A, et al. Opening of Psychiatric Observation Unit Eases Boarding Crisis. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2018;25(4):456-460. doi:10.1111/acem.13369

50. Magarey AW, Weng J, Looi JCL, Allison S, Bastiampillai T. Systematic Review of Psychiatric Observation Units and Their Impact on Emergency Department Boarding. *Prim Care Companion CNS Disord.* 2023;25(6):22r03468. doi:10.4088/PCC.22r03468

51. Stamy C, Shane DM, Kannedy L, et al. Economic Evaluation of the Emergency Department After Implementation of an Emergency Psychiatric Assessment, Treatment, and Healing Unit. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2021;28(1):82-91. doi:10.1111/acem.14118

52. Brenner R, Madhusoodanan S, Logiudice J, Castell G, MacKenzie T, O'Shaughnessy PM. A comparison study of the turnaround time for telepsychiatry versus face-to-face consultations in general hospital nonpsychiatric emergency rooms. *Ann Clin Psychiatry Off J Am Acad Clin Psychiatr.* 2020;32(1):12-16.

53. Freeman RE, Zhong C, Bahar P, et al. U.S. Emergency Department Telepsychiatry Use in 2019. *Telemed J E-Health Off J Am Telemed Assoc.* 2023;29(3):366-375. doi:10.1089/tmj.2022.0191

54. Shalev L, Eitan R, Rose AJ. The Use of Telepsychiatry Services in Emergency Settings: Scoping Review. *J Med Internet Res.* 2024;26:e51814. doi:10.2196/51814

55. Narasimhan M, Druss BG, Hockenberry JM, et al. Impact of a Telepsychiatry Program at Emergency Departments Statewide on the Quality, Utilization, and Costs of Mental Health Services. *Psychiatr Serv Wash DC.* 2015;66(11):1167-1172. doi:10.1176/appi.ps.201400122

56. Grover CA, Sughair J, Stoopes S, et al. Case Management Reduces Length of Stay, Charges, and Testing in Emergency Department Frequent Users. *West J Emerg Med.* 2018;19(2):238-244. doi:10.5811/westjem.2017.9.34710

57. Bristow DP, Herrick CA. Emergency department case management: the dyad team of nurse case manager and social worker improve discharge planning and patient and staff satisfaction while decreasing inappropriate admissions and costs: a literature review. *Lippincotts Case Manag Manag Process Patient Care.* 2002;7(6):243-251. doi:10.1097/00129234-200211000-00006

58. Gordon JA. Cost-benefit analysis of social work services in the emergency department: a conceptual model. *Acad Emerg Med Off J Soc*

*Acad Emerg Med.* 2001;8(1):54-60. doi:10.1111/j.1553-2712.2001.tb00552.x

59. Carlill G, Gash E, Hawkins G. Preventing Unnecessary Hospital Admissions: An Occupational Therapy and Social Work Service in an Accident and Emergency Department. *Br J Occup Ther.* 2002;65(10):440-445. doi:10.1177/030802260206501002

60. Bird S, Thompson C, Williams KE. Primary contact physiotherapy services reduce waiting and treatment times for patients presenting with musculoskeletal conditions in Australian emergency departments: an observational study. *J Physiother.* 2016;62(4):209-214. doi:10.1016/j.jphys.2016.08.005

61. Venkatesh AK, Geisler BP, Gibson Chambers JJ, Baugh CW, Bohan JS, Schuur JD. Use of observation care in US emergency departments, 2001 to 2008. *PLoS One.* 2011;6(9):e24326. doi:10.1371/journal.pone.0024326

62. Perry M, Franks N, Pitts SR, et al. The impact of emergency department observation units on a health system. *Am J Emerg Med.* 2021;48:231-237. doi:10.1016/j.ajem.2021.04.079

63. Kelen GD, Scheulen JJ, Hill PM. Effect of an emergency department (ED) managed acute care unit on ED overcrowding and emergency medical services diversion. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2001;8(11):1095-1100. doi:10.1111/j.1553-2712.2001.tb01122.x

64. Ross MA, Hockenberry JM, Mutter R, Barrett M, Wheatley M, Pitts SR. Protocol-driven emergency department observation units offer savings, shorter stays, and reduced admissions. *Health Aff Proj Hope.* 2013;32(12):2149-2156. doi:10.1377/hlthaff.2013.0662

65. Baugh CW, Venkatesh AK, Hilton JA, Samuel PA, Schuur JD, Bohan JS. Making greater use of dedicated hospital observation units for many short-stay patients could save \$3.1 billion a year. *Health Aff Proj Hope.* 2012;31(10):2314-2323. doi:10.1377/hlthaff.2011.0926

66. Gopalsami A, Wasserman N, Roach K, Perel M, Torbati S. The Halo Effect of an Emergency Department-Run Observation Unit on Hospital-Wide Throughput. *Ann Emerg Med.* 2025;86(3):S141. doi:10.1016/j.annemergmed.2025.06.340

67. Franklin BJ, Vakili S, Huckman RS, et al. The Inpatient Discharge Lounge as a Potential Mechanism to Mitigate Emergency Department

Boarding and Crowding. *Ann Emerg Med.* 2020;75(6):704-714. doi:10.1016/j.annemergmed.2019.12.002

68. Nasr Isfahani M, Davari F, Azizkhani R, Rezvani M. Decreased Emergency Department Overcrowding by Discharge Lounge: A Computer Simulation Study. *Int J Prev Med.* 2020;11:13. doi:10.4103/ijpvm.IJPVM\_582\_18

69. Jolly Graham A, Platt A, Knutsen K, Fletcher E, Gallagher D. Impact of geographical cohorting, multidisciplinary rounding and incremental case management support on hospital length of stay and readmission rates: a propensity weighted analysis. *BMJ Open Qual.* 2024;13(2):e002737. doi:10.1136/bmjopen-2023-002737

70. Pearce S, Marchand T, Shannon T, Ganshorn H, Lang E. Emergency department crowding: an overview of reviews describing measures, causes, and harms. *Intern Emerg Med.* 2023;18(4):1137-1158. doi:10.1007/s11739-023-03239-2

71. McKenna P, Heslin SM, Viccellio P, Mallon WK, Hernandez C, Morley EJ. Emergency department and hospital crowding: causes, consequences, and cures. *Clin Exp Emerg Med.* 2019;6(3):189-195. doi:10.15441/ceem.18.022

72. Eriksson CO, Stoner RC, Eden KB, Newgard CD, Guise JM. The Association Between Hospital Capacity Strain and Inpatient Outcomes in Highly Developed Countries: A Systematic Review. *J Gen Intern Med.* 2017;32(6):686-696. doi:10.1007/s11606-016-3936-3

73. Lingsma HF, Bottle A, Middleton S, Kievit J, Steyerberg EW, Marang-van de Mheen PJ. Evaluation of hospital outcomes: the relation between length-of-stay, readmission, and mortality in a large international administrative database. *BMC Health Serv Res.* 2018;18(1):116. doi:10.1186/s12913-018-2916-1

74. Kurek A, Makowski B, Shah R, Quiroga A. A Length-of-Stay Reduction Initiative to Enhance Hospital Efficiency. *NEJM Catal.* 2025;6(12):CAT.24.0523. doi:10.1056/CAT.24.0523

75. Hailu R, Wilcock AD, Zachrisson KS, Mehrotra A. National Trends in the Use of Specialty Consultations in Emergency Department Visits, 2009 to 2019. *Ann Emerg Med.* 2023;82(5):634-635. doi:10.1016/j.annemergmed.2023.06.021

76. Voaklander B, Gaudet LA, Kirkland SW, Keto-Lambert D, Villa-Roel C, Rowe BH. Interventions to improve consultations in the emergency department:

A systematic review. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2022;29(12):1475-1495. doi:10.1111/acem.14520

77. Brick C, Lowes J, Lovstrom L, et al. The impact of consultation on length of stay in tertiary care emergency departments. *Emerg Med J EMJ.* 2014; 31(2):134-138. doi:10.1136/emered-2012-201908

78. Cho SJ, Jeong J, Han S, et al. Decreased emergency department length of stay by application of a computerized consultation management system. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2011;18(4):398-402. doi:10.1111/j.1553-2712.2011.01039.x

79. Wallace D, Aher C, Wright P, et al. Expanding acute care treatment and disposition options: Creating a post-ED rapid clinic follow-up program. *Am J Emerg Med.* 2025;94:166-172. doi:10.1016/j.ajem.2025.04.054

80. Carmel AS, Steel P, Tanouye R, et al. Rapid Primary Care Follow-up from the ED to Reduce Avoidable Hospital Admissions. *West J Emerg Med.* 2017;18(5):870-877. doi:10.5811/westjem.2017.5.33593

81. Malloy KM, Pardo JL, Garifullin MV, Gurm HS, Parekh VI. Using Predictive Bed Planning to Reduce Case Cancellations and Create Growth Opportunities in High Occupancy Academic Health Systems. *J Am Coll Surg.* 2021;233(5, Supplement 2):e107. doi:10.1016/j.jamcollsurg.2021.08.286

82. Taylor M. *Hospital, Heal Thyself: One Brilliant Mathematician's Proven Plan for Saving Hospitals, Many Lives, and Billions of Dollars.* Wiley; 2024.

83. Moroço DM, Pazin-Filho A. Decreasing boarders in the emergency department by reducing clerical work in the discharge process of in-hospital patients in Brazil - an interrupted time-series analysis. *BMC Emerg Med.* 2022;22(1):99. doi:10.1186/s12873-022-00656-y

84. Powell ES, Khare RK, Venkatesh AK, Van Roo BD, Adams JG, Reinhardt G. The Relationship between Inpatient Discharge Timing and Emergency Department Boarding. *J Emerg Med.* 2012;42(2): 186-196. doi:10.1016/j.jemermed.2010.06.028

85. Khanna S, Sier D, Boyle J, Zeitz K. Discharge timeliness and its impact on hospital crowding and emergency department flow performance - Khanna - 2016 - Emergency Medicine Australasia - Wiley Online Library. Accessed December 16, 2025.

<https://onlinelibrary.wiley.com/doi/10.1111/1742-6723.12543>

86. Bodnar B, Kane EM, Rupani H, et al. Bed downtime: the novel use of a quality metric allows inpatient providers to improve patient flow from the emergency department. *Emerg Med J EMJ.* 2022;39(3):224-229. doi:10.1136/ememed-2020-209425

87. Patel PB, Combs MA, Vinson DR. Reduction of admit wait times: the effect of a leadership-based program. *Acad Emerg Med Off J Soc Acad Emerg Med.* 2014;21(3):266-273. doi:10.1111/acem.12327

88. Chang AM, Cohen DJ, Lin A, et al. Hospital Strategies for Reducing Emergency Department Crowding: A Mixed-Methods Study. *Ann Emerg Med.* 2018;71(4):497-505.e4. doi:10.1016/j.annemergmed.2017.07.022

89. Pardo JL, Garifullin MV, Farquhar NM, Parekh VI. Designing a Hospital Command Center with Proven ROI: The University of Michigan M2C2 Model. *NEJM Catal.* 2025;6(11):CAT.25.0080. doi: 10.1056/CAT.25.0080

90. Franklin BJ, Mueller SK, Bates DW, Gandhi TK, Morris CA, Goralnick E. Use of Hospital Capacity Command Centers to Improve Patient Flow and Safety: A Scoping Review. *J Patient Saf.* 2022;18(6): e912-e921. doi:10.1097/PTS.0000000000000976

91. Franklin BJ, Yenduri R, Parekh VI, et al. Hospital Capacity Command Centers: A Benchmarking Survey on an Emerging Mechanism to Manage Patient Flow. *Jt Comm J Qual Patient Saf.* 2023; 49(4):189-198. doi:10.1016/j.jcjq.2023.01.007