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Operational Challenges and Management Strategies Affecting Emergency Department Length of Stay: A Literature Review

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Abstract

Emergency department (ED) length of stay (LOS) is an important indicator of healthcare quality and operational efficiency. Prolonged ED LOS contributes to overcrowding, delays in treatment, morbidity, mortality, and reduced patient satisfaction. Numerous studies have examined factors associated with ED LOS, but evidence remains fragmented when viewed through the input-throughput-output conceptual framework. This review aimed to evaluate operational challenges affecting ED LOS and identify management strategies to improve patient flow. A literature search was conducted in PubMed and Google Scholar for studies published between 2021 and 2026. Title and abstract screening were conducted, and relevant full-text articles written in English were included. Three major operational challenges affecting ED LOS were identified. Input factors were related to ED overcrowding, which was associated with increased patient congestion, delayed triage, and prolonged LOS. Throughput factors included physician workload and nurse shortages, which negatively affected patient flow and care delivery. Output factors were dominated by boarding and access block, which were also associated with prolonged LOS, adverse patient outcomes, and increased mortality risk. Several management strategies were identified, including fast-track triage systems, physician-to-nurse teams, boarding-restriction protocols, and optimized bed-allocation models. In conclusion, overcrowding, staffing, and boarding are key operational challenges influencing ED LOS, and they are interconnected and addressed through coordinated strategies. Among them, boarding appears to have a greater influence on operational bottlenecks because it affects ED process efficiency, hospital-wide patient flow, and bed management. Strategies targeting boarding may provide broader improvements in ED LOS while simultaneously alleviating overcrowding, staff shortages, and workload.

Keywords: Emergency Department, Length Of Stay, Overcrowding, Staffing, Boarding

INTRODUCTION

The emergency department (ED) length of stay (LOS) is defined as the time between a patient's arrival to the ED and the time the patient leaves the ED (Andersson et al., 2025). A prolonged LOS in the ED raises concerns about overcrowding and the ED's inability to respond appropriately to emergent patients. Overcrowding in the ED increases the risk of delayed treatment, morbidity, mortality, and patient complaints (Habib & Sudaryo, 2023; Morley et al., 2018). Prolonged ED LOS is influenced by patient demographics like older age, clinical severity, operational factors, systemic factors, lack of insurance support, disposition time for more than 6 hours, and a higher number of ordered para-clinical tests (Kim et al., 2024).

Although multiple factors affect ED LOS, it can be divided into three major aspects: input, throughput, and output (Asplin et al., 2003). Input factors represent access to the ED. Throughput factors are internal factors, including diagnostic and decision-making time, the quality of medical personnel's work, and complementary testing performed in the ED. Output factors are affected by the availability of hospital beds, delays in patient transport to leave the ED, and patient boarding (Savioli et al., 2022). Hospital boarding is a major contributor to

prolonged ED LOS. Hospital boarding or access block occurs when planned or admitted patients remain in the ED due to an inability to transfer within a reasonable time frame (on average no more than 8 hours) (Australasian College for Emergency Medicine, 2022; Forero et al., 2011). As an indicator of ED crowding, access block increases the risk of medication delays and errors (Cheng et al., 2022).

Input factors, as the initial entry point, frequently trigger a domino effect on the overall performance of the emergency department. A primary strain during this phase is the unpredictable surge in low-acuity patient visits. When primary healthcare facilities in the community are underutilized or inaccessible, the ED is often forced to function as a safety net for non-emergent care. Consequently, this influx creates severe bottlenecks at the triage area, which not only prolongs initial waiting times but also diverts critical resources away from patients with life-threatening conditions.

Moving into the throughput phase, the internal operational complexities of the ED become the primary determinants of efficiency. Shortages in medical personnel and unbalanced nurse-to-patient ratios routinely slow down initial clinical assessments and immediate interventions. This issue is further compounded by turnaround times for complementary diagnostics, such as central laboratory and radiology results, which frequently act as major operational bottlenecks. Without integrated communication protocols and optimized intra-ED workflows, clinical decision-making is severely delayed, significantly inflating the overall LOS.

The culmination of these operational bottlenecks is most acutely felt during the output phase, primarily driven by the phenomenon of hospital boarding. When inpatient wards or intensive care units reach maximum capacity, admitted patients are forced to remain in the ED. This situation creates a vicious cycle where dynamic emergency beds are inadvertently converted into temporary holding units. This systemic failure in the output phase not only paralyzes the ED's capacity to receive new, incoming patients but also overburden emergency staff with secondary inpatient care duties.

While the input-throughput-output conceptual model is widely acknowledged, a comprehensive synthesis of how these three dimensions interact to exacerbate access block remains fragmented in current literature. Most prior studies have focused in isolation on single-faceted solutions, such as accelerating laboratory turnaround times or expanding physical ED space, without addressing the broader systemic links across the hospital infrastructure. Therefore, this review specifically aims to bridge this gap by mapping the interconnected nature of these operational challenges. Through this holistic approach, we seek to identify evidence-based, adaptable management strategies capable of reducing ED LOS while simultaneously safeguarding patient safety.

Numerous studies have independently evaluated factors associated with ED LOS and management strategies to reduce it. However, evidence remains fragmented when viewed through the input-throughput-output concept. Hence, understanding the contributions of overcrowding, hospital staffing, and boarding may help identify system-level strategies to improve ED LOS. Therefore, this review aims to evaluate operational challenges using the input-throughput-output conceptual model and to identify management strategies that affect ED LOS.

METODE

A literature search was conducted using PubMed and Google Scholar for studies published between 2021 and 2026. The search strategy used the keywords “emergency department length of stay”, “ED crowding”, “boarding”, “staffing”, and “ED LOS determinants”. After title and abstract screening, articles relevant to the operational determinants of ED LOS were selected for full-text review. Articles on emergency department (ED) length of stay (LOS) and its determinants were included. Only open-access, English-language studies were included in this paper. Conference abstracts and studies focusing exclusively on specialized ED populations, such as psychiatric or pediatric patients, were excluded.

RESULTS AND DISCUSSION

ED overcrowding is a critical issue affecting healthcare systems worldwide. Overcrowding occurs when an ED is compromised by an overload of patients awaiting care, including consultations, diagnosis, treatments, referrals, and discharges, that exceeds the service's operational capacity. Based on the input-throughput-output conceptual model, overcrowding lies within the input factor (Devia Jaramillo et al., 2025; Kim et al., 2024). ED crowding hinders ED staff's ability to provide adequate first aid to new emergency patients, as retained patients accumulate in the ED, contributing to congestion and prolonged LOS (Lee et al., 2022).

ED crowding may be measured by calculating the ED occupancy rate from the ratio of the total number of occupying patients to the total number of beds in the ED (Lee et al., 2022). The measurement of ED overcrowding may also be calculated based on the severity of the ED crowd as well as considering the type, location, and number of beds offered by the ED hospital service. A study conducted in Sweden found that, based on hospital bed occupancy, high levels of crowding (>95%) increase ED LOS by up to 11 minutes (Andersson et al., 2025).

Other factors may also influence overcrowding. Patients were more congested on weekdays compared to Friday and Saturday. Even more, patients who arrive on Tuesday, Wednesday, and Thursday were found to be more likely to have a prolonged LOS. This is due to physicians' tendency to schedule medical procedures or hospitalizations at the beginning of the week and discharge patients before the weekend (Lee et al., 2022).

Because multiple variables influence ED overcrowding, mitigation plans may begin either within or outside the ED. Overcrowding disrupts triage systems by blocking patient access to triage and increasing time spent in the ER, thereby indirectly affecting ED LOS (Savioli et al., 2022). The triage area has become a key target for interventions aimed at reducing ED overcrowding. Triage interventions handled by doctors, the introduction of fast-track triage, and point-of-care testing at the patient’s bedside reduce ED LOS, which in turn reduces the ED crowd (Devia Jaramillo et al., 2025). In addition, overcrowding is significantly caused by obstruction of outflow, or an access block. An access block is caused by crowding across the entire hospital, so the solution to ED overcrowding should focus not only on ED interventions but also on patient flow throughout the hospital. A study at a tertiary university hospital in Korea found that implementing a boarding restriction protocol effectively reduced ED crowding. This protocol is coordinated for patients requiring hospitalization, with the aim of moving them from the ED within the first 24 hours. Attending physicians were notified when patients were not assigned a bed within 18 hours. If the attending physician agrees to transfer, the patient will be dispatched at 24 hours. On the other hand, if the patient is non-transferable or refuses transfer, a priority bed allocation will be made for the patient over other patients in the ED (Lee et al., 2022). This suggests that hospitals may consider adapting this protocol to cater to their needs, available resources, service quality, and service capacity.

These findings suggest that ED overcrowding is not only a consequence of patient overflow but also reflects inefficiencies in patient flow throughout the hospital. Therefore, interventions that target both triage and hospital-wide discharge coordination may be more effective than an isolated ED-based solution approach.

Aside from input-related factors like overcrowding, throughput factors also play an important role in ED LOS. Throughput factors, such as staff utilization, are used as indicators to evaluate operational efficiency in hospital management. Staff utilization affects ED workflows and the number of patients the ED can care for. Failure to utilize available staff may lead to ED crowding, which eventually increases physician workload. As a result, service delivery, quality and safety of patient care, and the number of patients left-without-being-seen (LWBS) increase (Chen et al., 2024; Heslin et al., 2025).

Physicians experience dynamic fluctuations in workload throughout a shift, including patient observation, medical interventions, and frequent reassessments. Physician workload may be quantified by measuring the impact on ED LOS. However, this measurement does not reflect each physician's workload, given the variety of patient care needs. Hence, an alternative for quantifying physician workload is to calculate the patient-to-physician ratio throughout the

patient's stay in the ED. A study found that a higher patient-to-physician ratio was associated with longer ED LOS and worse patient outcomes. Among the workload categories analyzed, the 10-19-patient group performed better than the 20-29-patient group. This disparity provides a baseline for when workload exceeds a manageable threshold that could compromise patient care. Furthermore, a 1.79 increase in mortality risk was observed when these physicians worked above this threshold (Chen et al., 2024). Although the study was conducted in a single academic ED, this information could serve as a baseline for future hospital research, as many confounding factors, such as hospital size, population, resources, and staffing models, affect the patient-to-physician ratio.

Although physician workload has received considerable attention, nursing workforce shortages also contribute substantially to throughput inefficiencies. The previous COVID-19 pandemic further exacerbated this shortage. A survey in the United States conducted by the National Council of State Boards of Nursing's National Nursing Workforce revealed that 28% of surveyed nurses plan to retire within the next 5 years (Hodgson et al., 2024). This trend contributes to ongoing nursing shortages, especially in the ED, with high workloads and burnout rates that would gradually worsen. Shortages of registered nurses (RN) negatively impact the flow, ED crowding, and patient ED LOS. An increased number of patients in the ED means a higher workload for nursing staff. This also delays the patient care pathway, resulting in a longer ED LOS. This delay may eventually snowball and result in a crowded emergency department (Drennan et al., 2024).

Hospitals have tried to mitigate nurse shortages through nurse retention efforts, rapid hiring, and educational programs. These solutions, however, do not respond to an acute crisis. A study suggested implementing a physician-to-nurse team (PNT). The PNT consists of attending physicians and licensed practical nurses positioned next to triage, with mobile computers, procedure carts, and a private examination room. The team provides acute care for patients in the waiting room and decides whether a higher level of care is needed. If a patient requires a higher level of care, the remaining evaluation and treatment takes place in the ED. But if no higher level of care is needed, treatment and evaluation are conducted in the PNT hallway. It was found that implementing PNT shortens arrival-to-provider time, reduces 72-hour revisits, lowers the total number of patients who visit the ED, reduces ED discharge burden, and lowers ED LOS. Moreover, it reduces the trend of patients' LWBS (Heslin et al., 2025). This implementation demonstrates that PNT is a novel solution to improve throughput factors for hospitals experiencing nursing shortages and lacking the resources to undertake additional construction or implement new protocols in the ED.

Staffing-related factors inevitably influence ED LOS through workforce availability and workforce distribution. This evidence suggests that optimizing physician and nursing resources, rather than simply increasing the number of staff per shift, may improve patient flow and reduce delays in care delivery.

In addition to input-and-throughput factors, output factors, such as boarding, also remain a problem globally. The American College of Emergency Physicians (ACEP) defines boarding as the practice of holding patients in the emergency department after the decision to admit has been made. Hence, boarding time could be measured from the decision to admit to the patient's physical departure from the ED (American College of Emergency Physicians, 2023).

ED boarding is affected by total patient volume and the LOS of admitted and discharged patients. ED boarding parameters between hospitals may vary because they are tailored to each hospital's characteristics. Calculations of parameters may be based on the time of day when patient volume begins to increase or on a cutoff average time spent for patient boarding. In addition, the ED not only affects the patients who are boarded. It also affects patients who are simultaneously admitted through the ED during the board. A study in Pennsylvania compared different types of EDs, resulting in different increases of ED LOS. A rural academic center with an access block showed a 14-minute increase in ED LOS per patient boarded. On the other hand, a fully board-certified ED showed a 12-minute increase in ED LOS per patient

boarded (Laam et al., 2021). This signifies that the magnitude of ED LOS is highly dependent on the hospital type and ED characteristics.

ED boarding is affected by numerous factors, including bed occupancy and the imbalance between the available infrastructure approved and licensed by the facility and the demand for service in the ED (Motimele et al., 2025). Research has shown that bed occupancy has a non-linear relationship with ED LOS. Observations have shown that as bed occupancy increases, a greater proportion of patients have longer ED LOS. A maximum ED LOS was seen at bed occupancy levels of 100%. A potential mechanism for this relationship is access block (Paling et al., 2020). Access block occurs when ED patients who require inpatient care are unable to obtain appropriate hospital beds within a reasonable time frame (averaging 4 to 8 hours). Inaccessibility of resources over this time frame delays service delivery, resulting in poor-quality care for patients. In addition, access block also increases the risk of medication delays, medication errors, and adverse events (Cheng et al., 2022; Paling et al., 2020). Risk for access blocks can be seen from bed occupancy rates and ED LOS. A study in Shanghai found that patients who stayed and were not transferred to wards for more than 24 hours had an increased risk of in-hospital mortality and death within 30 days (Cheng et al., 2022). This suggests that patients who are at the greatest risk of access block impacts are the ones who were never admitted to the ward, as they may face delays in service, care, near misses, and risks of LWBS.

Strategies to address bed occupancy have been widely implemented worldwide. A model developed comprising four models, including: intra-departmental bed sharing, cross-departmental bed lending with a 5% capacity, optimized bed allocation, and combined optimization with bed borrowing, has shown improvements to ED LOS by 12 to 24 hours. These models provide solutions to bed occupancy problems in the ED. Strategies involving borrowing and sharing strategies compared with optimized bed allocation resulted in a two-fold higher rate of ED LOS (which can be up to 6 hours). The model tested at a teaching hospital in Taiwan demonstrated that the most promising approach to reducing ED congestion without increasing nursing workload was to integrate optimal bed allocation with bed borrowing. This highlights the importance of flexibility in managing ED congestion, including cross-departmental resource sharing and sharing entities within the hospital. Departmental bed lending with a 5% capacity remains an option for hospitals that prefer simplicity or are simply transitioning, allowing departments to adapt, since the model still provides benefits in reducing ED LOS (Wang et al., 2025).

Taken as a whole, the evidence indicates that boarding is strongly associated with prolonged ED LOS and adverse patient outcomes. Boarding reflects the operational limitations in inpatient settings rather than the ED performance alone. This suggests that effective solutions require hospital-wide coordination of bed management and patient flow.

CONCLUSION

In conclusion, based on the input-throughput-output conceptual model, overcrowding, staffing, and boarding are key operational challenges affecting ED LOS. They are interconnected and should be addressed through coordinated management strategies. Among the factors discussed, boarding appears to have a greater influence on operational bottlenecks because it affects ED process efficiency, hospital-wide patient flow, and bed management. Consequently, interventions targeting boarding may provide broader improvements in ED LOS while simultaneously alleviating overcrowding, staff shortages, and workload. Future research should evaluate integrated interventions that simultaneously target multiple operational factors across different healthcare systems.

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