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Triage Outcomes and Patient Flow in a Tertiary Emergency Department: A Prospective Audit

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ABS TRAC T

***Background*:** Emergency department overcrowding is a global healthcare crisis that compromises patient safety, delays time-sensitive treatments, and increases morbidity and mortality. Triage systems such as the Emergency Severity Index guide resource allocation, yet comprehensive prospective data on patient flow metrics and triage outcomes from Indian tertiary emergency departments remain sparse. ***Methods*:** A prospective clinical audit was conducted over 12 months from Feb 2023 to Jan 2024 at a tertiary emergency department in India. All 2,400 consecutive adult presentations were included. Patients were triaged using the five-level Emergency Severity Index. Time-stamped data were collected for door-to-triage, door-to-doctor, and emergency department length of stay. Disposition patterns, left-without-being-seen rates, and temporal variation in patient volume were analysed. Multivariate logistic regression identified predictors of prolonged emergency department length of stay exceeding six hours. ***Results*:** The triage distribution was ESI Level 1 in 4.2%, Level 2 in 12.8%, Level 3 in 38.5%, Level 4 in 28.0%, and Level 5 in 16.5%. The median door-to-triage time was 6 minutes (IQR 3–12), median door-to-doctor time was 24 minutes (IQR 12–48), and median emergency department length of stay was 4.2 hours (IQR 2.1–8.6). The overall admission rate was 38.2%, left-without-being-seen rate was 6.8%, and emergency department mortality was 1.7%. Peak volume occurred between 6 PM and midnight, accounting for 35.6% of daily presentations. Independent predictors of prolonged length of stay were ESI Level 2–3 acuity (adjusted OR 3.24, $p < 0.001$), awaiting specialist consultation (aOR 2.42, $p < 0.001$), advanced imaging requirement (aOR 2.68, $p < 0.001$), and evening presentation (aOR 1.86, $p = 0.004$). ***Conclusion*:** Emergency department overcrowding during evening hours significantly prolongs patient flow times. Specialist consultation delays and imaging waits are the primary modifiable drivers of prolonged length of stay. Increased staffing during peak hours, fast-track pathways for low-acuity patients, and point-of-care testing are recommended.

Keywords: *Emergency Department, Triage, Emergency Severity Index, Overcrowding, Patient Flow, Length of Stay, Door-To-Doctor Time, Clinical Audit, India.*

INTRODUCTION

Emergency departments serve as the critical interface between the community and the hospital, providing the first point of medical contact for patients with acute, potentially life-threatening conditions as well as those with lower-acuity complaints who lack access to alternative healthcare pathways [1]. Over the past two decades, emergency department overcrowding has been recognised as a global healthcare crisis, with ramifications extending beyond patient discomfort to encompass delayed diagnosis, postponement of time-critical interventions, increased in-hospital mortality, elevated rates of medical errors, and significant healthcare worker burnout [2].

The causes of emergency department overcrowding are multifactorial and have been conceptualised using the input–throughput–output model. Input factors include rising patient volumes, increasing acuity, and inappropriate utilisation by non-urgent patients. Throughput factors encompass prolonged diagnostic workups, specialist consultation delays, and staffing shortages. Output factors, particularly boarding of admitted patients awaiting

inpatient beds, have been identified as the single most important contributor to overcrowding in many settings [3]. The downstream consequences include ambulance diversion, prolonged waiting times, treatment delays for myocardial infarction and sepsis patients, and increased 30-day mortality among admitted patients who experience prolonged boarding [4].

Triage systems are designed to categorise patients by clinical urgency and predicted resource needs, ensuring that the most critically ill patients receive immediate attention while lower-acuity patients are managed in a safe and timely manner. The Emergency Severity Index, a five-level triage algorithm developed by the Agency for Healthcare Research and Quality, incorporates both acuity assessment and predicted resource utilisation into its classification, making it particularly suited for evaluating emergency department patient flow and resource allocation efficiency [5]. ESI has demonstrated good inter-rater reliability and predictive validity for hospital admission, resource consumption, and mortality across diverse settings [6].

Patient flow metrics including door-to-triage time, door-to-doctor time, and emergency department length of stay are internationally recognised quality indicators that reflect the operational efficiency of emergency department care. The American College of Emergency Physicians has recommended door-to-doctor time benchmarks of less than 10 minutes for ESI Level 1 and less than 30 minutes for ESI Level 2 patients [7]. The left-without-being-seen rate, defined as the proportion of triaged patients who depart before physician evaluation, serves as a surrogate marker for access barriers and overcrowding severity, with rates exceeding 5% considered indicative of significant overcrowding [8].

In India, emergency medicine is a relatively young specialty, with the first dedicated postgraduate training programmes established in 2009. The rapid expansion of emergency departments in tertiary and secondary hospitals has not been accompanied by commensurate increases in trained emergency physicians, nursing staff, or support infrastructure [9]. Prospective audit data on patient flow, triage outcomes, and overcrowding patterns from Indian emergency departments are essential for evidence-based workforce planning, infrastructure optimisation, and quality improvement initiatives, yet such data remain remarkably scarce in the published literature [10]. The present study was undertaken as a prospective audit to evaluate triage outcomes, patient flow metrics, and temporal patterns of overcrowding in a tertiary emergency department.

AIMS AND OBJECTIVES

The present audit was undertaken with the objectives of characterising the distribution of patients across Emergency Severity Index triage levels, measuring key patient flow metrics including door-to-triage time, door-to-doctor time, and emergency department length of stay, determining disposition patterns and left-without-being-seen rates, identifying temporal patterns of patient volume and overcrowding, and ascertaining the independent predictors of prolonged emergency department length of stay exceeding six hours through multivariate analysis.

MATERIALS AND METHODS

Study Design, Setting, and Ethical Approval

This was a prospective observational clinical audit conducted over a 12-month period from Feb 2023 to Jan 2024 at the Emergency Department of a 1,200-bed government tertiary care teaching hospital in northern India. The emergency department operated continuously on a 24-hour, 7-day basis and served as a major referral centre for the surrounding districts with a catchment population of approximately 4 million. The department had a physical capacity of 42 treatment spaces including 6 resuscitation bays, 12 acute care beds, 14 monitored observation beds, and 10 ambulatory treatment chairs. The study was approved by the Institutional Ethics Committee as a quality improvement audit with waiver of individual informed consent.

Sample and Data Collection

All consecutive adult patients (aged 18 years and above) presenting to the emergency department during the study period were included. Paediatric presentations (below 18 years), patients declared dead on arrival prior to triage, and those presenting for pre-scheduled procedures or direct ward transfers were excluded. A total of 2,400 adult presentations were audited. Data were collected prospectively using a standardised electronic data collection form. Trained data abstractors recorded time stamps for the following milestones: arrival at the emergency department (recorded by the registration clerk), completion of triage (recorded by the triage nurse), first physician contact (recorded by the treating physician), disposition decision (admission, discharge, or other), and physical departure from the emergency department. All times were synchronised using a single wall-mounted digital clock.

Triage Protocol

All patients were triaged by trained emergency nurses using the five-level Emergency Severity Index version 4 algorithm. ESI Level 1 designated patients requiring immediate life-saving intervention; Level 2 designated high-risk situations, altered mental status, or severe pain requiring emergent evaluation; Level 3 designated patients predicted to require two or more resources; Level 4 designated patients predicted to require one resource; and Level 5 designated patients requiring no resources. Inter-rater reliability was maintained through monthly triage concordance

exercises, with a target kappa of 0.80 or above.

Definitions and Outcome Measures

Door-to-triage time was defined as the interval from registration to completion of triage assessment. Door-to-doctor time was defined as the interval from registration to first physician contact. Emergency department length of stay was defined as the interval from registration to physical departure. Prolonged length of stay was defined as exceeding six hours, based on published quality benchmarks. Left without being seen (LWBS) was defined as departure after triage but before physician evaluation. Left against medical advice (LAMA) was defined as departure against physician recommendation after evaluation had commenced. Emergency department occupancy rate was calculated as the number of patients present divided by the number of available treatment spaces, measured at four-hour intervals.

Statistical Analysis

Data were analysed using SPSS version 28.0 (IBM Corp., Armonk, NY). Time intervals were reported as medians with interquartile ranges given their non-normal distribution (confirmed by the Shapiro-Wilk test). Categorical variables were compared using the Pearson chi-square test. The Kruskal-Wallis test was used for comparison of time metrics across ESI levels. Multivariate binary logistic regression identified independent predictors of prolonged emergency department length of stay exceeding six hours, with variables significant at $p < 0.10$ on univariate analysis entered using backward stepwise elimination. Adjusted odds ratios with 95% confidence intervals were reported. A two-tailed p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 2,400 adult emergency department presentations were audited over the 12-month study period, averaging 6.6 presentations per day. The demographic and clinical characteristics are presented in Table 1. The mean age was 42.4 ± 18.2 years, with 1,397 males (58.2%) and 1,003 females (41.8%). The most common presenting category was medical illness (1,109 patients, 46.2%), followed by trauma (595, 24.8%), surgical emergencies (396, 16.5%), and obstetric or gynaecological emergencies (300, 12.5%). Arrival by ambulance was documented in 562 patients (23.4%).

Table 1: Demographic and Clinical Characteristics (n = 2,400)

Parameter	n (%)
Age (years), Mean ± SD	42.4 ± 18.2
Male	1,397 (58.2%)
Female	1,003 (41.8%)
Presenting category: Medical	1,109 (46.2%)
Presenting category: Trauma	595 (24.8%)
Presenting category: Surgical	396 (16.5%)
Presenting category: Obstetric/Gynae	300 (12.5%)
Arrival by ambulance	562 (23.4%)
Referred from another facility	418 (17.4%)
Co-morbid illness present	864 (36.0%)

The ESI triage distribution and acuity-specific patient flow metrics are presented in Table 2. ESI Level 1 (resuscitation) accounted for 101 patients (4.2%), Level 2 (emergent) for 307 (12.8%), Level 3 (urgent) for 924 (38.5%), Level 4 (less urgent) for 672 (28.0%), and Level 5 (non-urgent) for 396 (16.5%). Thus, high-acuity presentations (Levels 1 and 2) constituted 17.0% of total volume, while low-acuity presentations (Levels 4 and 5) constituted 44.5%. The median door-to-triage time for the overall cohort was 6 minutes (IQR 3–12), with no significant variation across ESI levels (Kruskal-Wallis $p = 0.368$). The median door-to-doctor time was 24 minutes (IQR 12–48) overall, with a clear and statistically significant inverse relationship with acuity: ESI Level 1 patients were seen at a median of 4 minutes (IQR 2–6), ESI Level 2 at 12 minutes (IQR 8–18), ESI Level 3 at 28 minutes (IQR 16–44), ESI Level 4 at 42 minutes (IQR 28–62), and ESI Level 5 at 56 minutes (IQR 38–82, Kruskal-Wallis $p < 0.001$). The median emergency department length of stay was 4.2 hours (IQR 2.1–8.6), ranging from 2.8 hours for ESI Level 5 to 8.4 hours for ESI Level 2.

Table 2: ESI Triage Distribution and Patient Flow Metrics

ESI Level	n (%)	Door-to-Triage (min)	Door-to-Doctor (min)	ED LOS (hours)
Level 1 (Resuscitation)	101 (4.2%)	4 (2–8)	4 (2–6)	6.2 (2.8–12.4)
Level 2 (Emergent)	307 (12.8%)	5 (2–10)	12 (8–18)	8.4 (4.2–14.6)
Level 3 (Urgent)	924 (38.5%)	6 (3–12)	28 (16–44)	4.8 (2.6–8.2)
Level 4 (Less urgent)	672 (28.0%)	7 (3–14)	42 (28–62)	3.2 (1.8–5.4)
Level 5 (Non-urgent)	396 (16.5%)	8 (4–16)	56 (38–82)	2.8 (1.4–4.6)
Overall	2,400 (100%)	6 (3–12)	24 (12–48)	4.2 (2.1–8.6)
		$p = 0.368$*	$p < 0.001$*	$p < 0.001$*

The disposition patterns are presented in Table 3 and illustrated in Figure 1. Overall, 917 patients (38.2%) were admitted, 1,218 (50.8%) were discharged, 163 (6.8%) left without being seen or against medical advice, 62 (2.6%) were transferred to other facilities, and 40 (1.7%) expired in the emergency department. Admission rates varied markedly by ESI level: 68.3% for Level 1, 58.6% for Level 2, 42.8% for Level 3,

22.6% for Level 4, and 8.8% for Level 5 (chi-square for linear trend $p < 0.001$). Emergency department mortality was concentrated in the highest-acuity groups: 28.7% for ESI Level 1, 4.6% for Level 2, 0.9% for Level 3, 0.1% for Level 4, and 0% for Level 5. The LWBS rate was 6.8% overall but varied significantly by ESI level, being highest among Levels 4 and 5 (combined LWBS 10.4%) compared to Levels 1 through 3 (combined LWBS 2.1%, $p < 0.001$).

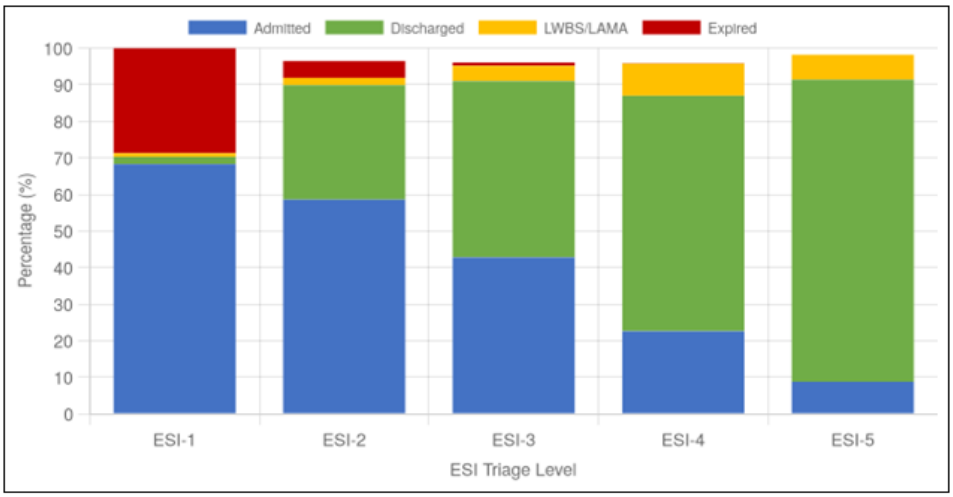

Figure 1: Disposition by ESI Triage Level (%)

Table 3: Disposition by ESI Level

Disposition	ESI-1 (%)	ESI-2 (%)	ESI-3 (%)	ESI-4 (%)	ESI-5 (%)
Admitted	69 (68.3%)	180 (58.6%)	395 (42.8%)	152 (22.6%)	35 (8.8%)
Discharged	2 (2.0%)	96 (31.3%)	445 (48.2%)	433 (64.4%)	327 (82.6%)
LWBS/LAMA	1 (1.0%)	6 (2.0%)	39 (4.2%)	59 (8.8%)	27 (6.8%)
Transferred	0 (0%)	11 (3.6%)	28 (3.0%)	22 (3.3%)	7 (1.8%)
Expired in ED	29 (28.7%)	14 (4.6%)	8 (0.9%)	1 (0.1%)	0 (0%)

The temporal distribution of patient volume and its impact on emergency department length of stay are illustrated in Figure 2 and detailed in Table 4. The peak period was 6 PM to midnight, accounting for 854 presentations (35.6% of daily volume). During this peak, median emergency department length of stay was significantly prolonged at 5.6 hours compared to 3.4 hours during the 6 AM to noon period ($p < 0.001$). The emergency department occupancy rate exceeded 120% of treatment capacity during peak hours on 78.4% of audited days. The median decision-to-admission time (interval from disposition decision to physical departure from the emergency department to the inpatient ward) was 2.8 hours (IQR 1.4–5.2), reflecting the significant boarding burden.

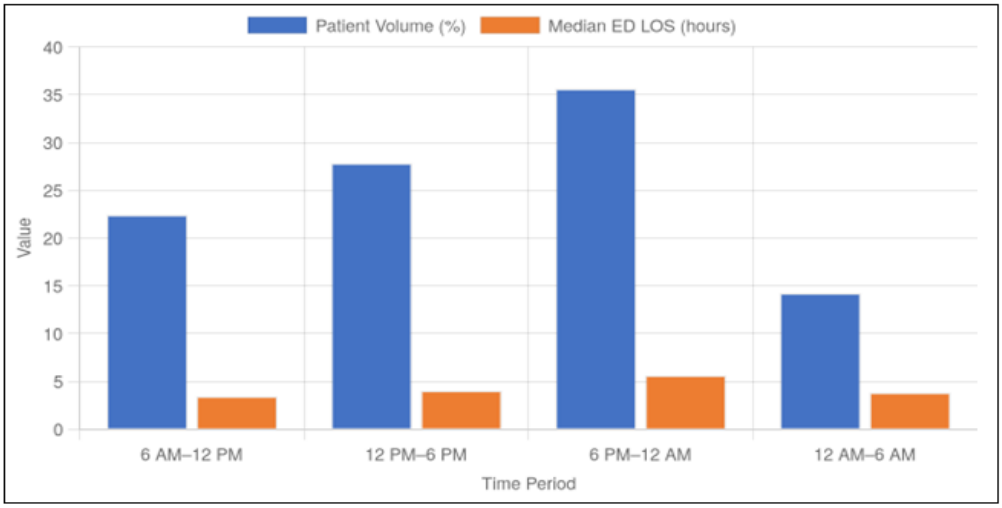

Figure 2: Patient Volume and ED Length of Stay by Time of Day (n = 2,400)

Table 4: Temporal Distribution and Overcrowding Metrics

Time Period	n (%)	Median LOS (hours)	Occupancy > 120% (% days)	LWBS (%)
6 AM – 12 PM	538 (22.4%)	3.4	12.6%	4.2%
12 PM – 6 PM	668 (27.8%)	4.0	34.8%	5.8%
6 PM – 12 AM	854 (35.6%)	5.6	78.4%	9.2%
12 AM – 6 AM	340 (14.2%)	3.8	18.2%	6.4%
p-value (Kruskal-Wallis)	—	< 0.001	—	0.002

The results of the multivariate logistic regression analysis identifying independent predictors of prolonged emergency department length of stay exceeding six hours are presented in Table 5. Overall, 768 patients (32.0%) experienced a length of stay exceeding six hours. After adjustment for confounders, the independent predictors were ESI Level 2–3 acuity (adjusted OR 3.24, 95% CI 2.12–4.96, p < 0.001), need for advanced imaging including computed tomography or magnetic resonance imaging (aOR 2.68, 95% CI 1.86–3.86, p < 0.001), awaiting specialist consultation (aOR 2.42, 95% CI 1.64–3.56, p < 0.001), admitted disposition (aOR 2.12, 95% CI 1.48–3.04, p < 0.001), evening presentation between 6 PM and midnight (aOR 1.86, 95% CI 1.32–2.62, p = 0.004), and arrival by ambulance or referral (aOR 1.64, 95% CI 1.14–2.36, p = 0.008). Age, sex, and specific presenting complaint category did not retain significance in the adjusted model.

Table 5: Predictors of Prolonged ED LOS (> 6 hours) — Multivariate Logistic Regression

Variable	Adjusted OR	95% CI	p-value
ESI Level 2–3 (vs 4–5)	3.24	2.12 – 4.96	< 0.001
Advanced imaging required	2.68	1.86 – 3.86	< 0.001
Awaiting specialist consultation	2.42	1.64 – 3.56	< 0.001
Admitted disposition	2.12	1.48 – 3.04	< 0.001
Evening presentation (6 PM–12 AM)	1.86	1.32 – 2.62	0.004
Arrival by ambulance/referral	1.64	1.14 – 2.36	0.008
Age > 60 years	1.34	0.94 – 1.92	0.108
Male sex	1.12	0.82 – 1.54	0.468
Medical vs surgical presentation	1.08	0.78 – 1.50	0.642

Table 6: Summary of Key Performance Indicators Against International Benchmarks

Indicator	This Study	International Benchmark	Status
Door-to-triage time	6 min (median)	< 10 minutes	Met
Door-to-doctor: ESI-1	4 min	Immediate (< 5 min)	Met
Door-to-doctor: ESI-2	12 min	< 10 minutes	Not met
Door-to-doctor: ESI-3	28 min	< 30 minutes	Met
ED LOS (median)	4.2 hours	< 4 hours	Not met
LWBS rate	6.8%	< 5%	Not met
ED mortality (ESI-1)	28.7%	< 25%	Not met
Admission rate	38.2%	20–30%	High

DISCUSSION

The present prospective audit of 2,400 adult emergency department presentations provides a comprehensive characterisation of patient flow and triage outcomes in an Indian tertiary emergency department, revealing significant overcrowding during evening hours with measurable impact on key quality indicators. These findings have important implications for operational planning, staffing models, and quality improvement in emergency departments across similar settings.

The ESI distribution observed in this study, with 17.0% high-acuity (Levels 1–2) and 44.5% low-acuity (Levels 4–5) presentations, is broadly consistent with the international pattern reported by the multinational EDDV study encompassing 36 emergency departments across 14 countries [11]. However, the admission rate of 38.2% is substantially higher than the 20 to 25% reported from North American and European emergency departments, reflecting the higher acuity of presentations at Indian tertiary centres and the role of the emergency department as the primary entry point for seriously ill patients in the absence of robust primary care gatekeeping [12].

The median door-to-doctor time of 24 minutes, while acceptable for ESI Levels 3 through 5, exceeded the recommended benchmark for ESI Level 2 patients (12 minutes versus the recommended 10 minutes). This finding is consistent with the analysis by Morley *et al*., [13], who demonstrated that even modest increases in door-to-doctor time above benchmarks were associated

with increased adverse events in medium-acuity patients. The ESI Level 1 door-to-doctor time of 4 minutes, however, was within the recommended immediate assessment standard, indicating effective prioritisation of the most critically ill patients.

The LWBS rate of 6.8% exceeds the internationally recommended threshold of 5% and is comparable to the 5 to 8% range reported by Pines *et al*., [14] in their international comparison of overcrowded emergency departments. Importantly, the LWBS rate was markedly higher during evening peak hours (9.2%) compared to morning hours (4.2%), directly correlating with the occupancy rate exceeding 120% during the 6 PM to midnight period. Patients who leave without being seen represent a patient safety concern, as a proportion may have undiagnosed serious conditions requiring urgent treatment [15].

Specialist consultation delay emerged as a significant predictor of prolonged length of stay (aOR 2.42), consistent with the findings of Ackroyd-Stolarz *et al*., [16] and White *et al*., [17]. In the Indian tertiary hospital model, many emergency department patients require specialist input for definitive management decisions, and delays in specialist response during evening and night hours, when on-call coverage replaces in-department presence, contribute substantially to throughput bottlenecks.

The decision-to-admission time of 2.8 hours reflects the boarding burden imposed by limited inpatient bed availability. Boarding has been identified as the single most important modifiable contributor to emergency department overcrowding in multiple large-scale studies. McCusker *et al*., [18] demonstrated that each additional hour of boarding was associated with a 2.5% increase in 30-day adverse outcomes among admitted patients, underscoring the urgency of addressing this issue through hospital-wide flow improvement strategies [19].

The emergency department mortality rate of 28.7% for ESI Level 1 patients is higher than the 18 to 22% benchmark reported from high-income country emergency departments, likely reflecting the more advanced illness severity at presentation, delayed pre-hospital care, and limited availability of critical care resources in the study setting. This finding highlights the need for investment in pre-hospital emergency medical services and critical care infrastructure in Indian hospitals.

The study had several strengths including its prospective design, consecutive patient enrolment, use of a validated triage system, and comprehensive time-stamped data collection. Limitations include the single-centre design, which limits generalisability, the restriction to adult patients, and the absence of patient outcome data beyond the emergency department encounter. The audit did not capture the perspectives of patients or staff regarding the overcrowding experience [20].

CONCLUSION

This prospective audit documented significant emergency department overcrowding during the evening peak period (6 PM to midnight), with 35.6% of daily volume concentrated in this six-hour window and corresponding increases in length of stay and left-without-being-seen rates above international benchmarks. Specialist consultation delays, advanced imaging requirements, and inpatient boarding were the primary modifiable drivers of prolonged emergency department length of stay. The following recommendations are proposed based on the audit findings: augmentation of physician and nursing staffing during the 6 PM to midnight peak period; establishment of a dedicated fast-track pathway for ESI Level 4 and 5 patients to reduce their occupancy time; implementation of a specialist response time target of 30 minutes with real-time escalation protocols; introduction of point-of-care testing for common laboratory investigations to reduce diagnostic turnaround time; hospital-wide bed management reform to reduce boarding through early discharge planning and bed-ahead strategies; and regular prospective audit cycles to monitor the impact of interventions on key performance indicators.

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