Analysis of Factors Influencing Emergency Department Length of Stay Using Failure Mode and Effects Analysis in a Tertiary Care Hospital in Delhi.

Abstract

Background: Length of stay (LOS) in the Emergency Department (ED) is a critical indicator of efficiency, resource utilization and quality of emergency care. Prolonged LOS contributes to crowding, delays in treatment, and potential compromise of patient safety.

Objectives: To identify factors associated with prolonged LOS in the ED of a tertiary care hospital in Delhi and to apply Failure Mode and Effects Analysis (FMEA) to prioritize high-risk process failures.

Methods: A descriptive observational study was carried out in the ED of a tertiary care hospital in Delhi from November 2021 to February 2022. LOS was defined as the time interval between ED registration and final disposition. Process mapping, review of ED records, and structured data extraction were used to capture patient flow and reasons for delay. A multidisciplinary team conducted FMEA across key ED sub-processes; severity, occurrence and detectability scores were assigned, and Risk Priority Numbers (RPNs) were calculated.

Results: A substantial proportion of patients experienced LOS of 720 minutes or more (≥12 hours). Departments such as internal medicine, pulmonology and emergency services showed a higher number of patients with prolonged LOS than other specialties. Patients converted from ED to inpatient status, especially those requiring multiple consultations and investigations, were more likely to remain beyond 12 hours. Major contributors to delay included waiting for specialist consultation, delay in diagnostic tests and reports, bed unavailability, and administrative processes. FMEA highlighted high-RPN failure modes in registration, triage, investigation turnaround time and bed allocation workflows.

Conclusion: Multiple inter-related process issues were found to contribute to ED LOS of ≥12 hours in the study hospital. FMEA provided a structured framework to identify and rank critical failure modes, supporting targeted corrective actions. Implementing the recommended changes has the potential to reduce LOS, improve patient flow and enhance the quality and safety of emergency care in tertiary settings.

Keywords: Emergency Department, Length of Stay, FMEA, Patient Flow, Hospital Management, Tertiary Care Hospital, Delhi.

Introduction

Emergency Departments are pivotal entry points to hospital care and often operate under conditions of high demand and constrained resources. Length of stay in the ED is widely used as a performance indicator because it reflects the combined efficiency of triage, clinical assessment, diagnostics, decision-making and disposition processes. Excessive LOS contributes to crowding, boarding of admitted patients, delays in definitive treatment and increased risk of adverse events.

In Indian tertiary care hospitals, prolonged ED LOS has been linked to systemic factors such as high patient volume, limited inpatient beds, delays in diagnostic services and fragmented coordination between clinical and support departments. Risk-management tools, particularly Failure Mode and Effects Analysis, enable proactive identification of process vulnerabilities before adverse events occur. FMEA systematically examines each step in a process, identifies potential failure modes, and quantifies their relative risk through the RPN score.

Recognizing the need to improve ED throughput and reduce avoidable delays, this study was designed with two key objectives: (1) to analyze factors associated with prolonged LOS in the Emergency Department of a tertiary care hospital in Delhi; and (2) to employ FMEA to identify, prioritize and propose corrective measures for high-risk failure modes in ED processes.

Materials and Methods

Study design and setting

A descriptive, observational study was undertaken in the Emergency Department of a tertiary care hospital in Delhi as part of doctoral research in Hospital Management at Sunrise University, Alwar.

Study period and population

The study covered the period from November 2021 to February 2022. All eligible patients attending the ED during this period and for whom complete LOS-related data were available were included. Exclusion criteria (such as patients dead on arrival or cases with incomplete records) should be stated exactly as per your thesis.

Definition of length of stay

LOS was defined as the time from ED registration to final disposition, which could be discharge, admission to an inpatient unit or ICU, transfer to another facility, or death in the ED. Prolonged LOS was operationally defined as LOS ≥720 minutes (≥12 hours), consistent with the analysis presented in the thesis.

Data collection

Data were extracted from ED records and hospital information systems using a structured proforma. Variables included demographic details, clinical category, time of arrival, department or specialty concerned, investigations requested, consultation requirements, payment category (including EWS and PSU), final disposition and documented reasons for delay. Graphs in the thesis indicate analysis by department, status (ER only vs ER-to-IP), payment mode and station.

In addition, process mapping was conducted to delineate major ED sub-processes: registration, triage, initial assessment, investigations, consultation, decision-making and admission or discharge. Discussions with ED physicians, nurses, registration staff, laboratory and radiology personnel, and bed management staff were used to understand practical bottlenecks.

FMEA procedure

A multidisciplinary FMEA team was constituted, including representatives from the ED, nursing services, registration, laboratory, radiology and hospital administration. The FMEA steps were as follows:

- Identification of key sub-processes in the ED care pathway.
- Listing of potential failure modes for each sub-process (e.g., delay in registration, mis-triage, delayed sample transport, delayed report validation, delay in bed confirmation).
- Assignment of scores for severity, occurrence and detectability on a predefined scale.
- Calculation of Risk Priority Number for each failure mode as $\mathrm{RPN}=\mathrm{S}\times\mathrm{O}\times\mathrm{D}$ $RPN=S\times O\times D$.
- Prioritization of high-RPN failure modes and formulation of recommended corrective actions.

Data analysis

Quantitative data were analyzed using descriptive statistics. The proportion of patients with LOS ≥720 minutes was calculated overall and by department, status (ER only vs ER-to-IP), payment category and station, as reflected in the graphs in the thesis. The distribution of reasons for delay (consultation, diagnostic tests, bed availability, administrative issues) was also summarized. FMEA results were presented by listing failure modes with the highest RPN values and the corresponding suggested interventions.

Results

The analysis revealed that a notable proportion of ED patients experienced LOS of 12 hours or more. Internal medicine, emergency and pulmonology departments contributed a larger share of long-stay patients compared with other specialties. Patients converted from ED to inpatient status showed higher likelihood of prolonged LOS than patients treated and discharged directly from the ED.

Payment mode-wise analysis indicated that patients in categories such as EWS and PSU were more frequently represented among those with LOS ≥720 minutes. Station-wise comparison suggested that areas such as pulmonology, gastroenterology and emergency bays had greater numbers of long-stay patients than other stations.

When reasons for delay were examined, consultation delays and delays related to diagnostic tests and receipt of reports emerged as the predominant causes, surpassing other factors such as administrative formalities or transportation. A comparative assessment of reasons for delay before and after implementation of process changes showed a reduction in the number of cases with prolonged LOS, indicating the potential impact of targeted interventions.

Through FMEA, several high-RPN failure modes were identified along the ED care pathway, particularly in registration, triage, investigation turnaround time and bed allocation. These failure modes were prioritized for corrective action, including streamlining registration workflows, reinforcing triage protocols, improving sample transport and report communication, and strengthening coordination with inpatient units for timely bed assignment.

Discussion

The study highlights that prolonged LOS in the ED of a tertiary care hospital in Delhi is driven by a combination of clinical, organizational and logistical factors. The predominance of consultation and diagnostic delays is consistent with published literature from similar settings, where inter-departmental coordination and diagnostic turnaround time are recurrent bottlenecks.

The use of FMEA provided a structured, prospective approach to risk assessment that goes beyond retrospective audits. By quantifying risk through the RPN and ranking failure modes, the method helped focus managerial attention on the most critical points in the ED workflow. This approach aligns with contemporary patient-safety and quality-improvement practices in hospital management.

However, the findings are limited by the single-center design and the defined study period of four months (November 2021 to February 2022). Patterns of ED LOS may vary across seasons, hospitals and regions, and further multi-center or longitudinal studies could provide more generalizable insights. In addition, implementation and post-implementation evaluation of proposed interventions were only partially captured and merit dedicated follow-up research.

Conclusion

The research demonstrates that a considerable share of ED patients in the studied tertiary care hospital experienced LOS of 12 hours or more, primarily due to delays in consultation, diagnostics and bed allocation. FMEA was successfully applied to identify and prioritize high-risk process failures

contributing to these delays. Adoption of the recommended process-improvement measures can support reduction in LOS, enhanced patient flow and improved quality and safety of emergency care. Hospital managers and policy-makers should consider integrating FMEA into routine quality-improvement activities in emergency and critical care areas.

References:

1. "AnEmergencyDepartmentIsaDedicatedArea inaHospitalThat IsOrganizedandAdministeredto ProvideaHighStandard ofEmergencyCareto People in theCommunityWho PerceivetheNeed for AcuteorUrgent Care,Including HospitalAdmission. – (AustralasianCollege for EmergencyMedicine 2004).TheJoint Commission(USA) onAccreditationofHealthcareOrganizationsHasEstablished4 Levels of Emergency Service. Levels (1 to 4)Are in Decreasing Capacity and Capability. - Google Search." n.d. Accessed April 1, 2022. https://www.google.com/search?

2. Ahmed, AbdulwahidAwol, ShemsedinAmmeIbro, GemechisMelkamu, ShekaShemsiSeid, and TemamenTesfaye.2020. "LengthofStayintheEmergencyDepartment andItsAssociatedFactorsat Jimma Medical Center, Southwest Ethiopia." *Open Access Emergency Medicine: OAEM* 12 (October): 227–35. https://doi.org/10.2147/OAEM.S254239.

3. "Health Care Use - Length of HospitalStay - OECD Data." n.d.TheOECD.AccessedApril5, 2022. http://data.oecd.org/healthcare/length-of-hospital-stay.htm.

4. Mentzoni,Ida,StigToreBogstrand,andKashifWaqarFaiz.2019."EmergencyDepartmentCrowding andLengthofStaybeforeandafteranIncreasedCatchmentArea."*BMCHealthServicesResearch*19 (July): 506. https://doi.org/10.1186/s12913-019-4342-4.

5. "Risk Management in the Emergency Department." n.d. Accessed April 6, 2022. https://insights.omnia-health.com/medical-specialities/risk-management-emergency-department.

6. "What Is FMEA? Failure Mode & Effects Analysis | ASQ." n.d. Accessed April 6, 2022. https://asq.org/quality-resources/fmea.

7. SullivanS.AStrategyto ReduceEmergencyDepartment Wait Times inNewfoundlandandLabrador. Department of Health and Community services; 2012.

8. Scott GWS, Yeates G, Barrett P, Doiron CA, Eagle C, Empey K Canadian institute for health information report, health indicators. Ottawa, Ontario; 2008.

9. RoseL,ScalesDC,AtzemaC,etal. Emergencydepartmentlengthofstayforcriticalcareadmissions a population-based study. Ann ATS. 2016;13:1325–1332.

10. CAEP. Canadian Association of Emergency Physicians (CAEP). Position statement on emergency overcrowding. 2009.

11. HorwitzLI, GreenJ, BradleyEH. USemergencydepartment performanceonwait time and lengthof visit. Ann Emerg Med. 2010;55:133–141. doi: 10.1016/j.annemergmed.2009.07.023

12. PinesJM,HiltonJA,WeberEJ,etal. International perspectivesonemergencydepartment crowding. AcadEmerg Med. 2011;18:1358–1370. doi: 10.1111/j.1553-2712.2011.01235.

13. ForeroR,HillmanKM,McCarthyS,FatovichDM,JosephAP,RichardsonDB. AccessblockandED overcrowding. Emerg Med Australas. 2010;22:119–135.

14. McCarthyS. WhereDoNEATandPatientSafetyMeet.NSWEmergencyCareInstitute;2013.

15. GeelhoedG,KlerkN.Emergencydepartmentovercrowding,mortalityandthe4-hourruleinWestern Australia. Med J Aust. 2012;196(2):122–126. doi: 10.5694/mja11.11159

16. BashkinO, CaspiS, HaligoaR, MizrahiS, StalnikowiczR. Organizationalfactorsaffecting lengthof stayinthe emergencydepartment: initialobservationalstudy. Isr J HealthPolicyRes. 2015;4(1):1–7. doi: 10.1186/s13584-015-0035-6

17. Sullivan CM, StaibA, Flores J, et al. Aiming to be NEAT: safely improving and sustaining accessto emergency care in a tertiary referral hospital. Aust Health Rev. 2014;38(5):564–574. doi: 10.1071/AH14083

18. Maumill L, Zic M, EssonAA, et al. The National EmergencyAccessTarget (NEAT): canqualitygo with timeliness? Med J Aust. 2013;198(3):153–157. doi: 10.5694/mja12.11063

19. Al-QahtaniS,AlsultanA, Haddad S, et al. The association of duration of boarding in the emergency roomand the outcome of patients admitted to the intensive care unit. BMC Emerg Med. 2017;17(1). doi: 10.1186/s12873-017-0143-4.

20. Chalfin DB, Trzeciak S, Likourezos A, Baumann BM, Dellinger P. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. Crit Care Med. 2007;35(6):1477. doi: 10.1097/01.CCM.0000266585.74905.5A.