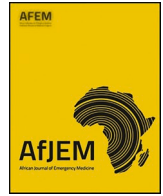




Contents lists available at ScienceDirect

## African Journal of Emergency Medicine

journal homepage: [www.elsevier.com/locate/afjem](http://www.elsevier.com/locate/afjem)

# Factors contributing to extended length of stay in the emergency department and potential strategies for improving patient flow in a central hospital in the Gauteng Province, South Africa

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## ARTICLE INFO

## Keywords:

Length of stay  
Emergency medicine  
Boarding  
Access block  
Crowding

## ABSTRACT

**Background:** Length of stay (LOS) is an integral part of inpatient care in hospitals, particularly in Emergency Departments (EDs). It is an essential performance indicator for the National Indicator Data Set in South Africa. Multiple studies have indicated a correlation between an increased LOS and worse patient outcomes in a variety of acute medical conditions. The study aims to establish the key factors of LOS in the ED at a central hospital in the Gauteng Province of South Africa.

**Methodology:** A cross-sectional study was conducted over seventeen months (Aug 2023 to Dec 2024) based on 2927 entries of patients admitted at the ED for more than 48 hours. No intervention was done as part of this study.

**Results:** The median LOS was 2.81 days (IQR: 2-3) with a minimum of 2 days and a maximum of 12 days. A regression analysis demonstrated that the most significant determinants for prolonged LOS were gender and disease group of boarded patients awaiting ward transfer. Significant differences ( $p < 0.001$ ) in the LOS between clinical disciplines were noted, with medical (45%) and surgical departments (46%) accounting for most boarding patients compared to all other clinical disciplines.

**Conclusions:** Data demonstrated that 80% of patients in the ED wait an average of 3 days before transfer into the wards. This extended ALOS in the ED has consequences for patient outcomes and the quality of healthcare provided. Based on the findings of this study, strategies to improve patient flow are essential in facilitating timeous discharge from wards and to prioritise the forward flow of patients waiting in ED.

## African relevance

- Extended LOS of patients in emergency departments remains an ongoing challenge both in Africa and globally.
- African countries face some of the highest burdens of ED crowding because of extended hospital stays due to boarding of patients, and this study explores the factors contributing to patient boarding and potential improvement strategies.
- This study identifies both systemic and operational challenges faced by hospital EDs in developing countries.

## Introduction

An overburdened public health care system, like in South Africa, requires a robust and active approach when aiming to achieve equitable and accessible health care. In preparation for the NHI implementation, systems in public healthcare facilities require sustainable and feasible solutions to address the numerous challenges faced by healthcare facilities [1]. A major challenge includes the prolonged length of stay (LOS) of patients, resulting in crowded departments such as the emergency department (ED).

Access block refers to the delay caused for patients in gaining access to inpatient beds after being admitted [2]. Patient boarding refers to the

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<https://doi.org/10.1016/j.afjem.2025.100896>

Received 28 October 2024; Received in revised form 30 July 2025; Accepted 10 August 2025

Available online 27 August 2025

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prolonged stay of patients in the ED and is often associated with access block [3]. It is well documented that prolonged LOS in EDs is often associated with poor patient outcomes and reduced patient satisfaction [4]. This is evidenced by increased complications, nosocomial infections, increased patient complaints, and poor satisfaction ratings [5]. The unique operational challenges in the ED, exacerbated by prolonged patient stays, can make it difficult for patients to convalesce and for those requiring urgent care to be attended to timeously [6].

The spectrum of care in a central hospital ED entails acute management and stabilisation, often followed by ongoing care of patients by admission to other specialty units, discharge, or down referral to lower levels of care. The ED triage area is often overburdened with patients who range from central-level acute care patients to those who should be managed at lower levels of care. Studies have found that inappropriately referred patients often result in the delay of patient management and sometimes lead to unnecessary inpatient admissions, contributing to further access block [7]. A study that focuses on the factors contributing to the extended length of stay of patients in the ED and the potential factors contributing to access block may offer a better understanding of various factors that contribute to prolonged stay in the ED of healthcare facilities in the South African public health care context. Prolonged stay in the ED usually results in access block, resulting in diversion of ambulances to other hospitals, which might have a detrimental effect on patient outcomes.

This study aimed to understand the key factors contributing to boarding of patients while incorporating a multi-disciplinary quality improvement project (QIP) for the ED involving different departments in the hospital such as ED, critical care, internal medicine, general surgery, and public health medicine. The study was conducted at a central hospital in Gauteng Province, South Africa, over a seventeen-month period from 01 August 2023 to 31 December 2024. It focused on analysing patient length of stay (LOS) in the emergency department (ED) and examined monthly LOS trends alongside the frequency of ambulance diversions during the same timeframe.

## Methods

**Study setting and design:** A cross-sectional analytical study was conducted using secondary data analysis of routinely collected patient data from the ED of the Steve Biko Academic Hospital, a central hospital situated in the Gauteng Province.

### Study population

The study population was patients with prolonged LOS in the ED of 48 hours or more. This definition of prolonged stay was based on the Ideal hospital framework for Hospitals and the Draft National Guideline for Management of Patient Waiting Times at Health Facilities, which recommends a maximum of 24 hours in the ED [8]. A period of 48 hours was used to clearly differentiate boarded patients from the accepted 24-hour stay patients and thus prevent the inclusion of every patient in the study and minimise any potential selection bias.

The monthly number of ambulance diversions was measured as a proxy indicator of access block. Ambulance diversions are requested when the ED is extremely congested and unable to manage any new patients, usually granted for four hours. Data on the number of granted diversions were collected and reported..

### Sampling

There was no sampling technique used for this study, as all patients who met the 48-hour criteria were included in the study. Data were collected over seventeen months (01 August 2023 to 31 December 2024), and verified daily using an electronic data collection tool. Patients were de-identified and given a study number in the dataset.

## Data acquisition and variables

Data were collected using the conceptual model for ED operations adapted from Asplin et al (2003) from the input to output phase [7] (Fig. 1). Routinely collected data during daily morning ED ward rounds were the primary source of data, supplemented by patient files and the facility's patient registration system for data verification.

### Data analysis

Summarised data are presented in the tables below as frequencies, percentages, medians, and means where appropriate. The LOS data for all variables did not follow a normal distribution; therefore, medians and interquartile ranges were reported, and non-parametric tests were applied. Data were analysed using STATA IC Version 18 (Stata Corp., 2023). Stata Statistical Software: Release 18. Stata Corp LLC.) Ethics approval was obtained from the Research Ethics Committee of the Faculty of Health Sciences at the University of Pretoria (No: 416/2023) as well as the Hospital Research Committee.

The various transitional phases of data collection as patients moved through the ED are depicted in Fig. 1. The input phase of ED operations includes patients' demographic profiling (age and gender) upon registration, triaging, and mode of arrival. In the throughput phase, ED doctors and emergency medicine specialists either discharged a patient or referred them for a consultation with other clinical specialists relevant to the working diagnosis. The specialist discipline to which the patient was referred reviewed the patient and made the final decision for admission or discharge. The output phase comprised of the separation of patients from the ED by discharge, admission, transfer, or death.

## Results

This section presents the findings of the study, including descriptive statistics and the results of a regression analysis used to examine the relationship between key variables and LOS in the ED. A total of 2927 patients were eligible for inclusion, with 92 entries being excluded due to missing information or duplication. The data are summarized in tables and figures to highlight significant associations relevant to the research aim of establishing the key factors contributing to LOS in the ED.

### Length of stay

Statistical analysis of the LOS demonstrated that data were not normally distributed (Shapiro-Wilk test statistic of 0.89;  $p < 0.001$ ). The median LOS was observed to be 2.81 days

(IQR: 2-3) with a minimum of 2 days and a maximum of 12 days.

### Input phase

As demonstrated in Table 1, the most commonly presenting age group was between the ages of 41 and 60 years. The age category of 0 and 18 years accounted for the least seen age group in the ED, which primarily represented paediatric patients. The most common mode of entry into the ED was self-referrals or walk-ins, with 84% of patients seen at the ED being self-referred. There was a significant difference in LOS between male and female patients (Mann-Whitney U Test;  $p < 0.001$ ), with females staying an average of 2.6 days and males staying longer, up to 3 days in the ED. There were no significant differences found in the remaining input phase variables.

### Throughout phase

The clinical disciplines were categorised into six groups comprising all medical and surgical specialties, with the majority of patients classified under the surgical disciplines. There were significant differences

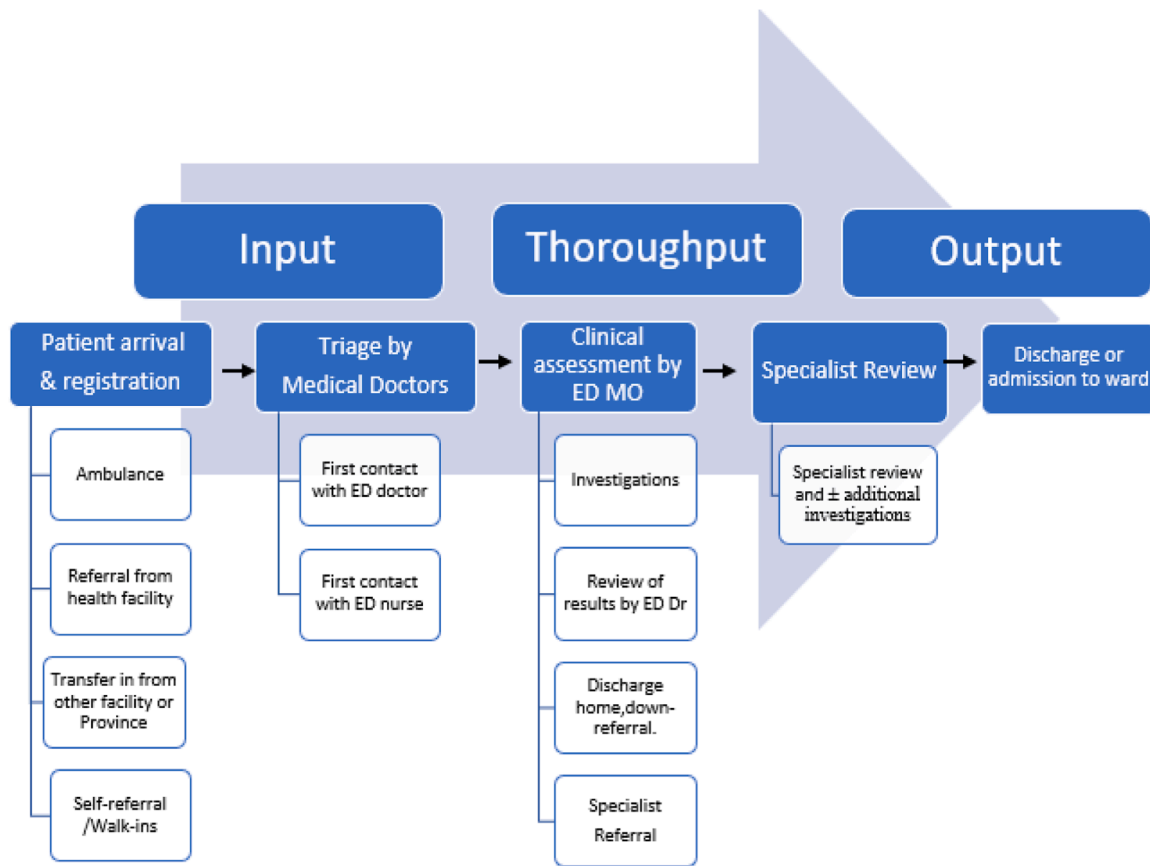


Fig. 1. Conceptual framework for emergency department transition phases.

**Table 1**  
Descriptive statistics of each transitional phase of the ED.

| Domain (Input)   | Variable            | Sub-category                             | Frequency(n) & percentage (%)   | ALOS (days) & 95% CI |
|--|---------------------|--|---|----------------------|
| Demographic characteristics                            | Gender              | Female                                   | 1541 (53)   | 2.7 (2.6- 2.7)       |
|  |                     | Male                                     | 1386(47)  | 2.9 (2.8- 3.0)       |
| Referral pathway                                       | Mode of entry       | 0 - 18                                   | 63 (2)  | 2.4 (2.0 -2.8)       |
|  |                     | 19 - 35                                  | 627 (21)  | 2.8 (2.7-2.9)        |
|  |                     | 36 - 50                                  | 809 (27)  | 2.8 (2.7-2.9)        |
|  |                     | 51-65 -                                  | 765 (26)  | 2.7(2.6-2.7)         |
|  |                     | 66 – 80                                  | 567 (19)  | 2.8(2.7 – 2.9)       |
|  |                     | 81 and above                             | 96 (3)  | 2.9(2.6 - 3.1)       |
|  |                     | Self-Referral/ Walk-ins                  | 2687 (84)   | 2.6 (2.5 – 2.7)      |
| Throughput phase<br>Clinical profiling                 | Clinical discipline | Ambulance                                | 209 (12)  | 2.7 (2.4-3.0)        |
|  |                     | Transfer in from public health facility  | 18 (3)  | 2.5 (2.0-3.1)        |
|  |                     | Private Hospital/private doctor referral | 10 (1)  | 2.8 (2.0 -4.0)       |
|  |                     | Medicine                                 | 1335 (46)   | 2.8 (2.7- 2.9)       |
|  |                     | General surgery                          | 1202 (41)   | 2.9 (2.6-3.0)        |
|  |                     | Neurosurgery                             | 172 (6)   | 3.0 (2.8-3.2)        |
|  |                     | Orthopaedics                             | 46 (3)  | 2.3 (2.1-2.5)        |
|  |                     | Gynaecology                              | 61 (2)  | 2.2 (2.0 -2.4)       |
|  |                     | Psychiatry                               | 2 (0,07)  | 2.5(1.5 -3.5)        |
|  |                     | Reason for boarding                      | No decision made for admission by referred specialist department (s). | 1,529(52.17)         |
| Awaiting bed/ward transfer                             | 1,348(46.02)        |  |   | 2.7(2.7- 2.8)        |
| Under investigation by referred specialist departments | 50(1.23)            |  |   | 2.9(2.4-3.1)         |
| Output phase   | Separation          | Sub-category                             | Frequency(n) & percentage (%)   | ALOS & CI            |
|  |                     | Admitted to ward                         | 2178 (74)   | 2.8 (2.7 – 2.8)      |
|  |                     | Discharged home                          | 608 (21)  | 2.7 (2.6 – 2.8)      |
|  |                     | Signed RHT                               | 46(2)   | 53 (2.6 – 2.5)       |
|  |                     | Demised                                  | 37(1)   | 3.1 (2.7 – 3.6)      |
|  |                     | Transfer                                 | 60(2)   | 2.7 (2.3 – 3.1)      |

between clinical disciplines in terms of LOS (Kruskal-Wallis test,  $p < 0.001$ ), with specific surgical departments (General Surgery and Neurosurgery) accounting for the longest stays. Surgical departments' LOS was 3 days CI; (2.7- 3.3) compared to the lowest LOS in Gynaecology of 2.1 days CI;(2.0 - 2.4).

Patients were initially diagnosed by the ED and confirmed by clinical disciplines. These diagnoses were coded using the standardised ICD-10 coding system. The most observed disease group was the diseases of the digestive system (ICD-10: K00-K95)

(n = 619, 22%). A significant difference in LOS between different disease groups was demonstrated (Kruskal-Wallis test,  $p < 0.001$ ) with certain infectious and parasitic diseases having the longest LOS (3.5 days, CI; 3.1 - 3.9) and pregnancy, childbirth and the puerperium having the lowest LOS (2.2 days; CI; 1.9 - 2.6).

Patients already reviewed by a clinical discipline with no decision for admission accounted for majority of boarded patients (n=1529,52). Reasons for boarding were: (a) patients awaiting review or additional investigations by a specialist with no decision made for admission (n=1529,52%), (b) patients admitted but had access block due to lack of beds in admitting wards (n=1348, 46%); and (c) those in which clinical disciplines had a dispute on which discipline should primarily manage the patients (n=50, 2%)

### Output phase

The output phase comprised of separation (discharge, admission, transfer or death) of patients, with most patients (74%) having been admitted to inpatient wards after a LOS of 2.81 days.

Multilinear regression analysis of LOS and factors in each ED transition phase was performed to estimate which of these factors in the three phases contributed significantly to boarding in the ED (See Table 2). A significance level of 0.05 was used to determine the statistical significance of predictor variables. The overall regression model was statistically significant (F-statistic of 5.50; degrees of freedom: 8, 2918 and  $p < 0.001$ ). However, an  $R^2$  value of 0.0148 indicates that only 1.48% of the variance in LOS could be explained by the model. This is a relatively low  $R^2$ , meaning that the model doesn't explain much of the variability of LOS. The factors that had a significant effect on LOS were gender in the input phase and disease group in the throughput phase. Taking only these two variables into account and comparing the effect of each gender and each disease group, it was demonstrated that males tend to stay longer than females in the ED (0.25 times longer). All disease groups had a significant effect on LOS excluding congenital malformations, deformations, and chromosomal abnormalities, diseases of the eye and adnexa and factors influencing health status and contact with health services (see supplementary table for disease groups).

### Access block and ambulance diversion results

Data on ambulance diversion requests were collected and compared with the number of monthly long-stay patients during the study period (Fig. 2). The study demonstrated a downward trend in both the number of prolonged stay patients and ambulance diversion during the study period; however, a scatter plot of the data (Fig. 3) demonstrated a weak negative relationship between the two variables with a Pearson's

correlation coefficient calculated as  $r = -0.2074$ ;  $p = 0.4244$ . Two outliers in October and November 2023, where 309 and 203 long-stay patients were recorded, but only 3 and 2 ambulance diversions were requested respectively in those months. This may have contributed to the observed relationship, which is not a reliable reflection of all other months, where fewer ambulance diversions were observed with fewer long-stay patients. The classification of patients that result in an ambulance diversion needs to be considered, as most diversion requests are for priority one (P1) patients, while less urgent patients (P2 and P3) remain boarded in the ED and are not reflected in the diversion data. As a result, the correlation is not statistically significant and does not provide strong evidence that LOS and diversions are meaningfully related in this data set.

The run chart in Fig. 4 demonstrates fluctuations around the median of 10 ambulance diversions that were granted. This observation may suggest that changes in ED patient flow were possibly linked to operational or systemic factors. There was a notable decline in ambulance diversions from August to November 2023, likely due to short-term improvements such as improved bed management. From December 2023 to March 2024, diversions remained relatively stable between 5–10 per month. A sharp peak occurred in May 2024 (~22 diversions), possibly due to ED crowding in the winter season or other external factors, followed by a quick drop in July, suggesting a continuous reactive intervention. Toward the end of the year (August–November 2024), diversion numbers increased moderately before returning to the median.

### Discussion

The provision of prompt, quality healthcare requires a continuous equilibrium between the availability of healthcare services (supply) and the utilisation of services by healthcare users (demand) [9,10]. The average number of patients that were treated and occupied the ED at any given time in 24 hours was 60, whereas the ED can only manage forty-five patients in terms of human resources and infrastructure available. This renders the unit crowded, understaffed, and overburdened to meet the demand, as evidenced by the alarming median LOS of 3 days of boarding across all groups that were studied, with slight variations noted.

Emergency medicine services provided by Steve Biko Academic Hospital are classified as highly specialised clinical services [11] and multiple factors need to be taken into consideration for boarding in the ED, such as self-referrals [12]. According to the South African Department of Health's Referral policy and guidelines, patients who have followed the correct referral pathways should be appropriately referred to the correct level of care, even in acute conditions that do not necessarily warrant a tertiary health care institution referral [12,13]. Considering the purpose of referral pathways in assisting tertiary institutions to only manage complicated medical conditions, one of the contributing factors for crowding and potentially prolonged LOS at the SBAH ED was self-referrals, accounting for 84% of patients. These patients usually arrived without referral documentation which potentially prolonged triaging and processing periods. A gap in knowledge and understanding of referral pathways by most healthcare users who present to the SBAH ED was identified and posed a need to be addressed at all levels of the

**Table 2**

Multilinear regression model for LOS .A regression analysis was used to identify key factors in each ED phase that contribute to patient boarding.

| ED phase   | Predictor Variables           | Coefficient | Std. error | t     | P-value | [95% conf. interval] |
|------------|-------------------------------|-------------|------------|-------|---------|----------------------|
| Input      | Gender                        | 0.248       | 0.045      | 5.51  | 0.000   | 0.159 - 0.337        |
|            | Age                           | -0.004      | 0.003      | -1.11 | 0.269   | -0.012 - 0.003       |
|            | Mode of entry                 | 0.023       | 0.021      | 1.10  | 0.273   | -0.018 - 0.065       |
| Throughput | Clinical specialty department | -0.004      | 0.012      | -0.04 | 0.972   | -0.023 - 0.023       |
|            | Disease group                 | -0.012      | 0.004      | -2.87 | 0.004   | -0.019 - 0.004       |
|            | Reason for boarding           | 0.032       | 0.022      | 1.47  | 0.141   | -0.011 - 0.075       |
| Output     | Outcome                       | 0.006       | 0.021      | 0.30  | 0.762   | -0.035 - 0.048       |

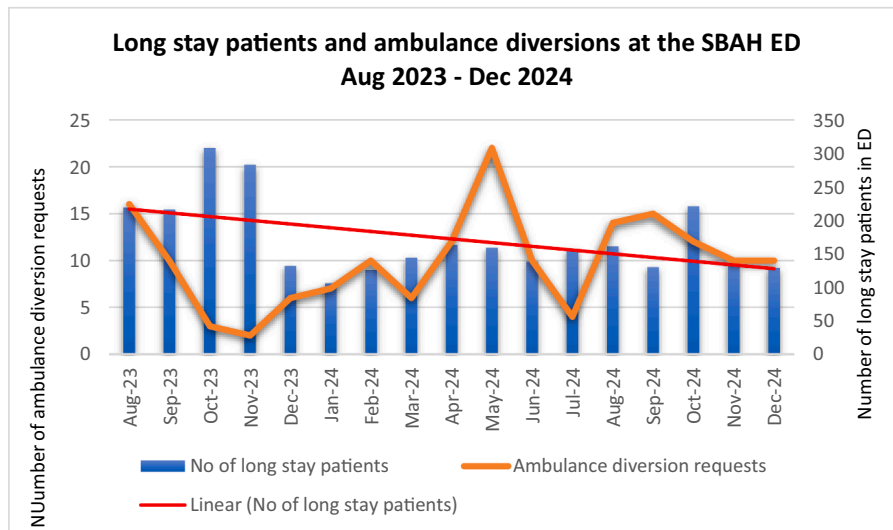


Fig. 2. Number of monthly long-stay patients vs granted ambulance diversions at the SBAH ED Aug 2023-Dec 2024.

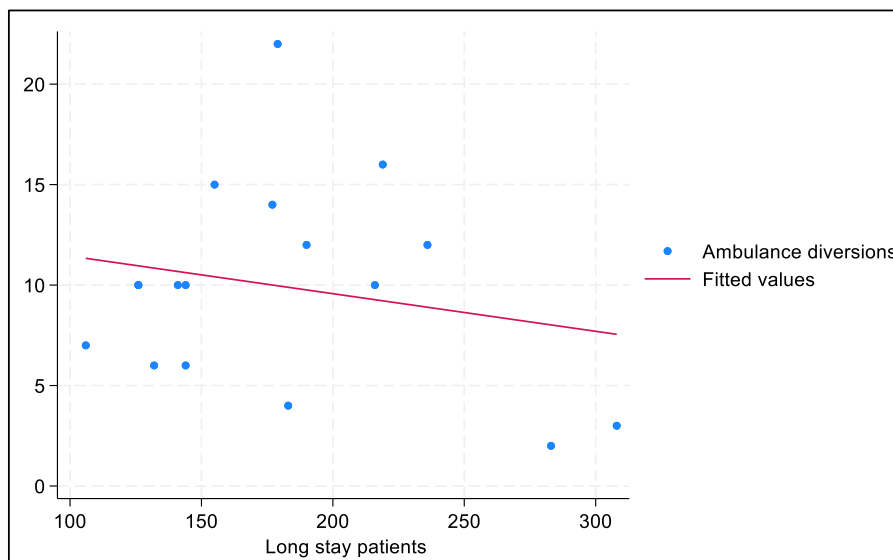


Fig. 3. Scatter plot of relationship between granted ambulance diversions and number of long-stay patients.

referral pathway. With the planned implementation of the NHI, it is critical for factors such as referral pathways to function effectively to relieve such system bottlenecks [14].

During the throughput phase, the unavailability of beds in the wards was one of the significant reasons for patients boarding in the ED for extended periods of time of up to 3 days. This suggested that the available infrastructure in terms of the number of approved and licensed beds in the facility did not match the demand for service, and thus, the ED was inevitably crowded with prolonged patient stays due to access block.

Indecision about admission by referred specialist department(s) was a major contributing factor to increased LOS in the ED (n=1,529). This was possibly due to multi-morbidity and complex clinical presentations of patients admitted to a central hospital. This finding highlighted the need to engage within the leadership structures of various clinical departments and improve knowledge of admission guidelines and standard operating procedures within clinical departments.

As part of a quality improvement strategy, a pool of data capturers was appointed who attended daily morning ward rounds and captured all the long-stay patients, which led to accurate tracking of long-stay

patients and facilitated their admission prioritization. In the absence of a hospital-based electronic patient record system, this system was introduced to track patients' length of stay, which allowed record keeping and timely access to patient information. It probably demonstrated the Hawthorne effect manifested in the reduction of prolonged stay patients and the number of ambulance diversions during the study period.

Prolonged LOS is a well-documented factor that contributes to increased health care costs in any healthcare setting [15]. Extended LOS in the ED and inappropriate referrals to the SBAH ED have the potential to increase cost drivers such as investigative services that could have been done at a lower level of care as well as inappropriate utilisation of specialized services and the cost per PDE [15]. There was minimal to no selection bias as all long-stay patients were included. Information bias was minimized using secondary data collection. Confounders may be present but were not studied.

**Limitations of the study**

The use of hourly time frames was not feasible in this study due to

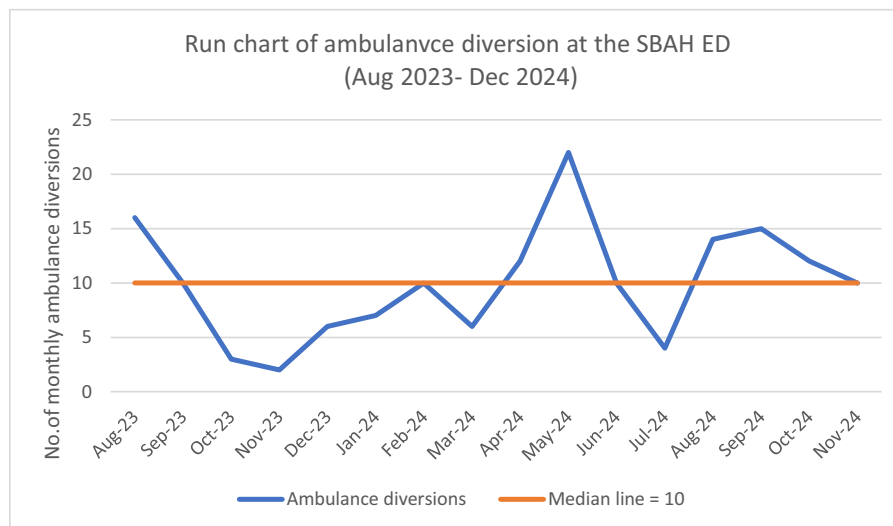


Fig. 4. Run chart depicting granted ambulance diversion trends and shifts.

limited human resources to collect time stamps. However, this could have added value to the data. Ambulance diversions can be further separated into patient classification to differentiate the specific classification of patients who are the driving force for ambulance diversions and identify potential confounders. The study is only applied to SBAH and may not be generalizable to other hospital settings.

## Conclusion

Multiple factors contribute to the LOS of patients in hospital EDs. Operational and systemic factors are key determinants of long-stay in the ED. Clinical disciplines with the greatest burden of disease, such as medical and surgical departments, require additional support and active systems in assisting with admissions into wards. The high percentage of self-referred patients identifies a community education gap in referral pathways. Collaborative efforts of various departments in hospitals can play a key role in alleviating crowding through constant communication of bed availability and prioritization of bed assignment to long-stay patients. The impact of such collaborative efforts has the potential to decrease the number of ambulance diversion requests and reduce access block. In resource-constrained settings with high patient burden, it is imperative to introduce innovative strategies that assist in alleviating crowding in health facilities by strengthening existing systems.

## Dissemination of results

The findings from this paper have not been disseminated beyond publication. Results were used for operational purposes within the hospital for daily bed management and patient flow improvement.

## Authors' contribution

Authors contributed as follows to the conception or design of the work; the acquisition, analysis, or interpretation of data for the work; and drafting the work or revising it critically for important intellectual content: All authors: Conceptualization, LM: Methodology, Software, Data curation, Writing- Original draft preparation. AE and LM: Investigation. DB and AE: Supervision. LM and DB: Writing- Reviewing and Editing". All authors approved the version to be published and agreed to be accountable for all aspects of the work.

## Declaration of competing interest

The authors declare no conflicts of interest.

## Supplementary materials

Supplementary material associated with this article can be found, in the online version, at [doi:10.1016/j.afjem.2025.100896](https://doi.org/10.1016/j.afjem.2025.100896).

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