Optimizing Emergency Department Length of Stay via Patient Flow Policy

Ade Heryana, Eka Suhartika, Putri Handayani, Veza Azteria
Public Health Department, Faculty Health and Sciences, Universitas Esa Unggul, Jakarta, Indonesia
Jl. Arjuna Utara No.9, Duri Kepa, Kebon Jeruk, Jakarta Barat, DKI Jakarta 11510
Korespondensi E-mail: heryana@esaunggul.ac.id

Abstract

Emergency Department Length of Stay (EDLOS) is a key indicator of hospital service quality. Extended EDLOS contributes to overcrowding, increased risk of adverse events, treatment delays, prolonged hospitalization, and higher mortality rates. This study aimed to evaluate arrival and departure policies to control EDLOS in a class B regional government hospital in West Jakarta. A quantitative approach was used to analyze 30,710 emergency visit records and 18,036 triage visit records from January to December 2022. Total sampling was applied, with bivariate binary logistic regression used to analyze arrival policy and a generalized linear model for departure policy. The results showed a median EDLOS of 4 hours and 32 minutes, with 22.7% of cases exceeding the 8-hour service standard. Arrival policies for morning shifts differ from those for day and night shifts, while departure policies remain consistent across all shifts. To prevent EDLOS exceeding 8 hours in the morning shift, priority should be given to children–adolescents, adults, and elderly patients over toddlers, psychiatric over pediatric cases, non-primary healthcare referrals over primary healthcare referrals, yellow triage over green, and female patients over males. Arrival patterns for day and night shifts were similar, except the child–adolescent category was not prioritized. Departure policy was influenced by payment method and discharge status in all shifts. The findings highlight the need for shift-based arrival and discharge policies to optimize EDLOS management in emergency care.

Keyword: length of stay, hospital, emergency visit, emergency department

Abstrak

Lama dirawat di unit gawat darurat (EDLOS) merupakan indikator utama kualitas layanan rumah sakit. Waktu tunggu yang panjang di IGD dapat menyebabkan penumpukan pasien, peningkatan risiko kejadian tidak diinginkan, keterlambatan penanganan, perpanjangan hari rawat inap, serta tingginya angka kematian. Penelitian ini bertujuan untuk mengevaluasi kebijakan kedatangan dan kepulangan pasien guna mengendalikan EDLOS di sebuah rumah sakit pemerintah daerah kelas B di Jakarta Barat. Penelitian ini menggunakan pendekatan kuantitatif dengan menganalisis 30.710 data kunjungan IGD dan 18.036 data triase dari Januari hingga Desember 2022. Pengambilan sampel dilakukan secara total sampling. Analisis regresi logistik biner bivariate digunakan untuk mengevaluasi kebijakan kedatangan, sementara model linier general digunakan untuk kebijakan kepulangan. Hasil menunjukkan bahwa median EDLOS adalah 4 jam 32 menit, dengan 22,7% kasus melebihi standar pelayanan 8 jam. Kebijakan kedatangan pada shift pagi berbeda dengan shift siang dan malam, sedangkan kebijakan kepulangan relatif sama di semua shift. Untuk mencegah EDLOS > 8 jam pada shift pagi, prioritas diberikan kepada pasien anak-remaja, dewasa, dan lansia dibanding balita, kasus psikiatri dibanding kasus anak, rujukan non-puskesmas dibanding dari puskesmas, serta triase kuning dibanding hijau. Pasien perempuan juga diprioritaskan dibanding laki-laki. Kebijakan kedatangan pada shift siang dan malam serupa, namun tanpa prioritas pada kelompok anak-remaja. Kebijakan kepulangan dipengaruhi oleh metode pembayaran dan status akhir pasien. Hasil ini menunjukkan pentingnya perbedaan kebijakan kedatangan dan kepulangan berdasarkan shift untuk mengoptimalkan pengelolaan EDLOS di layanan gawat darurat.

Kata Kunci: lama rawat inap, rumah sakit, layanan gawat darurat, unit gawat darurat

Introduction

Emergency Department Length of Stay (EDLOS) is one of services indicator that should fully attention by hospital management. Prolonged EDLOS causes accumulation of emergency patients that potentially resulting in a high risk of adverse events, delayed services, increased length of treatment days, and high mortality rates. Several studies proofed these hypothetical outcomes. Garcia Gigorro et al., (2015) found that patient who developed Intensive Care Unit (ICU) complications and who died in ICU had a prolonged EDLOS. For myocardial infarction (MI) case, patient with high risk of thrombolysis

had higher incidence of 1-year re-MI if EDLOS ≥ 8 hours (2). The delayed ICU transfer of critically ill ED patients with a ≥ 6 hours had increased the LOS and higher ICU and hospital mortality (3).

Even some studies proofed that prolonged EDLOS had better outcomes for the patients with trauma requiring hospitalization and severe sepsis, it should be elaborate for the burden of prolonged boarding in ED (4,5). To decrease the burden caused by bottleneck in ED patient flow, Hrycko et al., (2019) suggest to implement the ED hospitalist-led team including a hospitalist, advanced practitioner, and case manager. His work finding that the hospitalist-led team who actively manage the ED boarding patients can lead to hospital cot saving and decrease EDLOS.

EDLOS undeniable represent one of the most important performance measures. Indicator of prolonged EDLOS including waiting time, emergency environment, and unit inefficiency (7). Several studies had been measured the EDLOS as waiting time proximity in hospital setting. In German, the average EDLOS for 304,606 patients was 3 h 28 min (8). EDLOS study in Kanada found one-fourth emergency patients was 4 h (9), meantime over one-third emergency patients in Ethiopia had longer EDLOS (10), and in South Africa the average EDLOS almost 74 hours (11). COVID-19 pandemic affected the acceleration of EDLOS such as at Nepal tertiary referral hospital was average 1.75 h, and median EDLOS 5.5 h before COVID-19 pandemic in Indonesia (12).

Some countries had determined the national time target of emergency service to minimized EDLOS such as Indonesia Ministry of Health had established the 8 hours cut-off even this policy had unclear impact to increase patient satisfaction. Study in New Zealand found that the 6-hour time target policy of hospital ED patient discharged or admitted either improved or were unchanged outcomes after the introduction (13). In contrast the Four-Hour-Rule (4HR) emergency service policy at Australia increased key measures of ED performance even most of these positive changes did not continue to improve or were not fully sustain after the initial 2-year implementation (14,15).

The management of hospital has implemented the emergency policy to reduce EDLOS under national policy circumstances, i.e. 1) implemented the rapid admission policy (16); 2) pay-for-performance (P4P) initiative for ED activity (17); 3) improved the process of internal medicine consultation at suburban and academic teaching hospital affected the EDLOS (18); 4) instituted discharge before 10AM or noon (19); dan 5) preassigned 1 surgical intensive care unit (SICU) bed for the next trauma patient that decreased ED dwell time (20).

Most of the Emergency Unit services of government hospitals in Indonesia still have patients with EDLOS that do not meet the requirements according to the Minimum Service Standards (SPM) set by the Indonesian Ministry of Health, which is no more than 8 hours, specifically Class B regional government's hospital in West Jakarta. Preliminary study showed that about 19.0 – 25.1% of ED visit had exceed 8 hours Length of Stay.

We suggest the arrival and departure policy to address the reduction of EDLOS and improvement the emergency service outcomes. This study aims to recognize the policy when emergency patient in and out flow from ED controlled by emergency operation hour or shift. We hypothesized that patient's characteristics were the predictors of EDLOS for arrival patients, then the EDLOS of departure patients was influenced simultaneously between patient's characteristics and the payment method and departure status.

Research Method

We worked with conceptual framework that outcome of literature review of EDLOS study (picture 1). EDLOS hypothetic associate with 1) patient's characteristics that attributed the arrival visit i.e. gender, age, type of service (as proxy variable of diagnose), primary health care referral (H_1), and 2) emergency visit characteristics that attributed the departure visit i.e. payment method and departure status (H_2). We suggested that the resources for every shift significantly difference between shift or emergency operation hour, so that the arrival and departure policy analyzed in these three ED conditions.
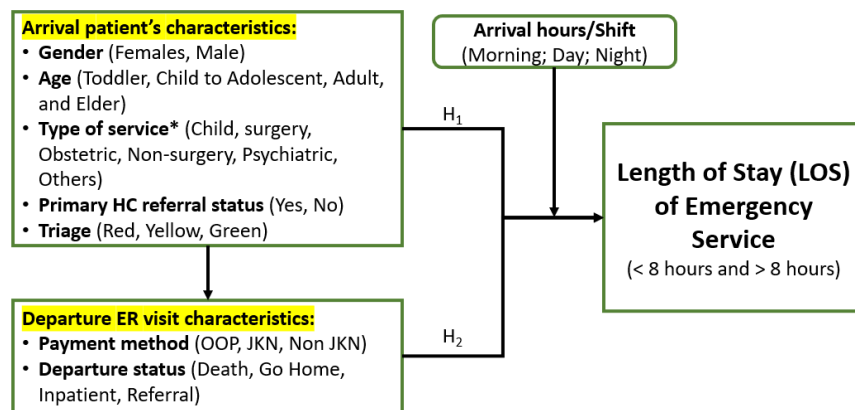
Figure 1.
The EDLOS Arrival and Departure Policy to Reduce Service Time

To decide whether to use a parametric or non-parametric statistical test, we arranged the normality test the EDLOS data and the result is this parameter has positive skewness curve and concluded all emergency service time is not normal distribution (see Table 1 for normality test result and Table 2 for variable definitions). Then we treat EDLOS data as binary outcomes in accordance with national service time target for emergency service (below or equal to 8-hour and more than 8-hour). The predictors variables then we treat as binary or ordinal outcomes, and the definitions of partial variables was depicted in Table 2.

Table 1.
Normality test of EDLOS data

Emergency visit	Shift	Skewness	Significance of normality test
Arrival visit	Morning	1.147	< 0.001
	Day	1.839	< 0.001
	Night	1.428	< 0.001
Departure visit	Morning	1.370	< 0.001
	Day	1.659	< 0.001
	Night	1.402	< 0.001

Table 2.
The definition of EDLOS and predictor variables

Variables	Classification and condition
EDLOS	$\geq$ 8-hour, if the gap between arrival and departure time more than 8 hours
	< 8-hour, if the gap between arrival and departure time below 8 hours
Gender/Sex	Female
	Male
Age	Toddler, for 0 – 5 years old patients
	Children to adolescent, for 6 – 18 years old patients
	Adult, for 19 – 45 years old patients
	Elder, for patients with > 45 years old
Type of services	Child, if classified as pediatric service patients
	Obstetric, if classified as gynecology service patients
	Psychiatry, if classified as psychiatrics service patients
	Surgery, if classified as surgeon service patients
	Non surgery, if classified as patients with other diseases and no need surgeon service
Arrival referral	PHC, if patients arrive or refer from primary health care facilities
	Non PHC, if patients arrive or refer from non-primary health care facilities

Triage	Green, accordance to emergency physician observation
	Yellow, accordance to emergency physician observation
	Red, accordance to emergency physician observation
Payment method	OOP or out of pocket, if self-payment patients
	JKN or Jaminan Kesehatan Nasional, if payment covered by national health security agency (BPJS Kesehatan)
	Non JKN, if payment covered by health insurance or security aside from national health security, i.e. private insurance, company health program, etc.
Departure status	Death, for patients who are declared medically dead
	Go home, for patients who are went home at own request or medical requirement or refused to be referred to another hospital
	Inpatient, for patients who are declared refer to inpatient facilities according to his/her medical condition
	Referral, for patients who are declared refer to other hospital with higher level services

EDLOS data obtained from 2022 emergency visit records of Class B regional government's hospital in West Jakarta. The dataset includes 30,710 records of all emergency visit and 18,036 in-between records of triage emergency visit data from January to December. Census method or total sampling was implemented to collect emergency visit data to investigate the association between ELDOS and patients or emergency visit characteristics.

Binary logistic regression was arranged in bivariate analytical model to address arrival policy. Departure policy designed based on Generalized Linear Model (GLM) that analyze the interaction of both payment method and departure status variables with patient's or emergency visit characteristics. Moreover, we classified both arrival and departure policy into prevention and response measures. The prevention, detection, and response were usually implemented as basic framework to build up the health crisis policy such as in cybersecurity (21), tuberculosis prevention (22), etc. Both prevention and response measures were determined by the result of slope of regression model or exponential beta of logistic regression. If the slope below 1 that mean the predictors as protecting factors to EDLOS > 8 hours so that we address as prevention policy for emergency department who in stable condition or consistently EDLOS < 8 hours. Meanwhile if the slope more than 1, the predictors as risk factors to EDLOS > 8 hours then we address as response policy for ED in unstable conditions or surge with emergency patient led to EDLOS $\geq$ 8 hours.

Result and Discussion

The Characteristics of Emergency Visit

We report the result into three parts of analysis i.e. 1) descriptive analysis to depict the characteristics of emergency visit; 2) result of partial binary logistics to reporting the association between EDLOS and patient's characteristics as the basis for build up the arrival policy; dan 3) result of generalized linear model analysis to reporting the association between EDLOS and interaction of both payment method and departure status with patient's characteristics as basis for build up the departure policy of emergency service.

Table 3 depicts the emergency visit characteristics from 30,710 records and in-between 18,036 records for specific triage for every shift or emergency operational hour. The median EDLOS for all shifts is 4h 31 min (IQR: 2h 24min to 7h 35min), and the longer time at morning shift i.e. 5h (IQR: 2h 36min to 8h 7min). Emergency visits at all shifts more widely had EDLOS < 8 hours, females, adult group, non-surgery service, refer or arrive from PHC, JKN covered, had to inpatient, and declared as green triage status. Moreover, Table 3 showed the detail patient's characteristics for every shift. This result indicated that emergency service time below the 8-hour national target indeed meet the New Zealand standards i.e. 6-hour (13). However, the results of this study do not meet the requirements when compared to the emergency service time standards that set by Australia i.e. 4-hour (14,15).

Table 3.
Characteristics of Emergency Visit

Variables	Morning Shift	Day Shift	Night Shift	All Shift
ED LOS (median)	5h 00min (IQR: 2h 36min to 8h 7min)	4h 27min (IQR: 2h 32min to 6h 58min)	4h 15min (IQR: 2h 12min to 7h 46min)	**4h 31min (IQR: 2h 24min to 7h 35min)**
EDLOS (percent)				
< 8 hours	76.0	74.4	81.0	**77.3**
> 8 hours	24.0	25.6	19.0	**22.7**
Sex (percent)				
Males	44.2	43.8	45.4	**44.5**
Females	55.8	56.2	54.5	**55.5**
Age (percent)				
Toddler	12.8	12.0	12.5	**12.5**
Children-Adolescent	10.7	8.9	11.6	**10.5**
Adult	48.8	44.4	44.2	**45.8**
Elder	27.6	34.7	31.6	**31.3**
Service type (percent)				
Child	15.5	13.5	15.0	**14.7**
Obstetric	12.2	9.8	8.0	**10.0**
Psychiatric	0.2	0.0	0.2	**0.1**
Surgery	7.0	6.4	7.0	**6.8**
Non surgery	65.0	70.2	69.9	**68.3**
Referral status (%)				
Primary health care (PHC)	95.6	96.8	96.9	**96.4**
Non PHC	4.4	3.2	3.1	**3.6**
Triage status (%)				
Green	63.3	60.3	63.8	**62.5**
Yellow	26.8	30.7	27.7	**28.3**
Red	9.9	9.0	8.5	**9.1**
Payment (percent)				
OOP	15.7	12.0	12.2	**13.3**
JKN	77.0	79.2	79.9	**78.7**
Non JKN	7.3	8.8	7.9	**8.0**
Departure status (%)				
Death	1.5	1.2	1.0	**1.2**
Go home (own req. or medical req. or referral refuse)	53.9	45.5	49.8	**48.8**
Inpatient	47.4	53.2	49.0	**49.8**
Referred to	0.2	0.1	0.2	**0.2**

Emergency Visit Arrival Policy

Table 4 showed the result of partial binary logistics to address the hypothetical test that EDLOS has association with patient's characteristics for particular shift. All of patient's characteristics was associated with EDLOS, except for the characteristics of the type of service that has associate in morning shift only especially for psychiatric service patients. Based on the results of this study, the following policies are recommended to prevent and respond the EDLOS in each service shift.

Table 4.
Partial Binary Logistics Result that Highlighted the Association between EDLOS
and Patient's Characteristics for Particular Shift

Patient's Characteristics	Morning Shift		Day Shift		Night Shift	
	P-value	Exp(B)	P-value	Exp(B)	P-value	Exp(B)
Sex (baseline = Males)						
Females	<0.001	1.465 (1.337–1.606)	<0.001	1.364 (1.23–1.501)	<0.001	1.530 (1.397–1.676)
Age (baseline = Toddler)						
Children-Adolescent	0.041	0.861 (0.747–0.994)	NS		NS	
Adult	<0.001	0.604 (0.509–0.717)	<0.001	0.650 (0.551–0.766)	<0.001	0.593 (0.506–0.695)
Elder	<0.001	0.378 (0.340–0.421)	<0.001	0.458 (0.408–0.513)	<0.001	0.334 (0.299–0.373)
Service type* (baseline = Child)						
Surgery	NS		NS		NS	
Obstetric	NS		NS		NS	
Non-surgery	NS		NS		NS	
Psychiatric	0.005	0,038 (0,00–0.369)	NS		NS	
Others	NS		NS		NS	
Referral status (baseline = PHC)						
Non PHC	<0.001	0.13 (0.078–0.227)	<0.001	0.192(0.114–0.322)	<0.001	0.110 (0.067–0.181)
Triage Status (baseline = Green)						
Yellow	<0.001	0.407 (0.335 – 0.49)	<0.001	0.406(0.334–0.493)	<0.001	0.368 (0.306–0.443)
Red	NS		NS		NS	

NS = Not Significance

For morning shift that ED operation at 07.00 AM to 02.00 PM we recommend the arrival policies as follows 1) the prevention measures to avoid the EDLOS > 8-hour that well-prepared emergency service for age group other than toddlers, patients need psychiatric service than other service, arrive or refer from non-primary health care, and patients who declared yellow triage status than others; and 2) the response measures to reduce the EDLOS > 8-hour i.e. prioritize the emergency female patients. For day and night shift basically not difference from morning shift, but the prevention measure not mentioned the children-adolescent age group and psychiatric service as well-prepared emergency service.

The implication of this result is hospital ED should prepare the preventive standard procedure to avoid arrival visit EDLOS especially for treats the non-toddler, psychiatric service, non-PH, and yellow triage patients, and the measure to response EDLOS from female patients. Several scholars had been studied the association between emergency patient's characteristics and EDLOS, and these results in-line with our study.

Toddler is age groups who need pediatric service and should more attention when service was delivered. The presence of parents or person who is guardian this age group is analogically with double edge sword. On the one hand it can facilitate emergency services, but in other hand can slow down the service time. This condition requires the emergency department to well-prepared services for age groups other than toddlers in order to avoid the extra time loading. The EDLOS of toddler patients is median 5h 52min (IQR: 3h 27min to 9h 6min). LOS study of pediatric emergency patient in Saudi Arabia showed that the median EDLOS is 100min (IQR: 53 – 272min) and the significant predictors morning arrival and presentation during summertime (23). Other study showed LOS of pediatric emergency patients had association with nighttime arrival, weekend arrival, ordered by own request, orange triage, and duration of pain (24), cardiac, respiratory, and neurological finding, departure status, and arrival time (25).

Psychiatric emergency patients evidently should more attention by hospital management to reduce the EDLOS. Study from 2011 – 2015 LOS data in Taiwan found the LOS is 17.6 hours and 26.5% visit lasting more than 24 hours and 7,5% more than 48 hours. Factors associated with this LOS are restraints system for patients, history of illicit substances, and initial arrival (26). Study during the COVID-19 pandemic, the influence of substances or alcohol intoxication evidently associated with EDLOS that require average 6.5 hours for every visit (27), and found psychiatric emergency patients spent longer EDLOS particularly i.e. 7.8 hour and caused by overcrowding of ED, the requirement of police officers

accompanying, and reorganize treatment process to promptly intervene by psychiatrics (28). This study recognized the requirement of hospital ED well-prepared the psychiatric emergency patients due to evidently need more treatment and procedure that shall affect the EDLOS. The EDLOS of psychiatric patients is 6h 27min (IQR: 1h 16min to 6h 52min) that longest that other services.

Emergency patients who refer or arrive from primary health care or PHC (or "puskesmas") are mostly covered by national health security or "Jaminan Kesehatan Nasional" program and require more rigid referral administrative procedure. The eligibility procedure to admit emergency PHC patients take more times. The longer EDLOS had experienced particularly for patients from PHC with farthest distance. Previous study found that the distance between the primary health care and hospital significantly influenced the EDLOS especially in patients with chronic obstructive pulmonary disease or COPD (29). This study recognized the arrival policy that should well-prepared the emergency service for PHC arrival patients to prevent longer EDLOS. The EDLOS of PHC arrival patients is 5h 8min (IQR: 2h 45min to 8h 14min).

Emergency triage is appropriate procedure to reduction the mortality rate. Wessman et al., (2022) found that the mortality rate has associate with EDLOS for triage priority levels 2 – 4. The implementation of the five-level emergency triage in India found that triage showed statistically significant association with duration of stay in ED (31). Compared to emergency traditional protocol, triage can decrease EDLOS according the study in South Africa (32). But the implementation of emergency triage in Canada found the decision time to determining the triage was the highest effective indicator of EDLOS (9). Hospital could decrease the service time of triage process with machine learning support as applied in Taiwan (33). This study recognized to well-prepared the emergency service particularly for yellow triage i.e. the secondary priority to immediate treatment caused of patients in stable condition so that ED can postpone the medical treatment for a while. The EDLOS of yellow triage has the median 6h 46min (IQR: 4h 16min to 10h 11min) that longest than others.

EDLOS correlate directly with the patient's age (34), and emergency female patients have longest service time than male (35), moreover for cardiac emergency patient's gender was significantly associate with EDLOS, and female had 23 minutes longer EDLOS than male (36). But for hypertensive emergency patients, gender was not a predictor of EDLOS even the male patients had 39% higher odds of mortality than female (37). This study found that females had longest EDLOS than males, but the sex is the risk factors for EDLOS with risk relative 1.465 (CI95%: 1.337 – 1.606) likely to EDLOS > 8-hour. ED should prioritize the female emergency patients when all patients EDLOS has tend to more than 8-hour.

Payment Method-Based Departure Policy for Emergency Visit
The result of generalized linear model that analyzed the interaction between patient's characteristics and payment methods showed in Table 5, and departure status in Table 6. From this result we can recognize the departure policy in particular emergency operation shift. Departure policy more dynamic than arrival due to the variability of interaction two predictors of EDLOS (payment method and departure status). We recognize the payment method-based departure policy for particular shift as follows (a) for morning shift, we recommend: 1) prevention policy to avoid EDLOS > 8-hour that prioritize the emergency a) out of pocket (OOP) adult and elder, obstetric, and green triage patients; b) the JKN obstetric patients; dan c) the Non JKN adult, and obstetric patients, and 2) response policy to reduce EDLOS i.e. prioritize the emergency a) the OOP red triage patients; b) the JKN female, male, toddler, elder, and non-PHC referral; and c) the Non JKN male, toddler to adolescent, non PCH, dan red triage patients; (b) for day shift, we recommend: 1) prevention policy to avoid EDLOS > 8-hour i.e. prioritize the emergency out of pocket (OOP) adult and green triage patients, and 2) response policy to reduce EDLOS i.e. prioritize the emergency a) the OOP non PHC patients; b) the JKN female, male, toddler to adolescent and elder, and PHC referral patients; and c) the Non JKN male, toddler to adolescent, and non PCH patients; and (c) For night shift we recommend: 1) prevention policy to avoid EDLOS > 8-hour that highlight prioritize the emergency out of pocket (OOP) female, children to adult, and green triage patients, and 2) response policy to reduce EDLOS that highlight prioritize the emergency a) the OOP elder and non-PHC patients; b) the JKN female, male, toddler, non-PHC and yellow and red triage patients; and c) the Non JKN male, non-PHC, and yellow triage patients

Based on Table 5, our study proofed that EDLOS has the significant association with patient's payment methods. Previous studies found that higher EDLOS was significantly associated with 'out of pocket' payment (38,39), national health insurance covered, and uninsured patients (40). Different from the results of previous research, in this study all of types of payment methods (OOP, national health security, and non-national health security) significantly associated with EDLOS when they interact with patient's characteristics i.e. sex, age, service type, arrival or referral status, and triage status. This result led to dynamic payment method-based arrival and departure policy for particular shift. On the other side, based on result in Table 6 we recognize departure status-based for emergency departure policy for prevention measures only. We can't propose the departure policy with recognizing the departure status when emergency service time already > 8-hours. Death, "go home", and inpatient departure status were significantly associated with EDLOS when they interacted with sex, age, referral status, and triage status. Previous studies were not investigated the association in interaction mode, and found that EDLOS significantly associated with concurrent premature departures (41), and the admission to inpatient care, transfer to remote facility particularly for mental health patients (39).

Table 5.
The Result of Association Between EDLOS and Interaction of Payment Method
with Patient's Characteristics

Interaction of Payment Method and Patient's Characteristics	Morning Shift		Day Shift		Night Shift	
	P-value	Exp(B)	P-value	Exp(B)	P-value	Exp(B)
OOP*Female	NS	-	NS	-	<0.001	0.491 (0.343 – 0.702)
JKN*Female	<0.001	1.878 (1.399 – 4.473)	<0.001	2.040 (1.536 – 2.708)	<0.001	1.503 (1.169 – 1.933)
JKN*Male	<0.001	3.203 (2.477 – 4.983)	<0.001	2.802 (2.109 – 3.724)	0.001	2.195 (1.706 – 2.825)
Non JKN*Male	<0.001	2.824 (1.937 – 4.112)	<0.001	2.632 (1.832 – 3.781)	<0.001	2.372 (1.718 – 3.276)
OOP*Children-Adolescent	NS	-	NS	-	<0.001	0.274 (0.191 – 0.395)
OOP*Adult	<0.001	0.390 (0.249 – 0.610)	0.014	0.589 (0.387 – 0.896)	<0.001	0.566 (0.419 – 0.765)
OOP*Elder	0.007	0.460 (0.262 – 0.810)	NS	-	0.001	1.679 (1.246 – 2.261)
JKN*Toddler	0.002	1.846 (1.243 – 2.741)	<0.001	2.688 (1.833 – 3.940)	0.027	1.619 (1.056 – 2.482)
JKN*Children-Adolescent	NS	-	0.019	1.592 (1.079 – 2.350)	NS	-
JKN*Adult	NS	-	NS	-	NS	-
JKN*Elder	<0.001	1.974 (1.361 – 2.862)	<0.001	2.000 (1.383 – 2.891)	0.003	0.545 (0.367 – 0.808)
Non JKN*Toddler	0.025	1.818 (1.077 – 3.070)	0.014	1.889 (1.137 – 3.137)	<0.001	0.245 (0.127 – 0.471)
Non JKN*Children-Adolescent.	0.007	2.790 (1.332 – 5.843)	NS	-	NS	-
Non JKN*Adult	0.001	0.454 (0.283 – 0.726)	NS	-	0.004	0.514 (0.326 – 0.811)
OOP*Obstetric	0.022	0.050 (0.004 – 0.654)	NS	-	NS	-
JKN*Obstetric	<0.001	0.032 (0.005 – 0.187)	NS	-	NS	-
Non JKN*Obstetric	0.013	0.079 (0.011 – 0.585)	NS	-	NS	-
OOP*Non PHC	NS	-	0.027	9.36 (1.291 – 67.826)	0.022	5.18 (1.265 – 21.212)
JKN*Non PHC	0.001	7.48 (2.340 – 23.933)	0.002	22.96 (3.186 – 165.4)	<0.001	15.20 (3.743 – 61.73)
NonJKN*Non PHC	0.005	5.31 (1.637 – 17.194)	0.005	16.86 (2.322 – 122.4)	<0.001	14.51 (3.544 – 59.44)
OOP*Green	0.001	0.304 (0.154 – 0.598)	0.001	0.242 (0.106 – 0.553)	<0.001	0.238 (0.131 – 0.433)
OOP*Red	0.001	3.625 (1.739 – 7.554)	NS	-	NS	-
JKN*Yellow	NS	-	NS	-	0.014	1.942 (1.143 – 3.302)
JKN*Red	NS	-	NS	-	0.012	2.013 (1.166 – 3.475)
Non JKN*Yellow	NS	-	NS	-	0.046	1.923 (1.011 – 3.657)
Non JKN*Red	0.043	1.931 (1.020 – 3.655)	NS	-	NS	-

INOHIM

Based on Table 6 we recognize the departure status-based departure policy for particular shift as follows, and the only one prevention measures due to all result has exponential beta below 0 (protecting factors). For morning shift, we recommend prevention policy to avoid EDLOS > 8-hour. First, prioritize the emergency the death male, female, toddler, adult, elder, and non-OHC patients; then the "go home" male, female, toddler to elder, and non-PHC patients; and c) the inpatient adult and PHC patients. For day shift, we recommend prevention policy to avoid EDLOS > 8-hour i.e. prioritize the emergency a) the death male, female, adult to elder, non-PHC, and all triage patients; b) the "go home" male, female, toddler to elder, non-PHC, and all triage status patients; and c) the inpatient adult, PHC, non-PHC, and all triage status patients. For night shift we recommend prevention policy to avoid EDLOS > 8-hour i.e. prioritize the emergency a) the death male, female, adult to elder, non-PHC, and red triage patients; b) the "go home" male, female, toddler to elder, non-PHC, PHC and all triage status patients; and c) the inpatient toddler, children-adolescent, adult, PHC, and green and red triage status patients.

Table 6.
The Result of Association Between EDLOS and Interaction of Departure Status
with Patient's Characteristics

Interaction of Departure Status and Patient's Characteristics	Morning Shift		Day Shift		Night Shift	
	P-value	Exp(B)	P-value	Exp(B)	P-value	Exp(B)
Death*Male	0.001	0.04 (0.01–0.281)	0.003	0.089 (0.018–0.436)	0.001	0.085 (0.021 – 0.344)
Death*Female	0.003	0.04 (0.01–0.329)	0.003	0.082 (0.015–0.433)	0.001	0.089 (0.021 – 0.383)
Go home (own)*Male	0.002	0.06 (0.01–0.357)	<0.001	0.049 (0.012–0.207)	<0.001	0.059 (0.018 – 0.196)
Go home (own)*Female	0.001	0.06 (0.01–0.324)	<0.001	0.048 (0.011–0.201)	<0.001	0.050 (0.015 – 0.166)
Death*Toddler	0.015	0.05 (0.004–0.555)	NS	-	NS	-
Death*Adult	0.005	0.03 (0.003–0.353)	0.009	0.067 (0.009–0.515)	<0.001	0.032 (0.006 – 0.188)
Death*Elder	0.001	0.06 (0.012–0.338)	0.002	0.062 (0.011–0.358)	<0.001	0.043 (0.010 – 0.184)
Go home*Toddler	0.011	0.15 (0.035–0.642)	0.001	0.063 (0.012–0.331)	<0.001	0.040 (0.011 – 0.151)
Go home*Child-adolescent	0.001	0.08 (0.019–0.363)	<0.001	0.025 (0.005–0.135)	<0.001	0.018 (0.005 – 0.068)
Go home*Adult	<0.001	0.05 (0.013–0.225)	<0.001	0.025 (0.005–0.129)	<0.001	0.015 (0.004 – 0.058)
Go home*Elder	0.001	0.08 (0.020–0.363)	<0.001	0.040 (0.008–0.210)	<0.001	0.030 (0.008 – 0.114)
Inpatient*Toddler	NS	-	NS	-	0.029	0.232 (0.063 – 0.864)
Inpatient*Child-adolescent	NS	-	NS	-	0.008	0.169 (0.045 – 0.629)
Inpatient*Adult	0.035	0.21 (0.051–0.899)	0.030	0.163 (0.031-0.840)	0.001	0.114 (0.031 – 0.421)
Death*Non PHC	<0.001	0.046 (0.012 – 0.172)	<0.001	0.042 (0.012 – 0.145)	0.019	0.053 (0.005 – 0.622)
Go home*Non PHC	<0.001	0.069 (0.023 – 0.206)	<0.001	0.023 (0.008 – 0.071)	0.005	0.033 (0.003 – 0.361)
Go home*PHC	NS	-	NS	-	0.011	0.018 (0.001 – 0.405)
Inpatient* PHC	<0.001	0.025 (0.007 – 0.087)	0.003	0.186 (0.061 – 0.565)	0.002	0.022 (0.002 – 0.249)
Inpatient*Non PHC	NS	-	<0.001	0.011 (0.003 – 0.240)	NS	-
Death*green	NS	-	0.031	0.036 (0.002 – 0.741)	NS	-
Death*yellow	NS	-	0.043	0.082 (0.007 – 0.926)	NS	-
Death*red	NS	-	0.002	0.026 (0.003 – 0.251)	<0.001	0.019 (0.002 – 0.174)
Go home*green	NS	-	<0.001	0.008 (0.001 – 0.067)	<0.001	0.008 (0.001 – 0.064)
Go home*yellow	NS	-	0.001	0.027 (0.003 – 0.219)	<0.001	0.023 (0.003 – 0.192)
Go home*red	NS	-	0.018	0.071 (0.008 – 0.635)	0.002	0.029 (0.003 – 0.259)
Inpatient*green	NS	-	0.041	0.112 (0.014 – 0.912)	0.037	0.108 (0.013 – 0.879)
Inpatient*yellow	NS	-	0.047	0.119 (0.015 – 0.969)	NS	-
Inpatient*red	NS	-	0.015	0.073 (0.009 – 0.599)	0.034	0.104 (0.013 – 0.847)

Conclusions

This study recommended the emergency arrival and departure policies to address the prevention and response measures for control the EDLOS in particular operation hours or shift. Emergency arrival policy significantly determined by patient's characteristics such as age, service types, referral status, and triage status for prevention measures. Meanwhile emergency arrival policy to response the longer EDLOS significantly determined by patient's gender only. Emergency departure policy significantly determined by interaction between patient's characteristics and either payment method or departure status. This result is novelty outcomes that previous study analyzes the association without interaction model. Departure policy based on payment methods significantly determined by interaction between OOP, national health security, and non-national health security coverage with all patient's characteristics both for prevention and response measures. On the other side, the departure policy based on departure status significantly determined by interaction between death, "go home", and inpatient status with patient's characteristics such as sex, age, referral status, and triage status for prevention measures only. The policy and practical implication of study is hospital management should well-prepared the arrival emergency service particularly has the characteristics that significantly increase the EDLOS, and should prioritize the female patients when emergency service time tend to increase over 8-hours. Moreover, hospital management should recognize the interaction both of payment method or departure status with patient's characteristics when build up the departure emergency policies.

References

1. Garcia Gigorro R, Talayero-Giménez de Azcárate M, Sáez-de la Fuente I, Chacón-Alves S, Molina-Collado Z, Lázaro-Martín N, et al. Impact of emergency department length of stay before icu admission on patient outcome. Vol. 3, Intensive Care Medicine Experimental . SpringerOpen; 2015.
2. Chen HC, Lee WC, Chen YL, Fang HY, Chen CJ, Yang CH, et al. The impacts of prolonged emergency department length of stay on clinical outcomes of patients with ST-segment elevation myocardial infarction after reperfusion. Intern Emerg Med. 2016 Feb 1;11(1):107–14.
3. Chalfin DB, Trzeciak S, Likourezos A, Baumann BM, Dellinger RP. Impact of delayed transfer of critically ill patients from the emergency department to the intensive care unit. Crit Care Med. 2007;35(6):1477–83.
4. Ramzee AF, El-Menyar A, Asim M, Kanbar A, Ahmed K, Daoud B, et al. The impact of emergency department length of stay on the outcomes of trauma patients requiring hospitalization: a retrospective observational study. World J Emerg Med. 2023 Mar 1;14(2):96–105.
5. Haji K, Haji D, Tiruvoipati R, Bailey M, Le Blanc V, Botha JA. Impact of length of stay in emergency department on the outcome in patients with severe sepsis. Crit Care Shock. 2010 Nov;13(4):132–7.
6. Hrycko A, Tiwari V, Vemula M, Donovan A, Scibelli C, Joshi K, et al. A Hospitalist-Led Team to Manage Patient Boarding in the Emergency Department: Impact on Hospital Length of Stay and Cost. South Med J. 2019 Dec 1;112(12):599–603.
7. Andersson J, Nordgren L, Cheng I, Nilsson U, Kurland L. Long emergency department length of stay: A concept analysis. Int Emerg Nurs. 2020 Nov 1;53.
8. Otto R, Blaschke S, Schirrmeister W, Drynda S, Walcher F, Greiner F. Length of stay as quality indicator in emergency departments: analysis of determinants in the German Emergency Department Data Registry (AKTIN registry). Intern Emerg Med. 2022 Jun 1;17(4):1199–209.
9. Nhdi N Al, Asmari H Al, Thobaity A Al. Investigating indicators of waiting time and length of stay in emergency departments. Open Access Emergency Medicine. 2021;13:311–8.
10. Ahmed AA, Ibro SA, Melkamu G, Seid SS, Tesfaye T. Length of stay in the emergency department and its associated factors at jimma medical center, southwest ethiopia. Open Access Emergency Medicine. 2020;12:227–35.
11. Mashao K, Heyns T, White Z. Areas of delay related to prolonged length of stay in an emergency department of an academic hospital in South Africa. African Journal of Emergency Medicine. 2021 Jun 1;11(2):237–41.

12. Kusumawati HI, Magarey J, Rasmussen P. Analysis of factors influencing length of stay in the Emergency Department in public hospital, Yogyakarta, Indonesia. Australas Emerg Care. 2019 Sep 1;22(3):174–9.

13. Jones P, Wells S, Harper A, Le Fevre J, Stewart J, Curtis E, et al. Impact of a national time target for ED length of stay on patient outcomes. New Zealand Medical Journal. 2017;130(1455).

14. Ngo H, Mountain D, Forero R. The four-hour rule in WA hospital emergency departments: How did it fare? EMA - Emergency Medicine Australasia. 2016;28.

15. Jones P, Schimanski K. The four hour target to reduce emergency department "waiting time": A systematic review of clinical outcomes. Vol. 22, EMA - Emergency Medicine Australasia. 2010.

16. Quinn J V., Mahadevan S V., Eggers G, Ouyang H, Norris R. Effects of implementing a rapid admission policy in the ED. American Journal of Emergency Medicine. 2007;25(5).

17. Grafstein E, Startup C, Innes G, Scheuermeyer FX, Coleman J. The impact of removing pay for performance incentives on ED flow. Canadian Journal of Emergency Medicine. 2015;17(Supplement 2).

18. Shin S, Lee SH, Kim DH, Kim SC, Kim TY, Kang C, et al. The impact of the improvement in internal medicine consultation process on ED length of stay. American Journal of Emergency Medicine. 2018 Apr 1;36(4):620–4.

19. Salehi L, Phalpher P, Jegatheeswaran V, Valani R, Herman J, Mercuri M. P128: Time of transfer of admitted patients from the ED: a potential area for improvement of patient flow in very high-volume emergency departments. CJEM. 2018;20(S1).

20. DiGiacomo JC, Angus LDG, Wallace R, Cardozo-Stolberg S, Gerber N, Munnangi S, et al. The impact of an ICU "bed Ahead" policy on ED length of stay and patient outcomes. Ann Surg. 2020 Feb 1;271(2):303–10.

21. Thapliyal V, Thapliyal P. Machine Learning for Cybersecurity: Threat Detection, Prevention, and Response. Darpan International Research Analysis. 2024;12(1).

22. Panda S, Kearns K, Cheng C, Lindestam Arlehamn CS. From antigens to immune responses: Shaping the future of TB detection and prevention. Vol. 141, International Journal of Infectious Diseases. 2024.

23. Yousef AA, Qahtani MHA, Al-Mutairi AK, Alqurashi FO, Alomar RS, Alshamlan NA, et al. Factors Affecting Length of Stay in Pediatric Emergency Department in a Teaching Hospital in Saudi Arabia. Medical Archives. 2023;77(4).

24. Negasi KB, Tefera Gonete A, Getachew M, Assimamaw NT, Terefe B. Length of stay in the emergency department and its associated factors among pediatric patients attending Wolaita Sodo University Teaching and Referral Hospital, Southern, Ethiopia. BMC Emerg Med. 2022;22(1).

25. Nassar MMAA, Hassan BA, El-Saadany HF. Factors affecting length of stay in pediatric emergency department in Zagazig university hospital. Egyptian Journal of Hospital Medicine. 2020;81(4).

26. Hsu CC, Chan HY. Factors associated with prolonged length of stay in the psychiatric emergency service. PLoS One. 2018;13(8).

27. Marzola E, Duranti E, De-Bacco C, Lupia E, Villari V, Abbate-Daga G. Psychiatric patients at the emergency department: factors associated with length of stay and likelihood of hospitalization. Intern Emerg Med. 2022;17(3).

28. Lee K, Jang K, Kim H, Bae G, Jang CS, Shin JH. Factors Affecting the Length of Stay in the Emergency Department in Psychiatric Emergency Patients in the COVID-19 Pandemic Context. Inquiry (United States). 2023 Jan 1;60.

29. Rana R, Gow J, Moloney C, King A, Keijzers G, Beccaria G, et al. Does distance to hospital affect emergency department presentations and hospital length of stay among chronic obstructive pulmonary disease patients? Intern Med J. 2022;52(3).

30. Wessman T, Ärnlöv J, Carlsson AC, Ekelund U, Wändell P, Melander O, et al. The association between length of stay in the emergency department and short-term mortality. Intern Emerg Med. 2022 Jan 1;17(1):233–40.

31.   Shivanna HK, Ramesh AC, Rangaswamy KMM. Implementation and evaluation of the five-level emergency triage (emergency severity index tool): A hospital-based, prospective, observational study. Journal of Emergency Practice and Trauma. 2022;8(1).

32.   Elbaih AH, Elhadary GK, Elbahrawy MR, Saleh SS. Assessment of the patients' outcomes after implementation of South African triage scale in emergency department, Egypt. Chinese Journal of Traumatology - English Edition. 2022;25(2).

33.   Chang YH, Shih HM, Wu JE, Huang FW, Chen WK, Chen DM, et al. Machine learning–based triage to identify low-severity patients with a short discharge length of stay in emergency department. BMC Emerg Med. 2022;22(1).

34.   Katrandzhiev I, Fucidzhieva R. Relationship between The Duration of The Examination in The Emergency Department and Some Characteristics of The Patients. Journal of IMAB. 2024;30(1).

35.   Onal EG, Knier K, Hunt AW, Knudsen JM, Nestler DM, Campbell RL, et al. Comparison of emergency department throughput and process times between male and female patients: A retrospective cohort investigation by the Reducing Disparities Increasing Equity in Emergency Medicine Study Group. JACEP Open. 2022;3(5).

36.   Langabeer JR, Champagne-Langabeer T, Fowler R, Henry T. Gender-based outcome differences for emergency department presentation ofnon-STEMI acute coronary syndrome. American Journal of Emergency Medicine. 2019;37(2).

37.   Francis-Morel G, Guevara NA, Malik M, Sotello D. Gender Disparities in Hypertensive Emergency Admissions: A National Retrospective Cohort Study. Cureus. 2023;

38.   Jimenez MLD, Manzanera RL, Mira JJ, Navarro IM, Wong JQ. A descriptive study on the factors affecting the length of stay in the emergency department of a tertiary private hospital in the Philippines. Acta Med Philipp. 2018;52(6).

39.   Stephens RJ, White SE, Cudnik M, Patterson ES. Factors associated with longer length of stay for mental health emergency department patients. Journal of Emergency Medicine. 2014;47(4).

40.   Pearlmutter MD, Dwyer KH, Burke LG, Rathlev N, Maranda L, Volturo G. Analysis of Emergency Department Length of Stay for Mental Health Patients at Ten Massachusetts Emergency Departments. In: Annals of Emergency Medicine. 2017.

41.   Cross KP, Cammack VH, Calhoun AW, Gracely EJ, Kim IK, Stevenson MD, et al. Premature departure from the pediatric emergency department: A cohort analysis of process- and patient-related factors. Pediatr Emerg Care. 2010;26(5).