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ORIGINAL RESEARCH

Clinical Predictors of Emergency Department Revisits within 48 Hours of Discharge; a Case Control Study

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Abstract: **Introduction:** Emergency department (ED) revisits increase overcrowding and predicting which patients may need to revisit could increase patient safety. This study aimed to identify clinical variables that could be used to predict the probability of revisiting ED within 48 hours of discharge. **Methods:** A retrospective case-control study was conducted between July 2018 and January 2019 at the Emergency Medicine Department in Ramathibodi Hospital, Bangkok, Thailand. Patients who revisited the ED within 48 hours of discharge (case group) and patients who did not (control group) participated. The predictive factors for ED revisit were identified through multivariate logistic regression analysis. **Results:** The case group consisted of 372 patients, who revisited the ED within 48 hours, and the control group consisted of 1488 patients. The most common reason for revisiting the ED was recurring gastrointestinal illness, in 107 patients (28.76%). According to the multivariate data analysis , five factors influenced the probability of revisiting the ED: age of more than 60 years (p < 0.001, OR = 2.04, 95%CI: 1.51-2.77), initial Emergency Severity Index (ESI) triage level of 2 (p = 0.007, OR = 1.20, 95%CI: 0.93-1.56), ED stay duration of 4 hours or longer (p = 0.013, OR = 1.12, 95%CI: 0.87-1.44), body temperature of ≥37.5°C on discharge (p = 0.034, OR = 1.34, 95%CI: 1.00-1.80), and pulse rate of less than 60 (OR = 1.55, 95%CI: 0.87-2.77) or more than 100 beats/minute (OR = 1.53, 95%CI: 1.10-2.11) (p = 0.011). **Conclusion:** According to the findings, the most important and independent predictive factor of ED revisit within 48 hours of discharge were, age ≥ 60 years, ESI triage level 2, ED length of stay ≥ 4 hours, temperature ≥ 37.5 C, and 60 > pulse rate ≥ 100 beats/minute.

Keywords: Emergency service, hospital; patient discharge; clinical decision rules; triage; Thailand

1. Introduction

Emergency department (ED) overcrowding is a significant problem in tertiary care hospitals. Many factors contribute to this problem, such as an increase in the number of patients who come to the ED and insufficient beds for inpatients. As a result of overcrowding, waiting time for treatment in ED increases, and specific resources are used unnecessarily (1). The average time between discharge and revisit to the ED has not yet been defined. Most authors refer to it as 24 to 72 hours (2-5). Revisit within 72 hours is a widely accepted quality assurance tool. The overall probability of revisiting the ED is approximately 3% in most studies and patients who revisit are considered to have a high risk for complications

and death (5).

Many researchers have analysed the factors involved in revisiting the ED: those related to the patient's illness, ED treatment, and medical service systems (6-8). Factors such as the nature of the disease, medical error, patient satisfaction (9), and inadequate assessment or treatment in the first ED visit (5) may account for revisits. If the interval is short (3–7 days), the cause may be related to improper treatment, treatment errors, or adverse events after treatment (10). A review of these causes is essential for quality assurance of inpatient care. These can be resolved by educating patients about the diagnosis and treatment (11).

Predicting which patients are likely to revisit the ED after discharge would help plan and adequately manage resources. Clinicians must identify essential variables to assess the probability of readmission after the discharge of a patient (12). Health care organizations have access to comprehensive medical histories, convenient for developing and testing tools to assess the probability of revisiting the ED after dis-

charge (13). This study aimed to identify clinical variables that could be used to predict the probability of revisiting the ED within 48 hours of discharge.

2. Methods

2.1. Study design and setting

A retrospective case-control study was conducted from July 2018 to January 2019, at the ED of Ramathibodi Hospital, a university-affiliated super tertiary care hospital in Bangkok, Thailand.

Patients who revisited the ED within 48 hours of discharge (case group) and patients who did not (control group) were compared and the predictive factors of ED revisit were identified through multivariate logistic regression analysis. The Ethics committee approved this study on Human Rights Related to Research Involving Human Subjects by Faculty of Medicine, Ramathibodi Hospital, Mahidol University, Bangkok, Thailand (Ethics code: MURA2018/377).

2.2. Participants

The patients who revisited the ED within 48 hours after discharge were recruited to comprise a case group. The patients who did not revisit within 48 hours after discharge were recruited to include a control group. We collected the control group from the emergency medical record (EMR) program. We excluded patients suffering from trauma, patients younger than 15 years of age, and patients who revisited with a different problem.

2.3. Data gathering

The following data, including baseline characteristics, clinical factors, and possible effective factors of revisit were collected: gender, age, initial triage level based on emergency severity index (ESI), chief complaint, first ED visit length of stay (LOS), vital signs before discharge (body temperature, systolic blood pressure, and pulse rate). Patients revisiting ED were defined as patients who returned to the ED with the same related symptom within 48 hours after ED discharge (14).

2.4. Statistical Analysis

We used Stata version 12 software (StataCorp, College Station, TX, USA) to conduct a two-sample comparison of proportions with the following assumptions: alpha = 0.05 (one-sided), power = 0.8, and N2/N1 = 4. The sample size that we planned to recruit was approximately 372 patients who revisited the ED and 1488 who did not.

The possible predictors of revisiting the ED within 48 hours after discharge were compared between the 2 groups to identify differences (p-value) in clinical characteristics using independent t-test and exact probability test. The predictive

factors were identified using univariate and multivariate logistic regression analysis and were presented with area under the receiver operating characteristic (AUROC) curve and 95% confidence interval (95% CI) and odds ratio (OR). Calibration of the prediction was presented using Hosmer–Lemeshow goodness-of-fit test.

3. Results

3.1. Baseline characteristics of participants

The average number of patients who revisited within 24 and 48 hours in the studied ED was 40 cases per month (0.02% of patients visiting the ED) and 80 cases per month (0.01% of patients visiting the ED), respectively. Of the 1582 patients who revisited the ED during the study period, 1210 were not eligible according to the research criteria (322 were younger than 15 years of age, 218 patients were suffering from trauma, and 670 revisited with a different problem). Therefore, the case group consisted of 372 patients who revisited the ED within 48 hours after being discharged, and the control group consisted of 1488 patients who did not revisit the ED (figure 1). The most common reason for revisiting the ED was recurring gastrointestinal illness, in 107 patients (28.76%). Most of the patients revisiting the ED within 48 hours after discharge were in ESI triage level 2 (16%), level 3 (40%), and level 4 (44%), respectively. Table 1 compares the baseline characteristics of patients between revisited and non-revisited cases. A significant difference was observed between groups regarding age group (p < 0.001), initial ESI triage level (p = 0.007), first ED visit length of stay (p = 0.013), discharge time body temperature (p = 0.034), and pulse rate (p = 0.011).

3.2. Modelling

According to the multivariate regression analysis (table2), five factors influenced the probability of revisiting the ED: age of more than 60 years (p < 0.001, OR = 2.04, 95%CI: 1.51-2.77), initial ESI triage level of 2 (p = 0.007, OR = 1.20, 95%CI: 0.93-1.56), duration of ED stay of 4 hours or longer (p = 0.013, OR = 1.12, 95%CI: 0.87-1.44), body temperature of ≥37.5°C on discharge (p = 0.034, OR = 1.34, 95%CI: 1.00-1.80), and pulse rate of less than 60 (OR = 1.55, 95%CI: 0.87-2.77) or more than 100 beats/minutes (OR = 1.53, 95%CI: 1.10-2.11) (p = 0.011).

The significant variables were scored considering their coefficient measures to divide patients into three groups: those with scores of 0 (low probability of revisiting ED), those with scores of 1 to 7 points (moderate probability of revisiting ED), and those with scores > 7 points (high probability of revisiting ED) (table 2). The positive likelihood ratio of score > 7 for returning to the ED within 48 hours after discharge was 1.48 (Table 3). The AUC of the model in predicting the need for ED revisit was 61% (95%CI: 58-67; figure 2).

Table 1: Comparing the baseline characteristics of patients who revisited and those who did not revisit the emergency department (ED) within 48 hours after discharge

Variables	Revisited (n = 372)		Not-revisited (n = 1488)		P
	N	%	N	%	
Gender					
Male	166	44.62	592	39.78	0.099
Female	206	55.38	896	60.22	
Age (years)					
≤40	85	22.85	499	33.53	
40-60	87	23.29	382	25.67	<0.001
> 60	200	53.76	607	40.79	
Initial triage level					
Level 2	120	32.26	376	25.27	0.007
Level 3, 4, or 5	252	67.74	1,112	74.73	
Underlying diseases					
Infectious	101	27.15	395	26.55	0.844
Neurologic	23	6.18	170	11.42	0.002
Gastroenterological	107	28.76	360	24.19	0.071
Respiratory	43	11.56	137	9.07	0.167
Cardiovascular	39	10.48	144	9.68	0.627
Endocrinologic	4	1.08	16	1.08	1.000
Haematologic	4	1.08	16	1.08	1.000
Nephrological	28	7.53	72	4.84	0.053
Ob-gynaecologic	13	3.49	38	2.55	0.373
Musculoskeletal	10	2.69	142	9.54	<0.001
Transportation to ED					
Ambulance	9	2.42	16	1.08	0.072
Walk in	363	97.58	1,472	98.92	
First ED visit, length of stay (hours)					
<4	218	58.60	976	65.59	0.013
≥4	154	41.40	512	34.41	
Discharge body temperature (degrees Celsius)					
≥37.5	95	25.54	302	20.30	0.034
Systolic blood pressure (mmHg)					
<90	0	0	1	0.07	
90–140	243	65.32	977	65.66	0.922
≥140	129	34.68	510	34.27	
Pulse rate (bpm)					
<60	277	74.46	1,211	81.38	
60–100	17	4.57	45	3.02	0.011
>100	78	20.97	232	15.59	

4. Discussion

The risk factors that cause patients to revisit to the ED within 48 hours after discharge were found to be age of more than 60 years, initial ESI triage level of 2 (No patient triage in level 1 revisit because every patient need to admission from ED), 4 hours or longer duration of ED stay in the first visit, body temperature of ≥37.5°C on discharge, and pulse rate of less than 60 or more than 100 beats/minutes on discharge.

The rate of revisit within 48 hours was 0.01% in our study. The result was better than the other studies that reported the 48-hour revisit rate to be 0.19% (4, 7). The patient discharge process in Ramathibodi Hospital would begin based on the opinion of the senior emergency resident and emer-

gency staff to reduce the revisit rate. Misdiagnosis was the most common cause of ED revisits (14); patient discharge by the experienced emergency staff was the key to lowering the revisit rate.

The study by Sri-on (14), which evaluated the risk factors that lead patients to revisiting the ED within 48 hours after discharge in Thailand, showed that most patients who revisit were older than 60 years and the majority of causative diseases were related to the digestive system; these findings are similar to our results. The first patient screening at triage revealed that patients with an urgent triage level were most likely to revisit within 48 hours (The urgent level was defined as ESI level 3 in this study). These findings are different from our results. In our hospital, patients with ESI level 2 are

Table 2: Multivariate regression analysis of predictors of emergency department (ED) revisit within 48 hours after discharge

Predictors	Odds ratio	95% CI	P value	Coefficient	Score
Age (years)					
<40	Reference	–	–	–	0
40–60	1.39	1.00–1.95	0.052	0.33	3
≥60	2.04	1.51–2.77	<0.001	0.72	7
ESI Initial triage level					
Level 2	1.20	0.93–1.56	0.158	0.19	1.5
Level 3, 4 , or 5	Reference	–	–	–	0
First ED visit length of stay (hour)					
<4	Reference	–	–	–	0
≥4	1.12	0.87–1.44	0.376	0.11	1
*Temperature ≥37.5°C					
No	Reference	–	–	–	0
Yes	1.34	1.00–1.80	0.053	0.29	2.5
*Pulse rate (bpm)					
<60	1.55	0.87–2.77	0.139	0.44	4
60–100	Reference	–	–	–	0
≥100	1.53	1.10–2.11	0.010	0.42	4

*Vital sign at the time of discharge; ESI: emergeing severity index; OR: Adjusted odds ratio; CI: confidence interval; ED: emergency department.
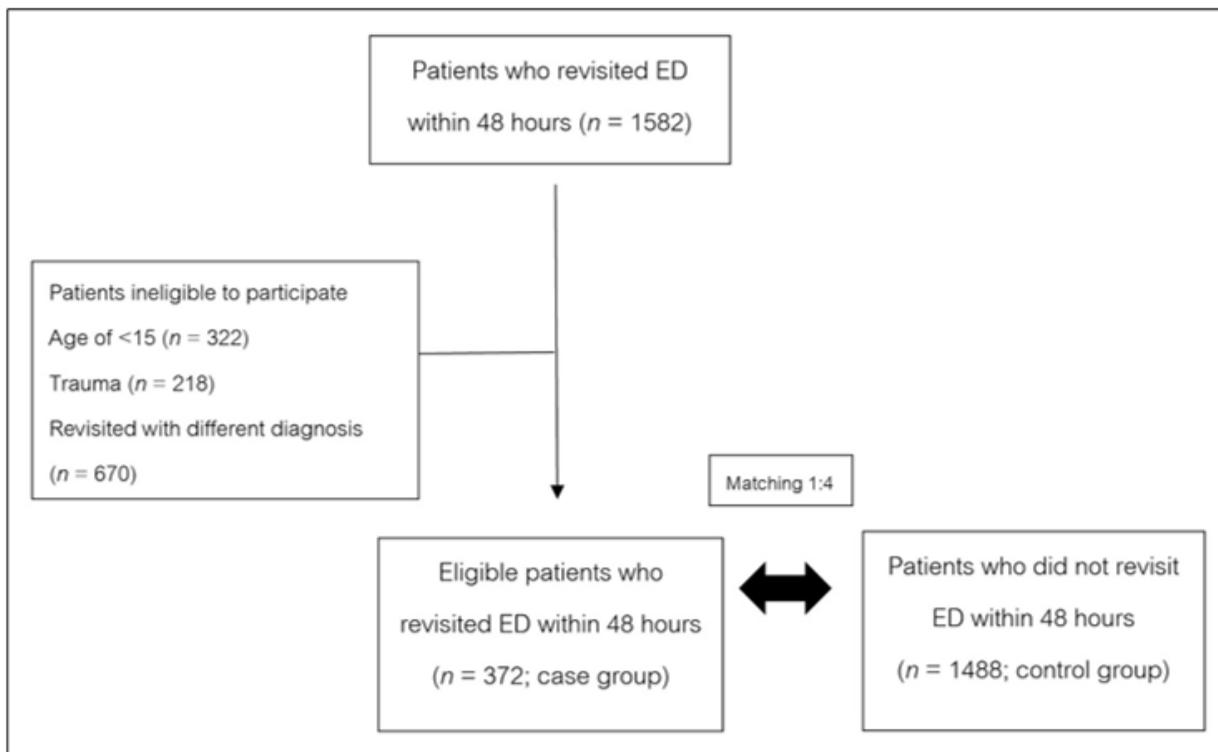
Figure 1: The process of selecting the study population. ED: emergency department.

mostly treated in ED, and the length of stay in ED for more than 4 hours because there was no available bed for admission. Some of the patients with ESI level 2 stayed in the ED for more than 4 hours as no bed was available, some of which were discharged by the emergency physician.

Many studies used the Identification of Seniors at Risk (ISAR) for identifying elderly patients at risk of adverse outcomes and predicting hospital readmission after ED discharge. However, the ISAR was unable to predict 48 hours revisit (15, 16). This study used the variables that were available be-
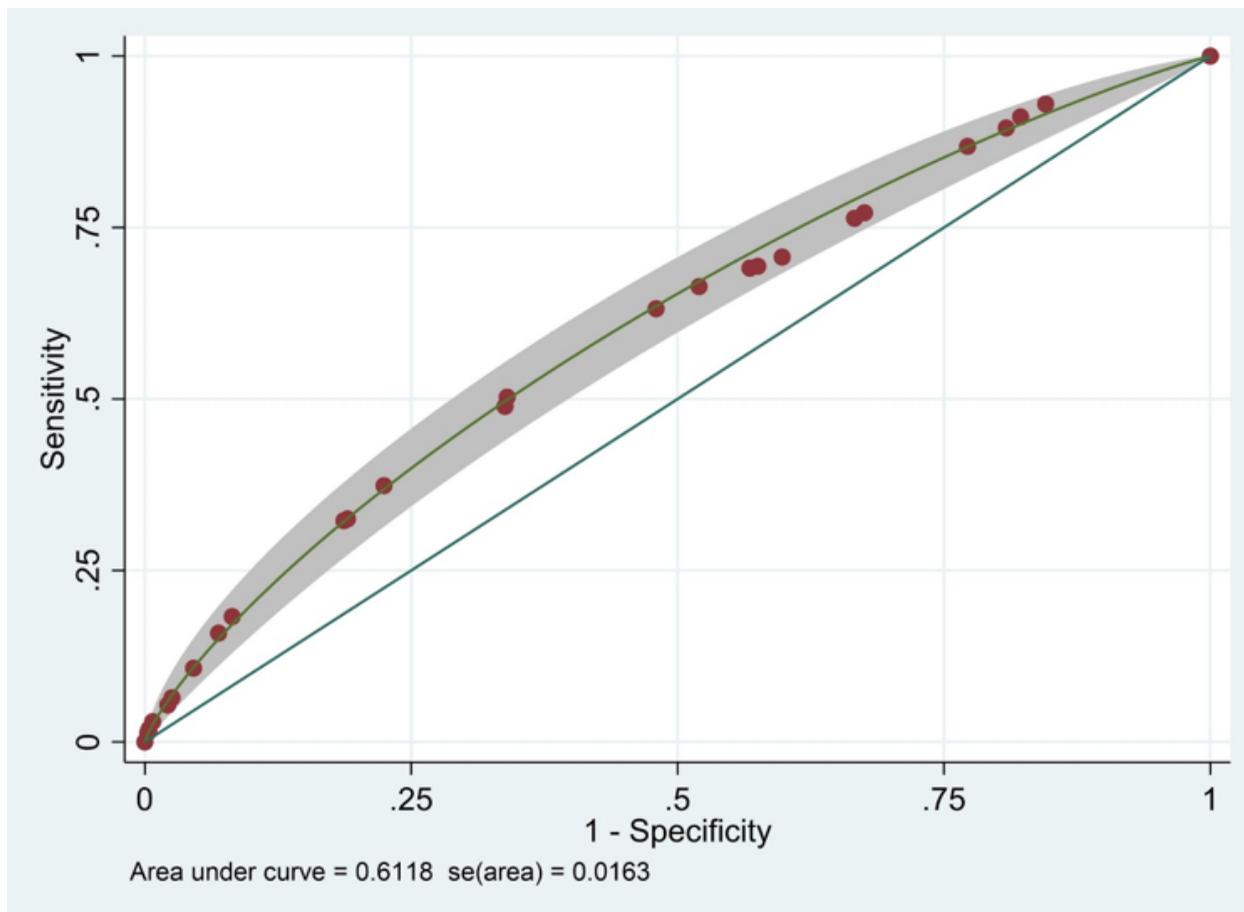
Figure 2: Area under the receiver operator characteristic curve of the model for predicting the probability of revisiting the emergency department within 48 hours after discharge.

Table 3: Groups of patients according to scores indicating the probability of returning to emergency department (ED) within 48 hours

Probability	Score	Revisited		No revisit		PLR	95% CI	P
		N	%	N	%			
Low	0	26	10.10	230	89.90	0.62	0.42–0.91	0.006
Moderate	1–7	159	17.45	752	82.54	0.85	0.74–0.96	0.004
High	>7	187	26.98	506	73.02	1.48	1.31–1.67	<0.001

CI: confidence interval; PLR: Positive likelihood ratio.

fore ED discharge, so they can be evaluated by an emergency nurse or doctor to predict ED revisit. Elderly patients, patients who are initially in triage level 2 when they visit the ED, those with a length of stay of more than 4 hours in ED, and those who have had a high body temperature, or abnormal pulse rate before discharge had a high probability of ED revisits.

If a patient's score is more than 0 points before discharge, special attention should be given; scores of 1 to 7 points indicate a moderate probability of revisit to the ED within 48 hours, and scores more than 7 show a high likelihood of re-

turning (Table 3). It may be necessary for patients with scores between 1 and 7 to be monitored according to the indications. Patients with high scores should be repeatedly evaluated before discharge. At the time of discharge, it is necessary to make an appointment to regularly monitor the patient within the following 24 to 48 hours to reduce the risk of complications that may result in a return to the ED after discharge. These patients may require more treatments than delivered in the ED.

In the ED of our hospital and those of large general hospitals in Thailand, the majority of patients admitted are older than

60 years of age, and during peak periods, patients may spend extra time in the ED, including waiting times. Laboratory examination, investigation of symptoms and treatment may take more than 4 hours; therefore, if the prediction score for probability of revisit to the ED after discharge is used to assess a patient before discharge, most patients will have high scores. The generated score may, therefore, be used as part of deciding whether to discharge the patient or not.

5. Limitations

There are some limitations to this study. Ramathibodi Hospital is a university hospital whose ED treats a large number of patients. The number of inpatient beds is quite limited; therefore, some patients who need to stay in the hospital may have to be referred to other centers for treatment or be discharged home. For patients who go to other hospitals, their data may not be available to Ramathibodi Hospital, and so it is impossible to determine certain variables that may be statistically significant.

The tool's predictive accuracy is 61%, which is low. This may be attributable to the fact that our sample was small. A larger population and investigation in multiple educational institutions may help increase the predictive accuracy of the tool.

6. Conclusion

According to the findings, the most important and independent predictive factor of ED revisit within 48 hours of discharge were, age ≥ 60 years, ESI triage level 2, ED length of stay ≥ 4 hours, temperature ≥ 37.5 C, and 60 > pulse rate ≥ 100 beat/minutes.

7. Declarations

7.1. Acknowledgements

None.

7.2. Author contribution

PT and CY conceptualized the research idea, collected data, performed the analysis and wrote the first draft of the manuscript. CY and WK provided oversight and supervision of the research. WK and CJ contributed in the data acquisition, analysis, or interpretation. All authors read and approved the final manuscript.

7.3. Funding/Support

None.

7.4. Conflict of interest

None.

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