Original Article

Factors Affecting Unpredictable Adverse Events after Admission to the Emergency Department Observation Unit

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Objective: To identify the predicting factors of unpredicted adverse event and in-hospital mortality after admission to the emergency department observation unit (EDOU).

Materials and Methods: A retrospective study of all non-traumatic patients who were admitted to an emergency department based observation unit between July 1, 2015 and June 30, 2016. The main outcome measurements were unpredicted adverse event and the secondary outcome was in-hospital mortality.

Results: Of the 1,037 patients enrolled, 52 (5%) developed unpredicted adverse event. Predictors of unpredictable adverse event included age older than 65 years (odds ratio [OR] 4.45, 95% confidence interval [CI] 2.15 to 9.20), the emergency department (ED) qSOFA score more than two (OR 3.15, 95% CI 1.48 to 6.70), cirrhotic patients (OR 3.83; 95% CI 1.45 to 10.10), cardiovascular patients (OR 6.28, 95% CI 3.18 to 12.41), initial body temperature at EDOU hotter than 38°C (OR 2.40; 95% CI 1.12 to 5.11), and initial pulse rate greater than 90/minute (OR 2.63, 95% CI 1.34 to 5.15). The hospital mortality at 3-day and 28-day of adverse event group were 0.1% (p<0.001) and 1.3% (p<0.001), respectively.

Conclusion: In determining the appropriateness of patients selected for an EDOU: elderly patients, cirrhotic patients, cardiovascular patients, and an ED qSOFA score more than 2, should be the qualifying criteria. Patients placed into the EDOU were more likely to develop unpredictable adverse events if they had a fever and/or tachycardia in the EDOU.

Keywords: Adverse event, Observation unit, Emergency department

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Since overcrowding in the emergency department (ED) has become a challenging issue around the world. The emergency department observation unit (EDOU) has established in many countries[1]. The main purpose of the EDOU is to treat and observe patients who are likely to stay for a relatively short period and require non-intensive intervention. It is an extension of the ED service and allows for serial review, investigations or treatment of patients to improve bed utilization, reduces ED overcrowding, and inappropriate discharges from the ED[1]. However, acutely serious conditions within these patients sometimes go unrecognized. It is inevitable that many cases will result in sudden crisis situations. The previous studies showed the number of the observed patients who had adverse events and being treated as critical patients was 2.9%[2]. In the EDOU of Songklanagarind Hospital, patients who had adverse events were 4.1%, these included unscheduled return ED visits within 48 hours 1.9%, hypotension 1.7%, patients required intensive monitoring and invasive procedures 0.7%, one patient died in the EDOU, and 2 patients died within 48 hours of ICU admission[3]. Appropriate patient selection will not only differentiate between patients who are suitable for short-term observation and those who can be discharged directly from the ED and managed as outpatients, but will also minimize hospital admission from the EDOU. Efficient use of short stay or observation units has been found to decrease inpatient admissions without adverse effects on representations[2,4].

The present study aimed to identify factors as prognostic predictors of unpredictable adverse events after admission to the EDOU and in-hospital mortality as a secondary outcome.

Materials and Methods

The present study was an observational, retrospective data collection between July 1, 2015 and June 30, 2016. The EDOU at Songklanagarind Hospital is a 15-bed short-stay unit located in an urban teaching hospital having the ED volume of over 45,000 patient

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visits per year. The EDOU is located near the ED on the first floor of the hospital. The unit has functioned as an observation unit since 2009. The EDOU is staffed by 2 attending physicians (one emergency medicine staff physician and one emergency medicine trainee) for 8 hours per day, and has round-the-clock nurse practitioner coverage. The EDOU admission criteria were age over 15 years, discharge prediction within 24 hours, non-severe illness, stabilized hemodynamics, and no requirement for intensive monitoring. Transfering to the observation unit is at the discretion of the ED attending physician with the acceptance of the observation unit provider staff. The exclusion criteria were pediatric patients due to limited resources of child care, patients who had unstable vital signs, patients who required intensive monitoring, patients transferred from other departments, patients who remained under the care of a non-ED emergency physician, and polytraumatized patients.

Outcome measurements

The data consisted of demography, initial ED vital signs, and vital signs before transfer to the EDOU, initial EDOU vital signs, laboratory results, ED qSOFA score, consultation, and adverse events in EDOU, result of treatment and death.

The primary outcome variable was unpredictable adverse events defined as either yes or no, included unstable hemodynamics, pulmonary congestion, heart failure, acute respiratory failure, atrial fibrillation with rapid ventricular rate (AF with RVR), upper gastrointestinal bleeding, acute coronary syndrome including ST elevation myocardial infarction (STEMI), unstable angina (UA), non-ST elevation myocardial infarction (NSTEMI), and altered mental status. Additional study data were gathered by reviewing the ED electronic medical records from the Hospital Information System.

The following terms and conditions were defined as follows:

Immunosuppression was defined as the presence of: HIV/AIDS, multiple myeloma, a total of 20 mg/day of prednisolone in the past 14 days, malignancy, organ transplant or current use of immunosuppressive medication.

The quick Sequential (sepsis-related) Organ Failure Assessment (qSOFA) score assigning one point each for: low blood pressure (SBP $\leq$100 mmHg), high respiratory rate ($\geq$22 breaths/minute) and altered mentation (Glasgow coma scale score <15).

Hemodynamical unstable patients define as the patient who had systolic blood pressure less than 90 mmHg or mean arterial pressure (MAP) less than 65 mmHg[5].

Statistical analysis

The statistical analysis was conducted using R software version 3.2.2. Continuous, variables were analyzed and reported as mean and median, while discrete variables were reported as percentage. The Wilcoxon rank-sum test was used for continuous and ordinal variables and the Pearson's Chi-squared test was used for categorical variables. Multivariate logistical regression model was used to evaluate affecting factors for unpredictable adverse events. The hospital mortality at 3-day and 28-day of adverse event group were also reported. A p-value <0.05 was considered statistically significant. The Institutional Ethics Committee Board approved the present study. The ethical registration number was REC 58-264-20-4.

Results

Demographic data

One thousand and thirty-seven patients were enrolled in the present study, 52 (5%) developed unpredicted adverse events. Patient characteristics varied considerably between the non-adverse event group and adverse event group (Table 1). The median EDOU length of stay was 25.6 hours which was not significant between the adverse event and the non-adverse event groups. Disposition from the EDOU included: 882 (85.1%) discharged patients, 105 (10.1%) patients admitted to the general ward, 10 (1%) patients admitted to the intensive care unit, and 40 (3.9%) referred patients. The number of 48-hour revisits was 22 (2.4%). The median hospital length of stay was 214.3 hours (Table 1).

The five main conditions of observed patients were: shortness of breath/chest infection/asthma/chronic obstructive pulmonary disease (18.2%), abdominal pain/gastroenteritis/vomiting (12.2%), renal colic/acute urinary retention/urinary tract infection/acute kidney injury (11.5%), anemia/thrombocytopenia (8.9%), and fever of unknown origin (7.7%) (Figure 1).

Factors affecting unpredictable adverse events

The vital signs of the patients were measured at various time of treatment. There were significant variables between the adverse event group and the non-adverse event group included body temperature greater than 38°C, pulse rate greater than 90 beats/minute and respiratory rate greater than 22/minute (Table 2).

Table 1. Demographic and baseline characteristics of patients

Characteristics	Non-adverse event group (n = 985)	Adverse event group (n = 52)	Total (n = 1,037)	*p*-value
Demographics				
Age (year), median (IQR)	60 (42, 73)	75.5 (66.8, 82)	57.5 (20.7)	<0.001
Age ≥65 years, n (%)	411 (41.7)	40 (76.9)	451 (43.5)	<0.001
Sex, n (%)				0.027
• Male	442 (44.9)	32 (61.5)	474 (45.7)	
• Female	543 (55.1)	20 (38.5)	563 (54.3)	
Underlying diseases, n (%)				0.002
Absent	751 (76.2)	2 (3.8)	801 (77.2)	
Present	234 (23.8)	50 (96.2)	236 (22.8)	
Pulmonary disease (e.g., COPD, asthma)	165 (16.8)	7 (13.5)	172 (16.6)	0.667
Diabetes mellitus	221 (22.4)	17 (32.7)	238 (23.0)	0.122
Hypertension	313 (31.8)	24 (46.2)	337 (32.5)	0.045
Liver disease	36 (3.7)	7 (13.5)	43 (4.1)	0.002
Renal disease	73 (7.4)	5 (9.6)	78 (7.5)	0.751
Cardiovascular diseases	102 (10.4)	23 (44.2)	125 (12.1)	<0.001
Cerebrovascular disease	111 (11.3)	13 (25.0)	124 (12.0)	0.006
Neoplastic disease	175 (17.8)	15 (28.8)	190 (18.3)	0.067
Other	193 (19.6)	9 (17.3)	202 (19.5)	0.821
Immunosuppression, n (%)	191 (19.4)	15 (28.8)	206 (19.9)	0.137
Altered mental status, n (%)	86 (8.7)	11 (21.2)	97 (9.4)	0.006
ED triage: Emergency Severity Index (ESI), n (%)				0.188
ESI 1	20 (2.0)	3 (5.8)	23 (2.2)	
ESI 2	336 (34.1)	23 (44.2)	359 (34.6)	
ESI 3	526 (53.4)	22 (42.3)	548 (52.8)	
ESI 4	101 (10.3)	4 (7.7)	105 (10.1)	
ESI 5	2 (0.2)	0 (0.0)	2 (0.2)	
Laboratory values				
WBC count ≥12,000/mm^3, n (%)	269 (27.3)	16 (30.8)	285 (27.5)	0.163
Hemoglobin level <10 g/dL, n (%)	191 (23.0)	18 (37.5)	209 (23.8)	0.034
Platelets <150,000/mm^3, n (%)	14 (1.7)	0 (0.0)	14 (1.6)	0.751
Creatinine level, median (IQR)	1.1 (0.7, 1.2)	1.3 (0.9, 1.6)	1.2 (0.9)	<0.001
Inpatient specialty consulted prior to transfer to the EDOU, n (%)	66 (6.7)	3 (5.8)	69 (6.7)	1.000
EDOU length of stay (hour), median (IQR)	20 (14, 36)	25.5 (15, 41.2)	25.6 (16.3)	0.22
Disposition, n (%)				<0.001
Discharge	870 (88.3)	12 (23.1)	882 (85.1)	
Admit general ward	83 (8.4)	22 (42.3)	105 (10.1)	
Admit intensive unit	1 (0.1)	9 (17.3)	10 (1.0)	
Refer	31 (3.1)	9 (17.3)	40 (3.9)	
48-hours revisit, n (%)	20 (2.2)	2 (9.5)	22 (2.4)	0.146
Hospital length of stay (hour), median (IQR)	118 (68, 209)	136 (76, 296)	214.3 (314.3)	0.420

IQR = interquartile range; COPD = chronic obstructive pulmonary disease; EDOU = emergency department observation unit

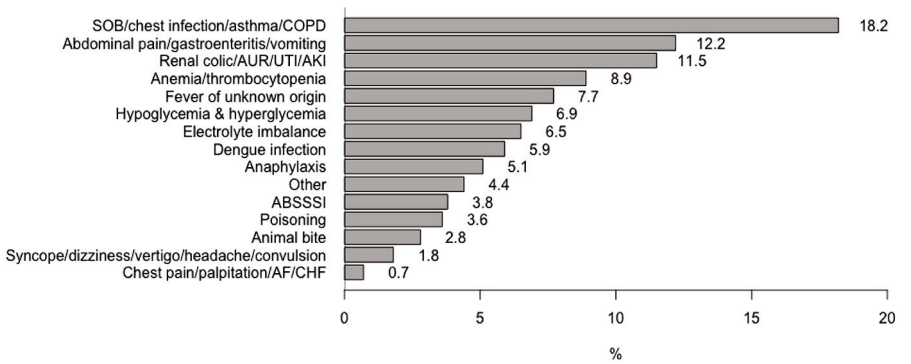

Figure 1. Conditions among observed patients with adverse events.

Table 2. Vital signs of patients

Characteristics	Non-adverse event group (n = 985) n (%)	Adverse event group (n = 52) n (%)	Total (n = 1,037) n (%)	*p*-value
Initial vital signs at ER				
Temperature ≥38.0°C	252 (25.6)	21 (40.4)	273 (26.3)	0.042
Tachycardia (≥90 beats/minute)	571 (58.0)	30 (57.7)	601 (58.0)	1.000
Tachypnea (≥22 breaths/minute)	777 (78.9)	49 (94.2)	826 (79.7)	0.012
Systolic blood pressure ≥140 mmHg	423 (42.9)	22 (42.3)	445 (42.9)	1.000
Hypotension (≤100 mm Hg)	54 (5.5)	5 (9.6)	59 (5.7)	0.344
Vital signs at ER before transfer to EDOU				
Tachycardia (≥90 beats/minute)	230 (23.5)	19 (37.3)	249 (24.2)	0.038
Tachypnea (≥22 breaths/minute)	579 (58.8)	39 (75.0)	618 (59.6)	0.029
Systolic blood pressure ≥140 mmHg	296 (30.3)	11 (21.6)	307 (29.8)	0.243
Hypotension (≤100 mmHg)	5 (0.5)	0 (0.0)	5 (0.5)	0.547
Initial vital signs at EDOU				
Temperature ≥38.0°C	147 (14.9)	12 (23.1)	159 (15.3)	<0.001
Tachycardia (≥90 beats/minute)	420 (43.0)	27 (57.4)	447 (43.7)	0.072
Tachypnea (≥22 breaths/minute)	918 (93.2)	51 (98.1)	969 (93.4)	0.272
Systolic blood pressure ≥140 mmHg	416 (42.6)	15 (31.9)	431 (42.1)	0.195
Hypotension (≤100 mmHg)	29 (2.9)	1 (1.9)	30 (2.9)	0.997

ER = emergency room; EDOU = emergency department observation unit

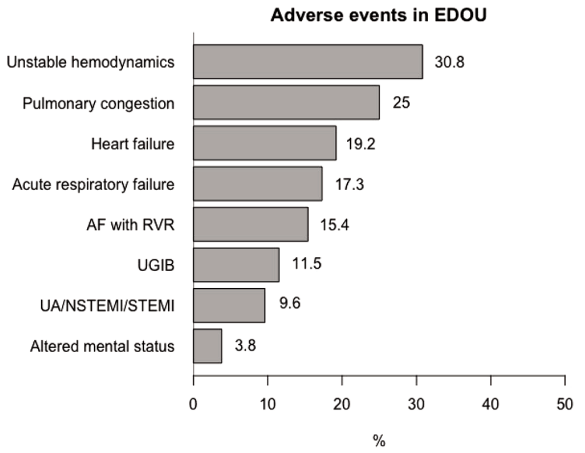

Figure 2. Adverse events in EDOU.

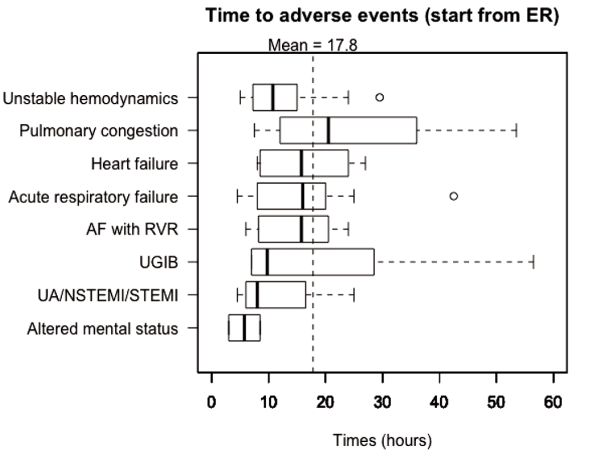

Figure 3. Time to adverse events (start from ED).

Fifty-two patients (5%) developed unpredicted adverse events classified as: 1) unstable hemodynamics (16, 30.8%); 2) pulmonary congestion (13, 25.0%); 3) heart failure (10, 19.2%); 4) acute respiratory failure (9, 17.3%); 5) atrial fibrillation with rapid ventricular rate (8, 15.4%); 6) upper gastrointestinal bleeding (6, 11.5%); 7) UA/NSTEMI/STEMI (5, 9.6%); and 8) altered mental status (2, 3.8%) (Figure 2). The mean time to an adverse event from the ED was 17.8 hours and the mean time to an adverse event from the EDOU was 13.2 hours (Figure 3, 4).

A multivariate analysis was performed. After adjusting for multiple factors, age older than 65 years (odds ratio [OR] 4.45; 95% confidence interval [CI] 2.15 to 9.20), ED qSOFA score more than or equal to

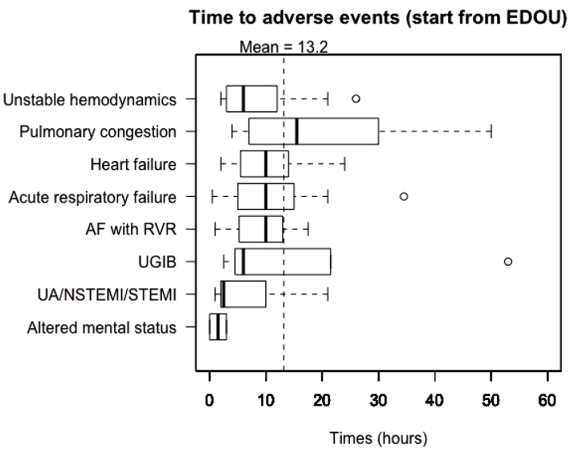

Figure 4. Time to adverse events (start from EDOU).

Table 3. Multivariable regression analysis of risk factors for unpredictable adverse events

Factor	Unadjusted OR (95% CI)	*p*-value	Adjusted OR (95% CI)	*p*-value
Age ≥65 years	4.66 (2.41 to 8.98)	<0.001	4.45 (2.15 to 9.2)	<0.001
Cirrhotic liver diseases	4.1 (1.73 to 9.72)	0.005	3.83 (1.45 to 10.1)	0.012
Cardiovascular diseases	6.87 (3.83 to 12.32)	<0.001	6.28 (3.18 to 12.41)	<0.001
qSOFA score ≥ 2 at ER	2.92 (1.51 to 5.65)	0.003	3.15 (1.48 to 6.7)	0.005
Initial vital signs at EDOU				
Temperature ≥38.0°C	1.94 (0.98 to 3.82)	<0.001	2.4 (1.12 to 5.11)	0.03
Tachycardia (≥90 beats per minute)	1.79 (0.99 to 3.24)	<0.001	2.63 (1.34 to 5.15)	0.004
Systolic blood pressure ≥140 mmHg	0.65 (0.09 to 4.83)	0.65	0.41 (0.21 to 0.81)	0.008

OR = odds ratio; CI = confidence interval; ER = emergency room; EDOU = emergency department observation unit

Table 4. In-hospital mortality and adverse events

In-hospital mortality	Non-adverse event group (n = 985) n (%)	Adverse event group (n = 52) n (%)	Total (n = 1,037) n (%)	*p*-value
48 hours in-hospital mortality	0 (0.0)	2 (3.8)	2 (0.2)	<0.001
3 days in-hospital mortality	0 (0.0)	1 (1.9)	1 (0.1)	<0.001
28 days in-hospital mortality	9 (0.9)	4 (7.7)	13 (1.3)	<0.001

2 (OR 3.15; 95% CI 1.48 to 6.70), cirrhotic patients (OR 3.83; 95% CI 1.45 to 10.10), cardiovascular patients, (OR 6.28; 95% CI 3.18 to 12.41), initial body temperature at EDOU hotter than 38°C (OR 2.40; 95% CI 1.12 to 5.11), initial pulse rate greater than 90 beat/minute (OR 2.63; 95% CI 1.34 to 5.15), and systolic blood pressure ≥140 mmHg (OR 0.41; 95% CI 0.21 to 0.81) remained predictive of unpredictable adverse events (Table 3).

Among observed patients, 48-hour in-hospital mortality was 2 (0.2%), 3-day in-hospital mortality was 1 (0.1%), and 28-day in-hospital mortality was 13 (1.3%) (Table 4).

Discussion

Although the previous studies have examined demographics, clinical outcomes, cost of EDOU, and EDOU failures, those studies did not focus on unpredictable adverse events after admission to EDOU. Patients admitted to the observation unit had too many unrecognized or undiagnosed critical conditions despite being under constant observation by the ED staff personnel[6].

The major decompensations suffered by patients included: 1) unstable hemodynamics; 2) pulmonary congestion; 3) heart failure; 4) acute respiratory failure; 5) atrial fibrillation with rapid ventricular rate; 6) upper gastrointestinal bleeding; 7) acute coronary syndrome (UA/NSTEMI/STEMI); and 8) altered mental status. The present study showed an unpredictable adverse event rate in the EDOU that was 5% greater than the studies by Kraisawat et al[3] and Chang et al[2] (4.1% and 2.49%, respectively). The present study, several patient factors were found to have significant independent association with unpredictable adverse events after admission to EDOU. Knowledge of these factors might improve patient selection for EDOU admission, resulting in earlier inpatient care for those require and more efficient use of EDOU and ED resources.

Elderly patients are four times more likely to have unpredictable adverse events. Comorbidities, such as cirrhotic liver diseases, are three times more likely to have unpredictable adverse events and cardiovascular diseases are six times more likely to cause unpredictable adverse events. Accordingly, Anthony et al[7] demonstrated that underlying comorbidities of older patients cause a higher rate of EDOU failures.

An ED qSOFA score more than or equal to 2 is three times more likely to lead to unpredictable adverse events according to Singer et al[5]. The presence of 2 or more qSOFA points near the onset of infection was associated with a greater risk of death or prolonged intensive care unit stay. These are outcomes that are more common in infected patients who may be septic than those with an uncomplicated infection. Based upon these findings, the Third International Consensus Definitions for Sepsis recommends qSOFA as a simple and prompt method to identify infected patients outside of the ICU who are likely to be septic.

The authors measured the vital signs three times: initially at the ED; before transfer to the EDOU; and initially at the EDOU. The initial vital signs at the ED did not significantly predict adverse events. If

the EDOU patients still had fever and/or tachycardia after receiving medical treatment and intervention in the ED, they were more likely to have unpredictable adverse events.

The 48-hour in-hospital mortality was 2 (0.2%), 3-day in-hospital mortality was 1 (0.1%), and 28-day in-hospital mortality was 13 (1.3%), which were less than the study by Chang et al[2] (in-hospital mortality 16, 59.2%). To decrease the mortality rate and improve the quality of immediate treatment in the ED and EDOU, early detection of potentially critical conditions, avoidance of delayed diagnosis, incomplete or under-investigation are necessary to prevent unpredictable adverse events.

The mean time to an unpredictable adverse event from the ED was 17.8 hours and the mean time to an unpredictable adverse event from the EDOU was 13.2 hours. According to the study by Kraisawat et al[3], the average short-stay observation was not more than 24 hours which was appropriate for observation and detection of unpredictable adverse events.

Conclusion

The factors related to unpredictable adverse events in the EDOU are: elderly patients, patients who had cirrhotic liver and cardiovascular diseases, and a qSOFA score more than or equal to 2. These factors can be used as markers for patients less suitable for admission to the EDOU, better suited for direct admission under a hospital team. Patients placed into the EDOU are more likely to develop unpredictable adverse events if they had fever and/or tachycardia. The hemodynamic status and vital signs of these patients should be closely monitored. Early detection of potentially critical conditions to prevent critical medical intervention is mandatory.

What is already known on this topic?

Several studies showed the usefulness of EDOU and factors predicting EDOU failure.

What this study adds?

This study shows the factors related to the unpredictable adverse events and in-hospital mortality in EDOU patients.

Authors' contributions

Dadeh A performed the literature search, study design, data collection, data analysis, data interpretation, critical revision and writing. Suwaluk P did the study design, data collection, data analysis, and data interpretation.

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Potential conflicts of interest

The authors declare no conflict of interest.

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