The association between length of stay in the emergency department and short term mortality

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Abstract

Background: Prolonged length of stay at the emergency department (ED-LOS) has been associated with increased mortality and hospital stay. The aim of this study was to investigate the association between ED-LOS and 7- and 30-days mortality in patients triaged according to Rapid Emergency Triage and Treatment System – Adult (RETTS-A), the most common used triage tool in Sweden.

Methods: All adult patients (> 18 years) visiting the ED at the Karolinska University Hospital, Sweden, from 1/1/2010 to 1/1/2015 (n=639 385) were included. Logistic regression analysis was used to determine association between prolonged ED-LOS and 7 and 30-days mortality rates. All patients were triaged according to the RETTS-A and subsequently separated into five quintiles of ED-LOS.

Results : In patients triaged with the highest medical urgency, longer ED-LOS was associated with a lower risk for 7-days mortality, for triage priority 1: OR 0.94 (CI 95% 0.92-0.96) compared to OR 1.03 (CI 95% 0.99-1.07) for triage priority 4, and for 30-days mortality: OR 0.97 (CI 95% 0.96-0.99) OR for triage priority 1 compared to 1.03 (CI 95% 1.01-1.05) for triage priority 4. In contrast, the opposite pattern appeared evident in the 3 other triage groups, where a longer ED-LOS was generally associated with an increased mortality risk. Pro-longed ED-LOS in patients admitted to in-hospital care was associated with lower 30- and 7-days mortality independently of triage priority whereas the opposite was observed for patients not admitted to in-hospital care.

Conclusion: Prolonged ED-LOS was associated with increased short term mortality in patients with lower clinical urgency and in patients not admitted to in-hospital care.

Abbreviations

Abbreviations

ED

Emergency department

ED-LOS

Emergency department length of stay

RETTS-A

Rapid Emergency Triage and Treatment system

Background

Emergency Department (ED) crowding is a term that is used to describe a phenomenon in the emergency department in which there is an imbalance between needs and access to proper care [1, 2]. ED crowding has been related to treatment delays, medical errors, and increased patient morbidity and mortality [1, 3–8].

Emergency department length of stay (ED-LOS) is a well-accepted ED performance indicator and is closely related to ED crowding, ED quality care and patient outcome [9–11]. Several studies, including trauma and non-trauma patients as well as patients with high and low clinical priority, have shown an association between increased ED-LOS and unfavourable outcome such as increased mortality and in-hospital length of stay [12–22].

To our knowledge, the association between prolonged ED-LOS and patient mortality has previously not been investigated in patients triaged according to Rapid Emergency Triage and Treatment System—Adult (RETTS-A), the most common triage tool in Sweden. Our aim was therefor to evaluate a possible association between prolonged ED-LOS and 7 and 30-days mortality rate in two of Sweden largest University hospitals.

Methods

Study design

This was a retrospective cohort study in emergency department patients.

Study setting and population

The locations were two university hospitals of Stockholm, Huddinge University hospital and the Solna University hospital. Total annual ED visits were around 150 000 patients. Between 1/1/2010 to 31/12/2016, 641 314 visits at the two hospitals ED's were included in this study and analysed. The patient data were extracted from the hospital administrative system. Patient data was excluded if there was no full documentation of all variables, if patients died upon arrival to the ED, if the patient's first triage priority was blue (the least acute triage priority 5—these patients did not present to the ED) or if the patient had an ED LOS >4000 minutes (values above 4000 minutes were assumed not to be probable and interpreted as type errors) leaving 639 385 patients that were included in the present analyses.

Study protocol

At arrival to the ED at both hospitals, the patient visit is immediately registered and triage according to RETTS-A is performed [23]. Triage priority is determined by using a combination of the patient's presenting symptoms and signs in addition to vital sign values. The patient's presenting symptoms are matched to one of 43 Emergency Symptoms and Signs (ESS) algorithms in accordance with RETTS-A. The more urgent of either the vital signs or presenting symptoms and signs becomes the patient's final triage priority. The RETTS-A triage scale priorities are: red, orange, yellow, green, and blue, in declining priority of acuity. Patients with blue priority, representing non-urgent complaints and minor injuries, were referred to a primary acute health care centre from the ED. Patients with green priority have vital signs in, or close to, normal range and less urgent complaints than yellow, orange, and red patients.

Data collection and variables

The collected variables were age, sex, any of the ten most common chief complaints pre-defined by RETTS-A (abdominal pain, chest pain, shortness of breath, painful or swollen extremity, malaise, dysrhythmia, allergic reaction, syncope, intoxication, fever and undefined), triage priority at arrival, if the patient was given prehospital care given by ambulance or not, if the patients were admitted to in-hospital care or not, if the patient presented to the ED in the weekend or not. The chief complaints can be seen as a crude proxy for co-morbidity and should eliminate some confounding associated with complaint.

Outcomes

Primary outcomes were 7- and 30-days mortality, counted from registration to the ED. Information on patient survival as dependent variable was extracted from the Swedish population register, administrated by the Swedish Tax Agency, which includes every Swedish resident and has a high validity and completeness. Thus there was a near complete follow-up of 7- and 30-day mortality for every patient visiting the EDs included in this study.

Statistical analyses

We presented descriptive data on the study cohort including mean and standard deviation for baseline characteristics. Patients were categorized into different quintiles of ED-LOS. Pearson Chi-square test and One-way ANOVA was used for comparison across groups.Multiple logistic regression models were performed to investigate the relationship between ED-LOS, continuous model and quintile model, and mortality. The model included age, sex and triage-priority, the ten most common chief complaints (to account for different risks associated with different complaints), prehospital care given or not, in-hospital care and when the patient presented to the ED (day of the week and time of the day). We tested multiplicative interactions and stratified instead of adjusting when needed. Odds ratios (OR) and 95% confidence intervals (CI) are presented. P-values < 0.05, two-sided, were considered significant. Statistical analyses were performed using the software STATA version 13.

Ethical considerations

An ethical permit has been issued from the Ethical Review agency in Stockholm, reference number: 2017/1252–31/1.

Results

Baseline characteristics

Different patient categories and ED-LOSare described in table 1. The age distribution was as follows, patients 18–59 years represented 58% of all patients, patients between 60–79 years represented 27% and patients 80 years represented 15% of the total number of patients. Patients age 80 had the longest ED-LOS, 297 min, patients between 60–79 years had an ED-LOS of 266 min and patients between 18–59 years had an ED-LOS of 235 min. Most patients (70%) were not admitted to in-hospital care. Non-admitted patients had shorter visiting time, 237 min compared to 260 min for admitted patients ($p<0.001$). The longest ED-LOS was observed for patients triaged with priority 3 ($p<0.001$).

Mortality

The number of deceased patients per quintile and triage priority expressed as percent are shown in table 2a and 2b. The total number of deceased patients within 7 days was 4421 and total number of patients deceased within 30 days was 12271. The number of deceased patients within 7-days peaked in the 1st quintile, 0.82 %, and decreased with increasing ED-LOS. The number of deceased patients in the 5th quintile was however almost as high as in the 1st quintile. In contrast, the number of patients deceased within 30-days peaked in the 5th quintile, 2.60 %, compared to 1.60 % in the 1st quintile. Patients triaged with triage priority 1 had the highest mortality compared to patients triaged with lower clinical urgency (table 2b).

We observed an interaction between triage priority, as well as hospital care, and most other variables. As a result, we decided to stratify analyses by age-group, triage priority and hospital care. Results from the logistic regression models are shown in table 3 and 4. In patients triaged with triage priority 1, longer ED-LOS was associated with a lower risk for 7-days mortality, for triage priority 1: OR 0.94 (CI 95% 0.92–0.96) compared to OR 1.03 (CI 95% 0.99–1.07) for triage priority 4, and for 30-days mortality: OR 0.97 (CI 95% 0.96–0.99) OR for triage priority 1 compared to 1.03 (CI 95% 1.01–1.05) for triage priority 4 (table 3). In contrast, the opposite pattern appeared evident in the 3 other triage groups, where a longer ED-LOS was generally associated with an increased mortality risk. Data were adjusted for age, sex and triage-priority, the ten most common chief complaints, if prehospital care was given or not, if in-hospital care was given or not and when the patient presented the ED (day of the week and time of the day).

Due to the inverse association between ED-LOS and mortality between patients triaged with priority 1 and patients triaged with priority 2–4, data were grouped into two groups, patients with triage priority 1 (high priority) and patients with triage priority 2–4 (lower priority). Analyses showed that both 7- and 30-days mortality was negatively associated with long ED-LOS when patients were admitted to in-hospital care independently of the triage priority OR 0.92 (0.89–0.94 CI 95%) for patients triaged with priority 1 and OR 0.98(0.97–1.00 CI 95%) for patients triaged with triage priority 2–4. In contrast, prolonged ED-LOS was associated with increased mortality for all patients not admitted to in-hospital care, independently of triage priority. Finally, prolonged ED-LOS in elderly patients was associated with increased 30-days mortality only in patients with low triage priority.

Discussion

In this study we observed that prolonged ED-LOS was associated with increased 7-and 30- days mortality rate in patients with lower medical urgency and patients not admitted to in-hospital care. In contrast, prolonged ED-LOS was associated with lower 7- and 30-days mortality in patients with the highest clinical urgency and in patients admitted to in-hospital care.

The effects of prolonged ED-LOS and ED crowding on non-favourable outcome have been well studied [1, 2] however very sparsely in the Swedish settings [24, 25]. Changes in the vital signs, directing the patient to high triage priority, are in RETTS-A closely related to 1-day mortality [26] and it is anticipated that patients with very urgent symptoms and deranged vital parameters have a high mortality [27], in this study reflected by a high mortality in patients with triage priority 1. In contrast to previous findings that prolonged ED-LOS is harmful for patients with high medical urgency (high triage priority), as for example observed in patients with non-ST-segment-elevation myocardial infarction [28] or in patients with sepsis [29] we were not able to find an increased mortality in patients triage with triage priority 1 and prolonged ED-LOS. The most plausible explanation for our observation is that patients with high clinical priority were quickly identified by the emergency department triage system RETTS-A and urgent care was given. Even though we were not able to analyse this in more detail, our results also suggest that patients with high clinical urgency and prolonged ED-LOS were not harmed by the continued ED-stay. Another finding was also that patients with long ED-LOS and admitted to in-hospital care, had lower mortality compared to patients with prolonged ED-LOS and not admitted to in-hospital care regardless of clinical urgency suggesting that further care and observation of the patients by the medical staff on the ward favours outcome.

Our results also suggest that prolonged ED-LOS in the Swedish setting using RETTS-A is harmful to low triaged patients. One explanation for this finding could be an effect of undertriage were patients with medical urgency remain undetected by the triage tool.

It is well described that patients with non-specific symptoms and low clinical urgency have prolonged hospitalization, an increased mortality and low triage priority [30, 31]. This is particularly important in elderly frail patients [32] but also included critical ill patients [33]. Further studies are needed in order to address the possible effects of undertriage in RETTS-A. Yet, the validity of different triage tools is often validated against proxy outcomes of ED performance such as re-admission rate or mortality. However the main aim for RETTS-A triage is to identify clinical urgency and not to predict 7- or 30-days mortality, suggesting that these results is not a flaw by the current triage tool RETTS-A[34].

ED-LOS is regarded as a key ED performance indicator in Sweden and is followed up annually by the National Board of Health and Welfare. A major trend for the whole Swedish population has been that ED-LOS is longer for elderly patients 80 years of age compared to patients 19–79 years, median ED-LOS 229 minutes compared to 215 minutes respectively. In the whole population 10 % of the patients have a median ED-LOS of 438 minutes [35, 36]. In this study elderly patients had the longest ED-LOS which is in line with the national annual survey [35, 36]. Elderly patients are especially exposed to the negative effects of ED crowing due to their higher comorbidity, lower physiological reserves and diffuse symptoms of medical urgency leading to under triage [37–41]. In line with the literature, our data indicated a small increase in 30-day mortality in elderly patients with low clinical urgency and long ED-LOS. Unfortunately, our data do not allow us to study this further.

Strengths and limitations

One strength in our study is the large cohort (approximately 600 000 visits during a 5-year period) and thus generalizable to the population at large. A major limitation was that we did not have access to all relevant underlying diagnoses and comorbidities of the included patients. However, underlying diagnosis and comorbidities are not used in RETTS-A. We had access to the chief complaints and adjusted for them, thus possibly of more relevance to the clinical milieu at the ED than comorbidity. Another limitation is that this is an observational study. In the current study, we included all patients seeking care at the ED at two large hospitals in our analyses, which means that the findings are more representative of the variety of patients encountered in clinical practice at ED than investigation with strict inclusion and exclusion criteria. Another limitation was that we did not included the degree of crowding in our analyses. There is today however no validated model to calculate crowding in the Swedish settings and such models are under validation [42]. Additionally, in order to assure a rapid care and a low ED-LOS for critically ill patients, different fast tracks have been developed to quickly bypass the crowded ED and to reduce mortality [43, 44]. Such fast tracks are recommended for example for patients with acute chest pain or stroke [45, 46] and were during the study time operating in both university hospitals. We can only speculate how these fast tracks affected 7-and 30-days mortality. Some of these patients probably had a short ED-LOS and increased mortality due to critical illness whereas others had a short ED-LOS and decreased mortality due to early intervention. Finally, triage priority may change during the ED-boarding time, we had however no access to these patient re-evaluations.

Conclusions

Our data suggest that prolonged ED-LOS is harmful and increases mortality in patients that not are admitted to in-hospital care and in patients with lower clinical urgency. We suggest that special attention has to be given to patients with low medical urgency and long ED-LOS by the ED-staff in order to protect from harmful outcome.

Declarations

Ethics approval and consent to participate

The study was approved by the regional Ethical Review Board in Stockholm 2017. Consent to participate was not required by the Ethical Review Board.

Consent for publication

This manuscript contains no individual person´s data, and therefor can be publish without consent from the participants.

Availability of data and material

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

TR researched data, performed statistical analyses, edited manuscript, contributed to discussion, and provided funding. AC and JÄ researched data, edited manuscript, contributed to discussion. TW edited manuscript and contributed to discussion. UE, OM critically revised the text and contributed to discussion. The authors of this manuscript have no conflict of interest to disclose. All authors have read and approved the manuscript.

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Tables

Table 1 **Patient categories and ED-LOS**

Categories	ED-LOS Time (mean, min ± SD, min-max)	n
Sex		
Men	252 ± 163	289882
Women	253 ± 164 *	349503
Age		
18-59	235 ± 152	373231
60 -79	266 ± 170*	176960
≥ 80	297 ± 181*	91123
In-hospital care		
Admitted patients	260 ± 195 *	190477
Non-admitted patients	237 ± 146	450837
Triage		
Triage priority 1	214 ± 160 (1-2370)	34363
Triage priority 2	260 ± 162 (8-2783)*	96913
Triage priority 3	276 ± 173 (0-3977)*	265826
Triage priority 4	229 ± 150 (2-3645)*	244212
Quintiles		
Quintile 1	86 ± 27 (0-124)	123098
Quintile 2	155 ± 17 (125-184)	129216
Quintile 3	216 ± 19 (185-251)	129082
Quintile 4	296 ± 28 (252 – 350)	129264
Quintile 5	498 ± 174 (351 – 3977)	130654

*Indicates statistically significant difference, p-value < 0.05.

Table 2a Mortality per quintiles of ED-LOS expressed as percent deceased patients per quintile

	Quintile 1 86 ± 27 min	Quintile 2 155 ± 17 min	Quintile 3 216 ± 19 min	Quintile 4 276 ± 173 min	Quintile 5 498 ± 174 min
Mortality					
Mortality 7d	0.82	0.57	0.63	0.66	0.79
Mortality 30d	1.60	1.48	1.87	2.10	2.60

ED-LOS = Emergency department length of stay. Data are expressed as % per ED-LOS quintile.

Table 2b **Mortality per triage priority expressed as percent deceased patients per triage priority**

	Triage priority 1	Triage priority 2	Triage priority 3	Triage priority 4
Mortality				
Mortality 7d	5.24	1.28	0.44	0.09
Mortality 30d	9.44	3.65	1.64	0.47

Data are expressed as % per ED-LOS quintile.

Table 3 **Logistic regression for the association between priority of triage, quintiles of length of stay and 7 and 30-days mortality**

7-days mortality	Triage Priority 1 OR (95% CI)	Triage Priority 2 OR (95% CI)	Triage Priority 3 OR (95% CI)	Triage Priority 4 OR (95% CI)
Continuous model				
ED-LOS (hours)	0.94 (0.92-0.96)	0.98 (0.96-1.01)	1.02 (1.00-1.04)	1.03 (0.99-1.07)
ED-LOS quintile model				
Quintile 1 86 ± 27 min	referent	Referent	referent	referent
Quintile 2 155 ± 17 min	0.80 (0.71-0.92)	0.93 (0.75-1.17)	1.14 (0.87-1.51)	1.04 (0.62-1.75)
Quintile 3 216 ± 19 min	0.73 (0.63-0.85)	1.13 (0.92-1.39)	1.24 (0.96-1.62)	0.79 (0.47-1.35)
Quintile 4 276 ± 173 min	0.67 (0.57-0.78)	0.97 (0.79-1.20)	1.36 (1.05-1.75)	1.03 (0.64-1.68)
Quintile 5 498 ± 174 min	0.64 (0.54-0.75)	1.00 (0.81-1.24)	1.37 (1.08-1.75)	1.24 (0.79-1.97)
30-days mortality	**Triage Priority 1 OR (95% CI)**	**Triage Priority 2 OR (95% CI)**	**Triage Priority 3 OR (95% CI)**	**Triage Priority 4 OR (95% CI)**
Continuous model				
ED-LOS (hours)	0.97 (0.96-0.99)	1.01 (1.00-1.02)	1.02 (1.01-1.03)	1.03 (1.01-1.05)
ED-LOS quintile model				
Quintile 1 86 ± 27 min	referent	Referent	Referent	referent
Quintile 2 155 ± 17 min	0.93 (0.84-1.04)	1.00 (0.87-1.14)	1.18 (1.02-1.37)	1.04 (0.82-1.34)
Quintile 3 216 ± 19 min	0.92 (0.82-1.03)	1.19 (1.04-1.36)	1.36 (1.18-1.56)	1.31 (1.04-1.65)
Quintile 4	0.83 (0.73-0.94)	1.13 (0.99-1.30)	1.35 (1.18-1.55)	1.27 (1.02-1.60)

276 ± 173 min				
Quintile 5 498 ± 174 min	0.86 (0.76-0.97)	1.19 (1.04-1.36)	1.45 (1.28-1.65)	1.50 (1.21-1.85)

Logistic regression, analyses adjusted for: age, sex, the ten most common chief complaints (to account for different risks associated with different complaints), prehospital care given or not, admission to in-hospital care and when the patient presented to the ED (day of the week and time of the day), Quintile 1 = ref.

Table 4 Logistic regression for the association between ED-LOS (h, continuous model) and 7 and 30-days mortality. All analyses were stratified by age, whether the patient was admitted to in-hospital care or not and triage priority

7-days mortality	Triage Priority 1 OR (95% CI)	Triage Priority 2-4 OR (95% CI)
Admission to in-hospital care	0.92 (0.89-0.94)	0.98(0.97-1.00)
No admission to in hospital care	1.11 (1.06-1.15)	1.11(1.09-1.14)
Age 18-59 years	0.89 (0.83-0.96)	1.04(0.99-1.04)
Age 60-79 years	0.94(0.91-0.97)	1.02(1.00-1.04)
Age ≥ 80 years	0.92(0.89-0.95)	0.99(0.98-1.01)
30-days mortality	**Triage Priority 1 OR (95% CI)**	**Triage Priority 2-4 OR (95% CI)**
Admission to in-hospital care	0.96(0.95-0.98)	0.99(0.99-1.00)
No admission to in hospital care	1.10(1.06-1.14)	1.12(1.11-1.13)
Age 18-59 years	0.93(0.88-0.98)	1.05 (1.02-1.07)
Age 60-79 years	0.96(0.94-0.98)	1.03(1.02-1.04)
Age ≥ 80 years	0.96(0.94-0.98)	1.02 (1.01-1.03)

Logistic regression, analyses adjusted for: sex, the ten most common chief complaints (to account for different risks associated with different complaints), prehospital care given or not, in-hospital care and when the patient presented to the ED (day of the week and time of the day.