

## RESEARCH ARTICLE

# FACTORS ASSOCIATED WITH LENGTH OF STAY IN THE EMERGENCY DEPARTMENT: A NARRATIVE REVIEW

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## Abstract

**Background:** Increasing demand and complex procedures may associate with the length of stay (LOS) in the Emergency Department (ED). Prolonged LOS may decrease the quality of ED care and increase patient harm. Therefore, it is pivotal to analyze factors that may contribute to ED LOS.

**Objective:** This review aimed to identify and discuss factors that contribute to the Emergency Department length of stay (ED LOS) to improve the quality of care.

**Methods:** Relevant healthcare databases including PubMed and CINAHL were searched using the combinations of search terms: length of stay, length of visit, emergency department, emergency room, and patient flow. Inclusion criteria included publications between 2007-2017.

**Results:** A total of 24 relevant papers was selected. The literature indicates that three main factors are associated with ED LOS: input (older patients and acuity level), throughput (diagnostic tests and or radiology, specialist consultation), and output (need for admission and boarding time).

**Conclusion:** Input, throughput, and output factors are contributed to ED LOS. Further review is necessary to determine organizational factors that may contribute ED LOS including the number of health staff, staff workload, flow studies, and health system.

**Keywords:** *length of stay, length of visit, emergency department, emergency room, patient flow*

## Introduction

Research in the United States of America (USA) has shown that the number of Emergency Department (ED) visits of adult patients increased from 330 to 358 per 100,000 population from 2006 to 2011. It increased by 66% faster than population growth from 2001-2008 (Pitts et al., 2012). The individual's health needs as part of overall health factors, consisting of morbidity, injury, etc. appear to be the primary predictors of increasing ED demand (He, 2011). Due to the increasing demand for ED care and more complex management procedures, patients commonly have prolonged waiting times and lengths of stay (LOS) (Chaou et al., 2016; Herring et al., 2009; Wilper et al., 2008). Emergency Department LOS, which is defined as the time interval between patient arrival and patient admission or discharge from the ED, may be an indicator of the quality of care received (Karaca et al., 2012). Prolonged LOS cause and magnify the impact of ED

crowding (Chaou et al., 2016). In addition, prolonged ED LOS not only decreases the quality of service but also increases the risk of patient harm (Horwitz et al., 2010). Therefore, it is pivotal to analyze factors that contribute to ED LOS. The aim of this review was to identify and discuss factors that contribute to ED LOS with the end goal of improving the quality of care in the ED.

## Development

### Literature Search Strategy

Relevant literature was examined following a thorough search of databases including PubMed and CINAHL using the following keywords: length of stay, length of visit, emergency department, emergency room, and patient flow. This review aimed to identify and discuss factors that contribute to ED

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LOS. Inclusion criteria included publication between 2007-2017. The search was limited to English language articles. Length of stay related to ward and in-patient bed stay, and non-scientific publications, correspondences, and commentaries were excluded.

### Identification and Selection of Relevant Articles

An Excel worksheet was used to facilitate the identification and selection process. Duplicates were removed. The articles were selected by reading and sorting based on the inclusion and exclusion criteria. A total of 24 relevant papers was selected for a more detailed review. The preferred reporting item for systematic review and meta-analysis (PRISMA) was utilized as a guide in reporting the searching process (fig. 1).

### Summarizing the Findings

Included articles were categorized into three main factors i.e. input, throughput, and output. Input factor is defined as a condition that may increase needed urgent care including

patient's age and patient acuity (Asplin et al., 2003). Throughput factor refers to the administration of elements through the ED patient flow which includes getting diagnostic tests (laboratory testing/radiology) and having consultations with specialists (Kusumawati, Magarey & Rasmussen, 2017). Output factor is defined as the last phase of the ED patient journey which includes the need to be admitted (the stage where patients require extensive medical treatment and care i.e. inpatient) and boarding time (the time interval from the doctor's decision to admit the patient until the patient leaves the ED) (Asplin et al., 2003; Kusumawati, Magarey & Rasmussen, 2017).

## Results

### Study Characteristics

24 studies were identified. Among these, 18 included ED patients (discharged, admitted, or both) (Brick et al., 2014; Casalino et al., 2014; Chaou et al., 2016; Ding et al., 2010;

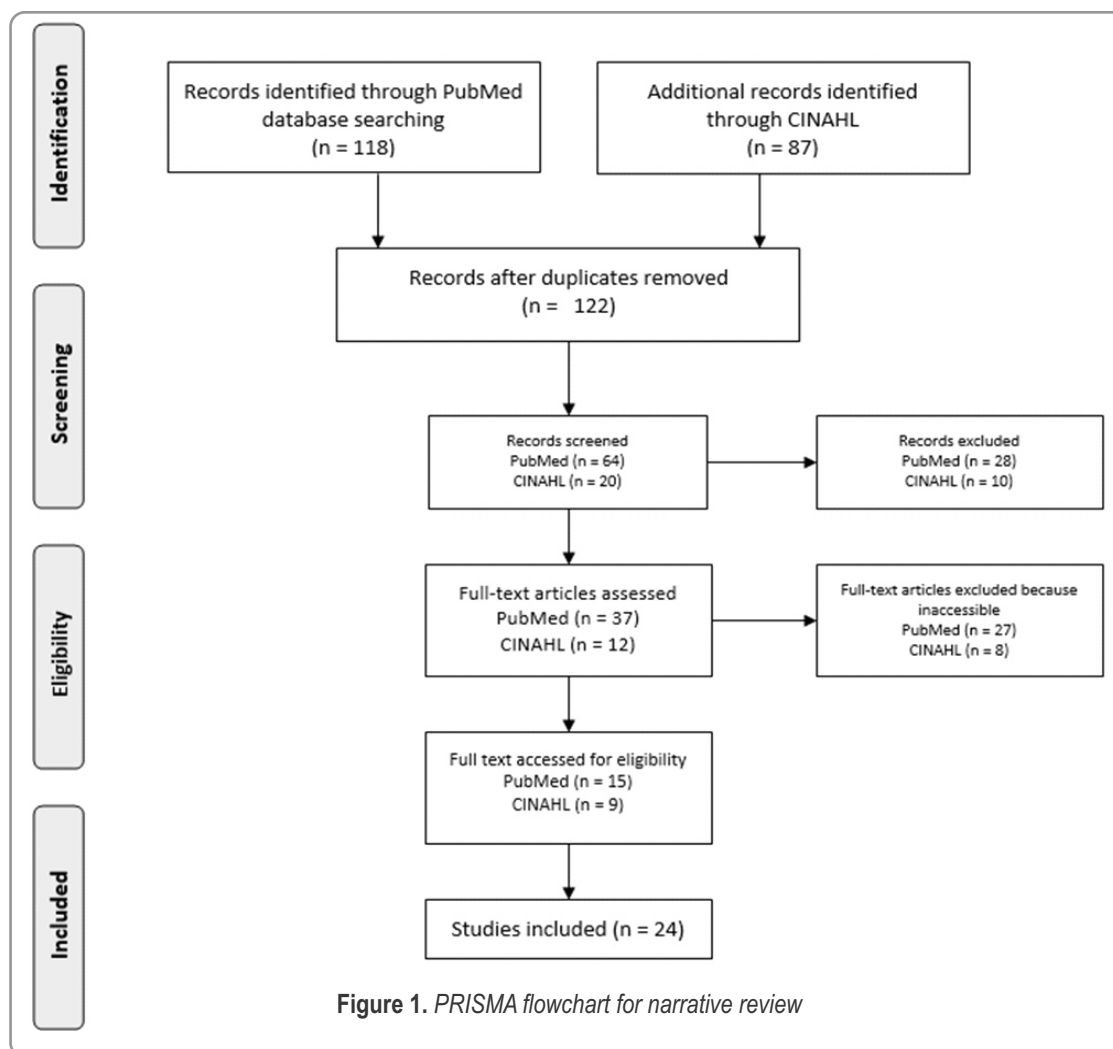


Figure 1. PRISMA flowchart for narrative review

Fogarty et al., 2014; Gardner et al., 2007; Kanzaria et al., 2014; Karaca et al., 2012; Kawano et al., 2014; Kreindler et al., 2016; Li et al., 2015; Lowthian et al., 2011; Mahsanlar et al., 2014; Mowery et al., 2011; Pines et al., 2009; Rose et al., 2012; Vegting et al., 2015; Wibulpolprasert et al., 2014), 4 studies included psychiatric patients or patients with mental health problems (Chang et al., 2012; Stephens et al., 2014; Shafiei et al., 2011; Weiss et al., 2012) and 2 included elderly patients (Brouns et al., 2015; Latham & Ackroyd-Stolarz, 2014). Primary studies were undertaken in the USA (9), Canada (3), Australia (3), Europe (4), and Asia (4), and 1 is a review study. This literature review differs from other literature reviews on the subject of ED length of stay (LOS) because the main cause of ED LOS was further subdivided into three factors with boarding time also considered as a factor associated with ED LOS.

### Study Findings

Three main factors (input, throughput, and output) have been used to predict ED stay (see Table 1). Key findings are presented to reveal the results of a more detailed review. The input-throughput-output framework was also made (see table 2).

#### Input factor

10 studies found that older patients spent a longer time in ED (Brick et al., 2014; Casalino et al., 2014; Chaou et al., 2016; Karaca et al., 2012; Li et al., 2015; Lowthian et al., 2011; Vegting et al., 2015; Weiss et al., 2012; Wibulpolprasert et al., 2014). 7 of 11 studies found that increased ED LOS was associated with higher acuity level of the patients (Brouns et al., 2015; Casalino et al., 2014; Karaca et al., 2012; Stephens et al., 2014; Vegting et al., 2015; Weiss et al., 2012). On the other hand, 3 studies stated that emergency patients spent a shorter time in ED (Chaou et al., 2016; Li et al., 2015; Rose et al., 2012). 1 study found that mid-level acuity of patients experienced the longest time in ED (Ding et al., 2010).

#### Throughput factor

The components of the throughput that may affect ED LOS include diagnostic testings (laboratory and radiology), and consultations with specialists. 9 studies explained that both diagnostic testing and or radiology contributed to prolonged ED LOS (Brouns et al., 2015; Casalino et al., 2014; Gardner et al., 2007; Kanzaria et al., 2014; Kawano et al., 2014; Li et al., 2015; Mowery et al., 2011; Vegting et al., 2015; Wibulpolprasert et al., 2014). In this review, 6 studies found that patient who receives specialized consultation spent a longer time in the ED (Brick et al., 2014; Brouns et al., 2015; Casalino et al., 2014; Mowery et al., 2011; Vegting et al., 2015; Wibulpolprasert et al., 2014).

#### Output factor

The last phase of ED flow was the need for admission and boarding time. Unsurprisingly, patients eventually admitted as inpatients experienced a longer time in the ED as compared to discharged patients. All the studies stated that the need for admission was associated with prolonged ED stay (Casalino et al., 2014; Chaou et al., 2016; Gardner et al., 2007; Latham & Ackroyd-Stolarz, 2014; Li et al., 2015; Lowthian et al., 2011; Stephens et al., 2014; Shafiei et al., 2011; Vegting et al., 2015; Wibulpolprasert et al., 2014). 1 of 3 studies explained that boarding time was prolonged in ED due to lack of Intensive Care Unit (ICU) beds (Mahsanlar et al., 2014).

## Discussion

### Input Factors

Older patients commonly stay longer in ED than those who are younger (Casalino et al., 2014; Fogarty et al., 2014; Kreindler et al., 2016; Lowthian et al., 2011). Seventy-five (75%) percent of older patients completed their ED treatment in more than four hours (Fogarty et al., 2014; Lowthian et al., 2011). Reasons why patients aged over 65 years stay longer include the severity of illness, the requirement for a longer time to be treated, and the lack of available long-term units. Older patients frequently arrive with unclear symptoms, may communicate poorly, have complex comorbidities, and more severe symptoms (Brick et al., 2014; Casalino et al., 2014; Chaou et al., 2016; Karaca et al., 2012; Kreindler et al., 2016). The elderly frequently need a longer time to be treated by a doctor (i.e., for assessment, diagnostic examination, and the doctor's decision on whether the patient should be admitted or be discharged) (Casalino et al., 2014). Doctors require at least 30 minutes to assess geriatric patients comprehensively (Casalino et al., 2014). Due to the lack of available long-term units within hospitals, elderly patients are frequently transferred to another institution. Also, transfer decisions involve a complex and time-consuming process (Casalino et al., 2014).

The acuity level was also associated with ED LOS. Ideally, patients who are classified as requiring resuscitation and urgent treatment (level I and II) spent the shortest time in ED with zero waiting time for assessment by the physician (Casalino et al., 2014). On the other hand, previous research also found that LOS was the longest for patients with medium severity and the shortest for those in the highest and lowest severity categories (short treatment or availability of fast track) (Kreindler et al., 2016). Based on Policy of Australian Triage Scale (ATS) and Canadian Triage and Acuity Scale (CTAS), a score of one represents a patient who requires immediate assessment and treatment (zero time). The maximum time the patient had to spent upon arrival until assessed by the doctors ranges from 15-120

minutes depending on their categories (15 minutes for imminently life-threatening, 30 minutes for potentially life-threatening/ situational urgency, 60 minutes for potentially serious, and 120 minutes for less urgent) (ACEM, 2003). Patients with higher acuity levels should be transferred immediately to a high-complex treatment area like ICU or the Operating Room (OR).

In contrast, most of the studies involved in this review stated that ED LOS was substantially increased with a high level of acuity. It can be theorized that doctors require more time to stabilize, observe, and decide on the appropriate destination (i.e., ICU or another ward) for high acuity patients (Rose et al., 2012). Other constraints such as lack of ICU beds are associated with prolonged ED LOS (Mahsanlar et al., 2014). Therefore, the acuity level cannot stand alone as a factor associated with prolonged ED LOS.

### **Throughput Factors**

Throughput factors are defined as the administration of elements through the ED patient flow including diagnostic tests/imaging and specialist consultation (Kusumawati, Magarey & Rasmussen, 2017).

A higher number of laboratory tests was associated with prolonged ED stay. For every five laboratory examinations, median LOS was prolonged by 10 minutes (Li et al., 2015). For each half an hour increase in test turnaround time (TAT), the median LOS is prolonged by 17 minutes (Li et al., 2015). Laboratory testing consists of three phases including pre-analytic, analytic, and post-analytic. Pre analytic phase (time between the doctor's request on the test until the sample arrives in the laboratory) contributed to prolonged TAT when samples were collected by non-laboratory workers who perform multiple tasks simultaneously (i.e. nurse) (Sheppard et al., 2008). In the analytic phase, the lack of laboratory personnel was associated with the delay in processing the samples (Stotler & Kratz et al., 2012). The post-analytic phase includes interpretation of results and reporting which were the doctor's responsibility (Stotler & Kratz et al., 2012). Therefore, it is pivotal to analyze the root cause of delays.

The type and complexity of the procedure, as well as the number of imaging tests done, contributed to prolonged ED LOS. In admitted patients, computed tomography (CT) examination increased ED stay by 32.7 mins (Kawano et al., 2014). Patients who underwent magnetic resonance imaging tests (MRIs) to investigate spine fractures spent the longest time ranging from 6-16 hours (Mowery et al., 2011). The utilization of radiology improves diagnostic and decision making, but it takes more time to upload the image and to interpret the results (Vegting et al., 2015).

Reasons for the association between diagnostic testing and ED LOS have been suggested, such as laboratory overuse, the utilization of unnecessary testing, and inappropriate test ordering behavior in ED (Kawano et al., 2014; Lapić & Rogić, 2015; Wibulpolprasert et al., 2014). Doctors commonly order more than two types of diagnostic testing for complex patients (Wibulpolprasert et al., 2014). The tests may not provide additional value for patient care. However, there was no further research to investigate whether those multiple tests were appropriate. On the other hand, additional tests were also viewed as indicators of quality particularly to comply with acceptable standards of diagnostics found in clinical pathways and guidelines. On the negative side, however, ordering additional tests may also be viewed as a way to maximize the hospital's laboratory resources (Lapić & Rogić, 2015).

In another review of patterns associated with prolonged ED stay, increased ED LOS was associated with the decision to consult or not consult physician specialists (Kreindler et al., 2016). Additionally, patients who needed consultations with specialists stayed over 200 minutes in the ED (Mowery et al., 2011) or had an additional 30 minutes of ED stay (Stephens et al., 2014).

Several reasons accounted for the additional time needed by specialists that contributed to prolonged ED stay. First, it can be difficult to contact specialist doctors. Aside from it, they can have difficulties interacting with emergency room doctors. As part of the culture, specialists will see the patient first and decide on discharge destinations (Mowery et al., 2011). Secondly, specialist consultants tend to handle the patients independently instead of working as a team (Vegting et al., 2015). Therefore, complex patients are seen by multiple specialists. Thirdly, specialist doctors are rarely directly available in ED because they are busy treating the patient in the wards or are operating in the daytime (Vegting et al., 2015).

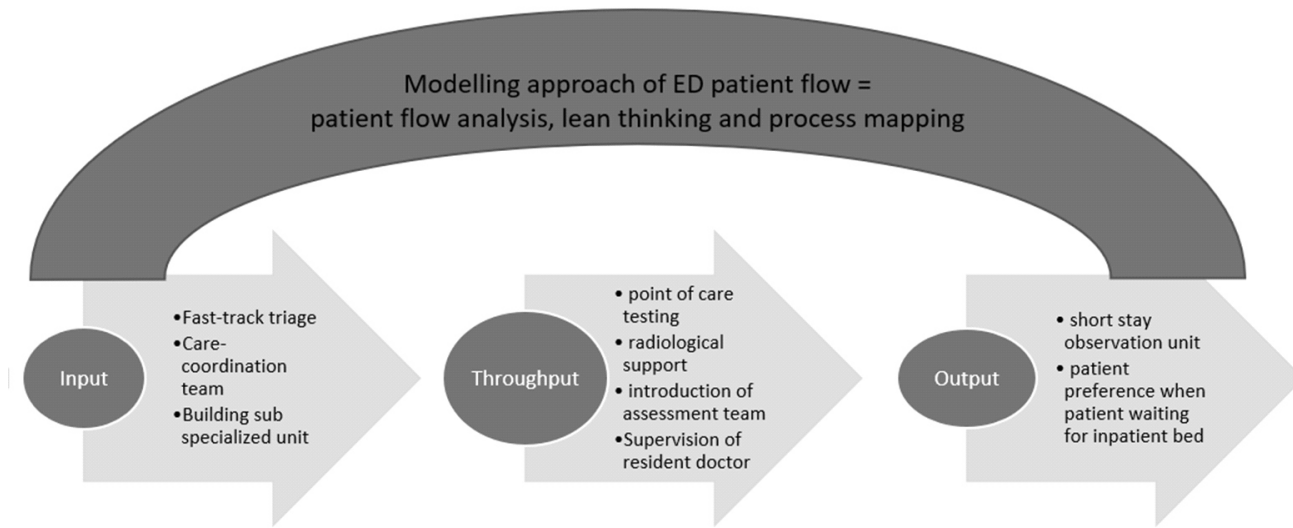
### **Output Factors**

The last phase of the ED patient's journey will depend on factors such as the need for admission and boarding time to the ward (Kusumawati, Magarey and Rasmussen, 2017).

A review that identified patient characteristics indicated that admitted patients had longer ED LOS than those discharged (Casalino et al., 2014; Kreindler et al., 2016). Admitted patients experience complex stages in their ED journeys, including waiting for admission, for a bed to become available, and boarding time after being admitted by the physician. Clinical care pathways of admitted patients which are more complex contributed to prolonged ED stay (Casalino et al., 2014).

A previous study found that median boarding time was 6.7 hours, consisting of 4.9 hours for the doctor's decision to admit and 1.8

Figure 2. Recommendation to improve ED patient flow



hours for transfer of the patient to an inpatient bed (Stolte et al., 2006). Ideally, in terms of boarding time, patients who have finished the treatment and require admission should be transferred to an inpatient bed within two hours (Hodgins et al., 2011). However, there was a delay in the transfer to an inpatient bed after the decision to admit was made (Hodgins et al., 2011). Delayed boarding times may occur as a result of factors (patient and system factor) including a lack of adequate inpatient beds (Li et al., 2015), lack of experienced staff to treat patients with a critical illness (Rose et al., 2012), the complexity of patients (Pines et al., 2009), and patients' specific needs (long term unit, need for cardiac monitoring or an isolation room) (Paoloni & Fowler, 2008).

The ability to transfer admitted patients from ED to inpatient beds will depend on the availability of hospital beds (Jayaprakash et al., 2009). The longest waiting time was from bed request to bed availability, accounting for more than nine hours which is longer than the treatment time (Au et al., 2008). Critically ill patients had longer ED stays due to bed shortages in the ICU or high demand for the same resources from admitted patients (medical/surgical wards) (Hawkins, 2007). Delay of transfer may cause prolonged ED LOS (Hawkins, 2007).

The limited number of general and special beds has led to competing priorities in terms of placement. Some hospitals may have highly efficient systems embedded in their processes; others may not have such systems in place. Bed placements are normally assigned to multi-tasking nursing supervisors who also have competing priorities (Jayaprakash et al., 2009).

### Recommendation

Some recommendations have been suggested to improve patient flow in the ED (figure 2). For input factor, The Victorian Hospital Demand Management Strategy (2001) developed and arranged models of care within ED and hospital, including fast-tracked triage and care-coordination teams (The Victorian Hospital Demand Management Strategy, 2007). Building a specialized sub-unit for the high-acuity level of psychiatric patients was one of the recommendations to stabilize critically-ill patients effectively in ED (Weiss et al., 2012).

For the throughput factor, applying point of care testing supports doctors to make decisions 19% faster than the centralized laboratory unit (Hawkins, 2007). For imaging procedure issues, the availability of radiological support within ED will also improve the quality of ED care (Vegting et al., 2015). The introduction of an assessment team including internal medicine, neurology, surgery, and an emergency doctor who work together to treat the patients will reduce multiple consultations (Vegting et al., 2015). Specialist consultants may be used to directly support and supervise resident doctors to make clinical decisions faster (Vegting et al., 2015).

For the output factor, availability of short-stay observation units (Forero et al., 2010) and providing other convenient places for patients when ED cubicle is full (ward corridor or ED corridor) (Bartlett & Fatovich, 2009) are the solutions when the patient is waiting for an in-patient bed. Application of model and instruments to analyze the issues of ED patient flow such as patient flow analysis (Dixon et al., 2015), lean thinking (Dickson et al. 2009), and process mapping (Martin et al 2011) can be used to investigate bottleneck areas and to track patient journey in the ED.

Table 1. Data extraction of included studies

No	Author	Year	Country	Factors studied						Key Findings
				Input		Throughput		Output		
				age	acuity level	diagnostic tests	specialist consultation	need for admission	boarding time	
1	Brick et al. <sup>8</sup>	2014	Canada	V			V			Advanced age and multiple consultation were associated with prolonged ED LOS
2	Brouns et al. <sup>28</sup>	2015	Netherland		V	V	V	V		Prolonged ED LOS was associated with high acuity, number of diagnostic tests, more than 1 specialist consultation, and need for admission
3	Casalino et al. <sup>9</sup>	2014	France	V	V	V	V	V		Increased ED LOS was associated with older patient, high acuity and complexity, hematology test, x-ray examination, CT/MRI test, specialist consultation and admitted patient
4	Chang et al. <sup>24</sup>	2012	USA					V		Admitted patient with psychiatric disorder was associated with increased ED LOS
5	Chaou et al. <sup>5</sup>	2016	Taiwan	V	V			V		For discharged patients, longer ED LOS was examined for older patients. For admitted patients, shorter ED was noted for high acuity and more severe patients
6	Ding et al. <sup>10</sup>	2010	USA		V					Acuity level 3 patients stayed in waiting room the longest
7	Fogarty, Saunders & Cummins <sup>11</sup>	2014	Ireland						V	There was association between ED boarder and delay over 6 hours
8	Gardner et al. <sup>12</sup>	2007	USA			V		V		Diagnostic test was strongly associated with prolonged LOS for discharged patients. Admitted patients experience longer time than discharge
9	Kanzaria et al. <sup>13</sup>	2014	USA			V				Median LOS of patient who underwent advanced diagnostic imaging (ADI) was longer than patients without ADI
10	Karaca et al. <sup>6</sup>	2012	USA	V	V					Older patients experienced longer ED LOS. More severe patients (patient with blood disease, neoplasm and mental health problems) stayed the longest in ED
11	Kawano, Nishiyama & Hayashi	2014	Japan			V				In discharged patients, diagnostic tests increased ED LOS by 72,5 mins. In admitted patients, CT examination increased ED stay by 32,7 mins.
12	Kreindler et al. <sup>15</sup>	2016	Several countries	V	V	V	V	V		In general, elderly persons experienced longer ED stay than younger. Most of the studies found that ED stay was longest for patients with highest acuity or lowest acuity (fast track). Diagnostic tests and specialist consultation increased ED LOS. All of studies stated that admitted patients stayed longer in ED than discharged.

13	Latham & Ackroyd <sup>29</sup>	2014	Canada	V				V	Older patients were associated with longer ED LOS due to diagnostic examination and consults. ED LOS of admitted patients was doubled compared to those who were discharged.
14	Li et al. <sup>16</sup>	2015	Australia	V	V	V		V	Older persons experienced prolonged ED stay. Emergent patients stayed shorter than less urgent patients. Those who were exposed to an increased number of diagnostic test experienced longer ED stays. Discharged patients spent shorter time in the ED than admitted patients
15	Lowthian et al. <sup>17</sup>	2012	Australia	V	V			V	Median LOS increased with advancing age. Higher acuity patients spent longer time in ED (>4 hours). Admitted patient experienced longer time in ED
16	Mahsanlar et al. <sup>18</sup>	2014	Turkey					V	Critical patients spent longer time in ED due to lack of Intensive Care Unit beds.
17	Mowery et al. <sup>19</sup>	2011	USA			V	V		Patients who needed an MRI to examine spine fractures experienced longest time in ED. Patient who need specialist consultation experience longer time in ED.
18	Pines, Russel & Hollander <sup>20</sup>	2009	USA					V	Boarding time associated with ED LOS in black patients
19	Rose et al. <sup>21</sup>	2012	Canada		V				Shorter ED LOS was associated with higher acuity level
20	Shafiei, Gaynor & Ferrel <sup>25</sup>	2011	Australia					V	Admitted psychiatric patient was associated with increased ED LOS due to waiting for bed availability (>8hours)
21	Stephens et al. <sup>26</sup>	2014	USA		V			V	Admitted patients and patient with high acuity level (suicidal idea) experienced longer time in ED
22	Vegting et al. <sup>22</sup>	2015	Netherland	V	V	V	V	V	Elderly experienced longer time. Higher level of acuity patients spent more than 4 hours in ED LOS. All of patients who underwent radiology examination exceeded 4 h target. Most patients who need specialist consultation spent more than 4 hours in ED. Admitted patients did not achieve 4 h target
23	Weiss et al. <sup>27</sup>	2012	USA	V	V			V	Elderly was related with increased ED LOS. patients who have high acuity level (positive toxicity screening) spent longer time in ED. Hospitalized patients experienced longer time in ED.
24	Wibulpolprasert et al. <sup>23</sup>	2014	Thailand	V		V	V	V	Geriatric patients spent more than 8 hours in ED. Diagnostic test, x-ray, CT, Ultrasonography (USG) were associated with ED LOS. Admitted patients experienced prolonged ED stay.

Table 2. *Input, Throughput and Output Framework in ED*

Factors contributed to LOS	Input phase	Throughput phase	Output phase	Author and published year
Patient factors	Older patient, highest/lowest level of acuity, high ED demand	Not identified in this study findings	Need for admission, patient specific needs (long term unit, need for cardiac monitoring or an isolation room)	Brick et al. (2014), Brouns et al. (2015), Casalino et al. (2014), Chaou et al. (2016), Karaca, et al. (2012), Kreindler et al. (2016), Latham & Ackroyd (2014), Li, et al (2015) Lowthian et al. (2012), Vegting et al. (2015), Wibulpolprasert et al. (2014), Ding et al. (2010), Rose et al. (2012), Stephen et al. (2014), Weiss et al. (2012), Chang et al. (2012), Gardner et al (2007), Shafiei, Gaynor & Ferrel (2011), Weiss et al. (2012), (Paoloni & Fowler, 2008)
ED system factors	Not identified in this study findings	Availability of specialist consultation, shortage of diagnostic testing, limited number of laboratory personnel, lack of experienced staff to treat patients with critical illness	Longer ED boarding time due to lack of staff, clinical care pathways system	Brick et al. (2014), Brouns et al. (2015), Casalino et al. (2014), Gardner et al. (2007), Kanzaria et al. (2014), Kawano, Nishiyama & Hayashi (2014), Kreindler et al. (2016), Li et al. (2015), Mowery et al. (2011), Vegting et al. (2015), Wibulpolprasert et al. (2014); Mahsanlar et al. (2014), Pines & Hollander (2008), Fogarty, Saunders & Cummins (2014), Rose et al. (2012)
Hospital system factors	Limited access for primary health care	Not identified in this study findings	Lack of inpatient beds/ICU bed, lack availability of long-term unit	Li et al. (2015), Mahsanlar et al. (2014), Casalino et al. (2014)

## Conclusion

Input (older age, medium severity level), throughput (diagnostic examination, the number of specialist consultation), and output (lack of inpatient bed and patients' conditions that are deemed admissible) contribute to prolonged ED LOS. Recommendations have been suggested to improve patient flow. Further review is necessary to determine organizational factors that may contribute ED LOS including the number of health staff, staff workload, flow studies, and health system.

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