Note of the editors: This is a BOWMAN-generated English translation of the officially indexed Spanish-language article, which should be cited as Emergencias 2026;38:359-375. In this translated version, the editors have supervised the process; however, it cannot be ruled out that some errors resulting from the artificial intelligence translation process may have gone unnoticed.

REVIEW ARTICLE

Association between the emergency department length of stay in patients requiring hospitalization and in-hospital mortality: a systematic review and meta-analysis

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Objective. To assess the association between the emergency department length of stay (EDLOS) and in-hospital mortality through an updated systematic review and meta-analysis.

Methods. A systematic review and meta-analysis was conducted in accordance with the PRISMA 2020 recommendations to identify studies published between January 2022 and December 2025 evaluating the association between EDLOS and in-hospital mortality. The identified studies were combined with those included in a former systematic review covering the period up to January 15, 2022. Searches were conducted across PubMed, MEDLINE, Web of Science, EMBASE, and Cochrane using the same search strategy. Studies including exclusively patients admitted to intensive care units (ICUs) were excluded. Separate meta-analyses were performed for each cutoff used to define prolonged EDLOS, along with an overall meta-analysis including all studies using a cutoff ≥ 6 hours; when the same study reported several cutoffs, only the longest cutoff was considered.

Results. A total of 6,982 records were identified, and 16 new studies were included (9 suitable for meta-analysis). Together with the 20 studies from the former review (13 included in the meta-analysis), 36 studies were analyzed, 22 of which (9.3 million patients) were included in the quantitative synthesis. No statistically significant association was observed between prolonged EDLOS and in-hospital mortality for any of the cutoffs analyzed: < 4 hours (OR, 0.83; 95% CI, 0.29–2.35), ≥ 4 hours (OR, 0.82; 95% CI, 0.46–1.46), ≥ 5 hours (OR, 0.60; 95% CI, 0.21–1.70), ≥ 6 hours (OR, 0.95; 95% CI, 0.75–1.21), ≥ 8 hours (OR, 1.10; 95% CI, 0.73–1.65), and ≥ 24 hours (OR, 0.78; 95% CI, 0.56–1.08). Similarly, the overall meta-analysis showed no association (OR, 1.02; 95% CI, 0.85–1.23). Heterogeneity was high (I^2 = 80–98%; I^2 = 97% in the overall analysis), and no relevant publication bias was detected. Studies analyzing EDLOS as a continuous variable suggested increasing mortality with progressively longer stays. Some studies identified associations between prolonged EDLOS and longer hospitalizations, greater resource use, higher hospital costs, specific complications, and a greater need for ICU admission.

Conclusions. The available evidence does not confirm an association between prolonged EDLOS and in-hospital mortality among hospitalized patients. The high degree of heterogeneity limits interpretation of the findings and highlights the need for studies using more homogeneous methodologies and definitions of EDLOS. Moreover, interpretation is limited by the inability to consistently distinguish care time from boarding time across the primary studies.

Keywords: In-hospital mortality. Hospital emergency departments. Emergency department length of stay. Systematic review. Meta-analysis.

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Tiempo de estancia en urgencias de los pacientes que precisan hospitalización y mortalidad hospitalaria: revisión sistemática y metanálisis

Objetivo. Evaluar la asociación entre el tiempo de estancia en urgencias (TEU) y la mortalidad intrahospitalaria mediante una revisión sistemática y metanálisis actualizado.

Métodos. Se realizó una revisión sistemática y metanálisis siguiendo las recomendaciones PRISMA 2020 para identificar estudios publicados entre enero de 2022 y diciembre de 2025 que evaluaran la asociación entre el TEU y la mortalidad intrahospitalaria. Los estudios identificados se combinaron con los incluidos en una revisión sistemática previa que abarcaba hasta el 15 de enero de 2022. La búsqueda se realizó en PubMed, MEDLINE, Web of Science, EMBASE y Cochrane utilizando la misma estrategia bibliográfica. Se excluyeron los estudios que incluían exclusivamente pacientes ingresados en unidades de cuidados intensivos (UCI). Se realizaron metanálisis independientes para cada punto de corte utilizado para definir un TEU prolongado y un metanálisis global que incluyó todos los estudios con un punto de corte ≥ 6 horas, considerando únicamente el punto de corte más prolongado cuando un mismo estudio aportaba varios.

Resultados. Se identificaron 6.982 registros y se incluyeron 16 estudios nuevos (9 aptos para metanálisis). Junto con los 20 estudios de la revisión previa (13 incluidos en el metanálisis). Se analizaron estos 36 estudios, y 22 (9,3 millones de pacientes) se incorporaron a la síntesis cuantitativa. No se observó una asociación estadísticamente significativa

entre un TEU prolongado y la mortalidad intrahospitalaria para ninguno de los puntos de corte analizados: < 4 horas (OR = 0,83; IC 95%: 0,29-2,35), ≥ 4 horas (OR = 0,82; IC 95%: 0,46-1,46), ≥ 5 horas (OR = 0,60; IC 95%: 0,21-1,70), ≥ 6 horas (OR = 0,95; IC 95%: 0,75-1,21), ≥ 8 horas (OR = 1,10; IC 95%: 0,73-1,65) y ≥ 24 horas (OR = 0,78; IC 95%: 0,56-1,08). El metanálisis global tampoco mostró asociación (OR = 1,02; IC 95%: 0,85-1,23). La heterogeneidad fue elevada (I^2 = 80-98%; I^2 = 97% en el análisis global) y no se detectó sesgo de publicación relevante. Los estudios que analizaron el TEU como variable continua sugirieron un incremento de la mortalidad con estancias progresivamente más prolongadas. Algunos estudios detectaron asociación entre TEU prolongado y mayor duración de la hospitalización, consumo de recursos, costes hospitalarios, complicaciones específicas, e ingreso en UCI.

Conclusiones. La evidencia disponible no confirma una asociación entre un TEU prolongado y la mortalidad intrahospitalaria en pacientes hospitalizados. La elevada heterogeneidad limita la interpretación de los resultados. Además, la interpretación está limitada por la imposibilidad de diferenciar que parte de TEU corresponde al *boarding time* (tiempo entre decisión de ingreso y salida de urgencias). Son precisos estudios con metodologías y definiciones del TEU más homogéneas.

Palabras clave: Mortalidad hospitalaria. Servicios de urgencias hospitalarios. Estancia en urgencias. Revisión sistemática. Metanálisis.

Introduction

Overcrowding in emergency departments (EDs) is one of the main challenges facing current health care systems and has intensified in recent years as a result of increasing demand for care, population aging, and the growing clinical complexity of patients. Among the indicators used to assess ED performance, emergency department length of stay (EDLOS) has become one of the most relevant measures of efficiency, quality of care, and availability of hospital resources.[1-3] EDLOS is usually defined as the time elapsed from a patient's arrival in the ED until discharge, hospital admission, or transfer to another health care facility. This indicator encompasses multiple clinical and organizational processes, including initial assessment, diagnostic testing, clinical decision-making, and, particularly, hospital bed availability. Unlike other indicators related to overcrowding, such as boarding time (the time from the decision to admit until the patient leaves the ED), EDLOS reflects the patient's entire pathway through the ED and constitutes an overall measure of system performance.[1-3]

Several observational studies have suggested that prolonged EDLOS in patients subsequently admitted to hospital may be associated with poorer clinical outcomes, including increased in-hospital mortality, more complications, longer hospital stays, and greater use of health care resources.[1-4] The proposed underlying mechanism is that prolonged EDLOS could lead to diagnostic and therapeutic delays, limit early access to specialized units, and increase exposure to adverse events related to overcrowding. However, the results published to date have been inconsistent, probably owing to considerable heterogeneity between studies in the populations included, the cutoffs used to define a prolonged stay, and the methods used to adjust for confounding factors.

In 2023, Lauque *et al.* published the first systematic review with meta-analysis specifically focused on the association between EDLOS and in-hospital mortality, including all studies published up to December 2021.[4] Although the authors observed a trend toward increased mortality associated with longer EDLOS, they emphasized the high methodological heterogeneity of the available studies and concluded that the existing evidence was insufficient to establish a causal relationship. In addition, the analysis included both studies examining hospitalized patients in general and studies exclusively including patients admitted to ICUs, whose care pathways differ substantially. Since then, numerous large observational studies have been published, some based on national or multicenter administrative registries.[5-21] Incorporating this new evidence makes it possible not only to increase the precision of available estimates but also to reassess the consistency of the association between EDLOS and mortality through analyses stratified by the different cutoffs used to define prolonged EDLOS. Therefore, the objective of the present study was to update the available evidence through a systematic review and meta-analysis of studies including hospitalized patients in general (not exclusively ICU patients) that evaluated the association between EDLOS and in-hospital mortality, adding studies published between January 2022 and December 2025 to those included in the previous systematic review.

Methods

Study design and protocol

We conducted a systematic review and meta-analysis to evaluate the association between EDLOS and in-hospital mortality. The study followed the recommendations of the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement.[22] The protocol was registered in the PROSPERO (International Prospective Register of Systematic Reviews) database under identifier CRD420261407159.[23] This review updates the meta-analysis published by Lauque *et al.*,[4] incorporating studies published between January 15, 2022 and December 31, 2025 and combining them with the evi-

dence synthesized previously. The literature search was conducted on January 2, 2026, after the inclusion period ending December 31, 2025 had closed.

Search strategy

The search strategy reproduced that used by Lauque *et al.,* retaining the same free-text and controlled terms (MeSH or equivalents) and updating only the search period.[4] Publications in English and Spanish were included. The search was conducted in PubMed, MEDLINE, EMBASE, Web of Science, and the Cochrane Central Register of Controlled Trials. Terms were searched in titles and abstracts (Title/Abstract) and, where possible, using the relevant indexed terms specific to each database. The additional EMBASE search used a strategy adapted to its controlled vocabulary (Emtree), while maintaining the same search concepts, eligibility criteria, and time period as the other databases. The complete search strategies are presented in Table 1. Similarly, the reference lists of included studies were reviewed manually to identify additional potentially eligible publications.

The retrieved references were imported into Rayyan (Rayyan Systems Inc., Cambridge, MA, USA), which was used to remove duplicates and select studies.[24] The literature search and screening of titles and abstracts were independently performed by two authors (C.L.D.P. and C.R.). Discrepancies were resolved by consensus and, when necessary, with the participation of a third author (C.B.), under the methodological supervision of an author experienced in emergency medicine research (O.M.).

Eligibility criteria

Original studies involving adults (≥ 18 years) seen in EDs who required hospitalization were included if EDLOS was the principal exposure variable and mortality was analyzed as a primary or secondary outcome. Studies had to provide an association measure or sufficient information to estimate one. Studies selecting only ICU admissions were excluded. Systematic reviews, narrative reviews, meta-analyses, editorials, letters to the editor, protocols, conference abstracts, and studies focused exclusively on boarding time, access block, or overnight stays in the ED without specifically assessing EDLOS were also excluded. Further exclusions were studies without access to the full text, duplicate publications or reports based on the same cohort without additional relevant information, and studies performed in highly selected populations with limited comparability to the remaining studies.

Data extraction

Data were extracted using a standardized form recording author, publication year, country, care setting, study design, sample size, population characteristics, definition of EDLOS, cutoff used to define prolonged stay, mortality outcome, association measures, and variables included in adjustment models. When a study provided several adjusted models, the model with the greatest clinically relevant degree of adjustment was selected. Moreover, if a study reported other outcomes in addition to mortality, these were recorded.

The exposure definition was specifically reviewed for each study, distinguishing between EDLOS, defined as the total time from arrival in the ED until departure, and boarding time, corresponding to the interval after the decision or request for admission. Studies focused exclusively on boarding time without specifically evaluating EDLOS were excluded, whereas studies analyzing both exposures could be included if they provided EDLOS-specific results.

Methodological quality assessment

Risk of bias in the included studies was assessed using ROBINS-E (Risk Of Bias In Non-randomized Studies – of Exposures).[25] Domains assessed included bias due to confounding, participant selection, exposure classification, deviations from intended exposure, missing data, outcome measurement, and selection of the reported result. Before assessment, the main confounding domains relevant to the association between EDLOS and mortality were defined a priori. Particular consideration was given to initial clinical severity and case-mix, including variables such as triage level, physiological parameters, severity scores, diagnosis, and comorbidity. Particular attention was paid to potential confounding by indication arising from prioritization of admission for the most severely ill patients. Each domain and overall risk of bias were classified according to the ROBINS-E categories. Assessment was independently performed by two authors (C.R., C.B.), and discrepancies were resolved by consensus.

Publication bias

Publication bias was assessed through visual inspection of funnel plots and Egger's regression test.[26]

Assessment of certainty of the evidence

The overall certainty of the evidence was assessed using the GRADE (Grading of Recommendations Assessment, Development and Evaluation) approach, considering the domains of risk of bias, inconsistency, indirectness, imprecision, and publication bias.[27,28]

Statistical analysis

Meta-analyses were performed to estimate the association between prolonged EDLOS and in-hospital mortality. Whenever possible, the effect measures reported by the studies were converted to a common metric to allow quantitative pooling. Separate meta-analyses were conducted for each cutoff used to define a prolonged emergency department stay when 2 or more studies

Table 1. Details of the database search characteristics

Sources and search dates	Search strategy	Results	Notes
PubMed (NLM) Period: 2022-01-15 to 2025-12-31	((("Death"[MeSH] OR "Mortality"[MeSH] OR "Child Mortality"[MeSH] OR "Hospital Mortality"[MeSH] OR death*[Title/Abstract] OR mortalit*[Title/Abstract]) AND ("Emergency Responders"[MeSH] OR "Emergency Medicine"[MeSH] OR "Evidence-Based Emergency Medicine"[MeSH] OR "Emergency Service, Hospital"[MeSH] OR "Emergency Medical Services"[MeSH] OR "Emergency Services, Psychiatric"[MeSH] OR "Pediatric Emergency Medicine"[MeSH] OR "emergency room*"[Title/Abstract] OR "emergency department*"[Title/Abstract] OR "emergency ward*"[Title/Abstract] OR "emergency patient*"[Title/Abstract] OR "ED"[Title/Abstract] OR "ER"[Title/Abstract] OR "emergency medicine"[Title/Abstract] OR "emergency medical service*"[Title/Abstract] OR "emergency unit*"[Title/Abstract] OR "emergency responder*"[Title/Abstract]) AND ("Length-of-Stay"[MeSH] OR "waiting time"[Title/Abstract] OR "length-of-stay"[Title/Abstract] OR "length-of stay"[Title/Abstract] OR "lengths of stay"[Title/Abstract] OR "LOS"[Title/Abstract] OR "wait time"[Title/Abstract] OR "EDLOS"[Title/Abstract] OR "stay length*"[Title/Abstract] OR "HLOS"[Title/Abstract] OR "IPLOS"[Title/Abstract]))	1,594	All terms were searched in the "Title/Abstract" fields and in "MeSH" terms when available. Filters applied: Languages (English and Spanish).
Web of Science y Medline (Core Collection) (Clarivate) Period: 2022-01-15 to 2025-12-31	(((TOPIC: "emergency room*" OR "emergency department*" OR "emergency ward*" OR "emergency patient*" OR "ED" OR "ER" OR "emergency medicine" OR "emergency medical service*" OR "emergency unit*" OR "emergency responder*") AND (TOPIC: "waiting time" OR "length-of-stay" OR "LOS" OR "wait time" OR "EDLOS" OR "stay length*" OR "IPLOS" OR "lengths of stay" OR "HLOS")) AND (TOPIC: death* OR mortalit*))	1,862	All terms were searched in "Topic" fields (including title, abstract, and keywords). Filters applied: Languages (English and Spanish).
Cochrane Library (Cochrane Collaboration) Period: 2022-01-15 to 2025-12-31	((("Death" OR "Mortality" OR "Child Mortality" OR "Hospital Mortality" OR death* OR mortalit*) AND ("Emergency Responders" OR "Emergency Medicine" OR "Evidence-Based Emergency Medicine" OR "Emergency Service, Hospital" OR "Emergency Medical Services" OR "Emergency Services, Psychiatric" OR "Pediatric Emergency Medicine" OR "emergency NEXT room*" OR "emergency NEXT department*" OR "emergency NEXT ward*" OR "emergency NEXT patient*" OR "ED" OR "ER" OR "emergency medicine" OR "emergency NEXT medical service*" OR "emergency NEXT unit*" OR "emergency NEXT responder*") AND ("Length of Stay" OR "waiting time" OR "length of stay" OR "lengths of stay" OR "LOS" OR "wait time" OR "EDLOS" OR "stay NEXT length*" OR "HLOS" OR "IPLOS")))	115	All terms were searched in "TI/AB/KW" fields (including title, abstract, and keywords) and in "MeSH" terms when available. Filters applied: Languages (English and Spanish).
EMBASE [Plataforma: Embase.com] Period: 2022-01-15 a 2025-12-31	('emergency room*':ab,ti OR 'emergency department*':ab,ti OR 'emergency ward*':ab,ti OR 'emergency patient*':ab,ti OR 'ed':ab,ti OR 'er':ab,ti OR 'emergency medicine':ab,ti OR 'emergency medical service*':ab,ti OR 'emergency unit*':ab,ti OR 'emergency responder*':ab,ti OR 'emergency medicine'/de OR 'pediatric emergency medicine'/de OR 'psychiatric emergency service'/de OR 'evidence-based emergency medicine'/de OR 'hospital emergency service'/de OR 'rescue personnel'/de) AND ('waiting time':ab,ti OR 'length of stay':ab,ti OR 'length-of-stay':ab,ti OR 'los':ab,ti OR 'wait time':ab,ti OR 'edlos':ab,ti OR 'stay length*':ab,ti OR 'iplos':ab,ti OR 'lengths of stay':ab,ti OR 'hlos':ab,ti OR 'length of stay'/de) AND ('death*':ab,ti OR 'mortalit*':ab,ti OR 'death'/de OR 'mortality'/de OR 'childhood mortality'/de OR 'hospital mortality'/de)	3,411	The same search concepts and time criteria as in the other databases were used, with controlled terms adapted to Emtree. Filters: English and Spanish.
Records identified		6,982	
Unique records		2,292	

reported data, and random-effects models were always used. Given the multiplicity of EDLOS cutoffs, studies with EDLOS < 4 hours or > 8 hours were pooled for these analyses. In addition, an overall analysis was conducted including studies that used a cutoff ≥ 6 hours, considering only the longest cutoff when the same study provided several analyses with different cutoffs. This decision was based on the authors' consideration that the first 6 hours of EDLOS can, in most cases, be attributed to the clinical care process in many health care systems, whereas time exceeding 6 hours also comprises, in most cases, a substantial part of the waiting time for transfer from the ED to an inpatient ward (boarding time). Between-study heterogeneity was assessed using the I^2 statistic and was classified as low (< 25%), moderate (25–49%), high (50%–74%), or very high (≥ 75%). A sensitivity analysis of the overall meta-analysis was also performed by excluding studies classified by ROBINS-E as having high or very high risk of bias, to assess the robustness of the estimate to potential confounding problems, especially confounding by indication.

Results

Study selection

The literature search identified 6,982 records from the databases searched. Following deduplication and screening of titles and abstracts, 31 articles were retrieved for full-text assessment. Ultimately, 16 new studies were included, 9 of which provided sufficient data for meta-analysis.[1,2,5,6,8–13,15,17–21] These were added to

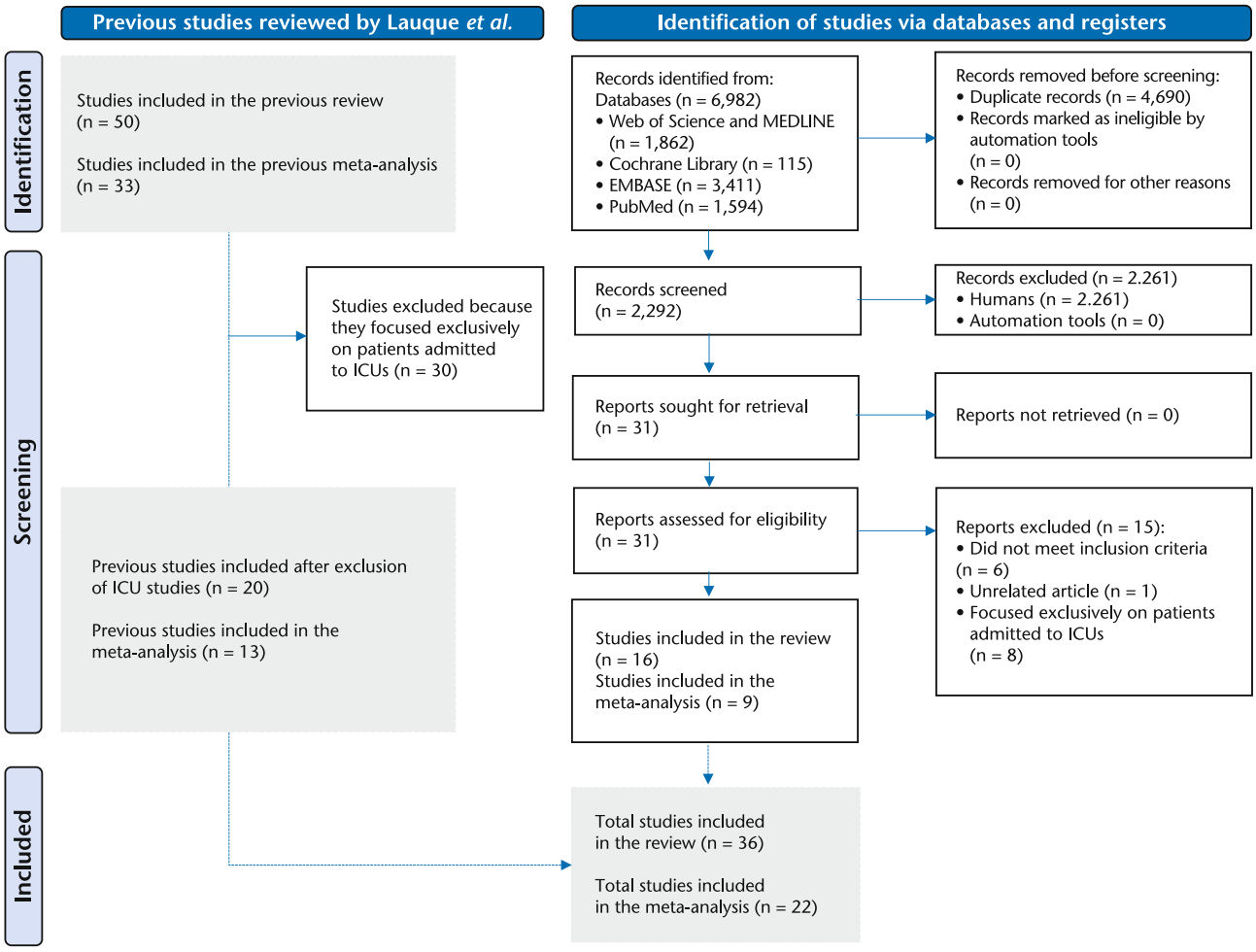


Figure 1. PRISMA flow diagram.

the studies included in the systematic review by Lauque *et al.* (20 in total, 13 eligible for meta-analysis).[29–48] Thus, a total of 36 studies were included in this systematic review, 22 of which were included in the quantitative synthesis (Figure 1).

Characteristics of the included studies

The 36 included studies evaluated the association between EDLOS and in-hospital mortality in hospitalized adults and originated from different health care systems and care settings (Table 2). Ten studies were from Europe (3 from the United Kingdom, 2 from France, 2 from Spain, 1 from Sweden, 1 from Norway, and 1 from Finland), 11 from Asia (3 from Taiwan, 2 from China, 1 from Israel, 2 from Qatar, 1 from Indonesia, and 2 from Thailand), 9 from the Americas (8 from the United States and 1 from Canada), and 6 from Australia. There was substantial heterogeneity in the definition of prolonged stay, with cutoffs ranging from > 4 hours to > 48 hours, although the most frequent cutoffs were 6 and 8 hours.

Although most studies assessed in-hospital or 30-day mortality as their primary endpoint, several also assessed other clinically relevant endpoints. Among these, notable findings included longer hospital admission or total hospital stays, observed in several studies even without an increase in mortality.[5,17,18,34] Associations between prolonged EDLOS and greater resource use and hospital costs[17], the need for ICU admission[9], risk of prolonged hospitalization[5], and specific complications related to the underlying disease were also reported. These included reinfarction among patients with acute coronary syndrome[29], poorer functional recovery and neurological complications after stroke[39], and trauma-related adverse events.[30]

The analyses of mortality showed marked heterogeneity in the methods used to analyze EDLOS: continuous variables,[37,43–48] categories,[2,5,6,10,15,17,18,29–36,39–42,45,46] restricted cubic splines,[5] or machine-learning models,[13] highlighting the methodological diversity of the available evidence. Moreover, in addition to the studies included in the quantitative synthesis (meta-analysis), which are discussed below, some studies that analyzed EDLOS as a continuous variable without a cutoff defining it as prolonged showed a nonlinear relationship between EDLOS and mortality, with risk increasing only for very long stays or in certain patient subgroups,[5,6,10,18]

Table 2. Details of the database search characteristics

Study (ref.), year	Design	Population	EDLOS definition	Outcome	Main result	Adjustment/analysis	Observations	Included in MA
Diercks *et al.*[29], 2007	Retrospective multicenter registry-based cohort.	42,780 patients with non-ST-elevation acute coronary syndrome treated at 550 US hospitals.	EDLOS categorized as < 4 h, 4–8 h, and > 8 h; primary exposure: stay > 8 h.	In-hospital mortality, reinfarction, and adherence to recommended treatments.	Stays > 8 h were associated with lower use of some recommended treatments and a higher risk of reinfarction, but not with significant differences in in-hospital mortality.	Multivariable logistic regression adjusted for age, sex, BMI, race, insurance, cardiovascular risk factors, and cardiac history.	Specific clinical population (NSTEACS). Prolonged EDLOS appeared to affect the quality of the care process more than mortality.	Yes
Richardson *et al.*[30], 2009	Prospective cohort based on a single-center trauma database.	3,918 trauma patients admitted from the ED at a US level I trauma center.	Non-delayed transfer ≤ 6 h vs delayed transfer > 6 h from the ED.	In-hospital mortality and delay-related sentinel events.	Mortality was higher among those transferred early, who were more severely ill. After accounting for selection by severity, mortality did not increase with time in the ED.	Multivariable analysis adjusting for age, mechanism of injury, race, sex, Glasgow score, CT findings, and Injury Severity Score.	Strong confounding by indication: triage prioritized early admission for the most severely ill patients.	Yes
Mowery *et al.*[31], 2011	Single-center retrospective cohort.	3,973 trauma activation patients admitted to a US health care system; those undergoing immediate surgery were excluded.	EDLOS analyzed as a continuous variable and using a 2-h cutoff.	In-hospital mortality and length of admission.	Longer EDLOS was independently associated with higher hospital mortality after adjustment for trauma severity.	Logistic regression adjusted for age, sex, Injury Severity Score, and Revised Trauma Score.	The absolute increase in risk per unit of time was small but consistent. Selected trauma population.	Yes
Plunkett *et al.*[32], 2011	Single-center retrospective observational cohort.	23,114 emergency medical admissions at one UK hospital.	EDLOS using multiple cutoffs: 2.6, 3.9, 5.8, and 8.7 h.	In-hospital mortality.	Longer waiting time was associated with a progressive increase in mortality; the association persisted after adjustment.	Logistic regression adjusted for sex, severity, triage, diagnosis, Charlson index, ICU admission, transfusion, troponin, and care times.	Not included in the updated meta-analysis because no single directly comparable cutoff was available.	No
Mitra *et al.*[33], 2012	Multicenter retrospective cohort.	10,107 general medical patients admitted from three Australian EDs.	Time to establish a disposition/admission plan; main comparison using an EDLOS of 8 h.	In-hospital mortality and total ED stay.	Longer time to establish the admission plan was associated with higher in-hospital mortality, even after adjustment.	Logistic regression adjusted for age, sex, triage category, hospital, and time to disposition plan.	Exposure approximates the pre-admission-decision care component rather than boarding alone.	Yes
Chong *et al.*[34], 2013	Single-center retrospective cohort.	15,886 older patients hospitalized from an Australian ED.	EDLOS < 4 h, 4–8 h, and > 8 h.	In-hospital mortality and hospital length of stay.	Neither EDLOS > 8 h nor EDLOS < 4 h was independently associated with mortality; EDLOS > 8 h was associated with a longer hospital stay.	Logistic regression adjusted for age, sex, and comorbidities/main diseases.	Study focused on older patients; distinction between effects on mortality and hospital utilization.	Yes
Flabouris *et al.*[35], 2013	Retrospective cohort using linked administrative and clinical data.	43,484 patients admitted from an Australian tertiary hospital ED to a ward, ICU, or high-dependency unit.	Categorical EDLOS with an 8-h cutoff and continuous analysis.	Hospital mortality and admission destination/unit.	After adjustment, EDLOS was not independently associated with mortality among admitted patients.	Backward stepwise regression including age, sex, EDLOS, origin and admission unit, time and day of arrival/departure, and Australian triage scale.	Included ward, ICU, and high-dependency admissions together; information was used from patients not selected solely for ICU admission.	Yes

(Continued)

Table 2. Details of the database search characteristics (Continue)

Study (ref.), year	Design	Population	EDLOS definition	Outcome	Main result	Adjustment/analysis	Observations	Included in MA
Junhasavasdikul *et al.*[36], 2013	Single-center retrospective observational cohort.	381 emergency medical patients admitted to a hospital in Thailand.	Admission delay from the ED; EDLOS categorized by the delay until a hospital bed became available.	Hospital mortality and adverse outcomes during admission.	Admission delay did not show an independent association with mortality after adjustment.	Logistic regression adjusted for age, sex, diagnosis, lead-time, triage category, MEWS, and functional/oncological status.	Small single-center sample. The definition of delay depended on the local bed-allocation process.	Yes
DeRose *et al.*[37], 2014	Multicenter retrospective cohort based on administrative data.	136,740 adult patients admitted from 14 US EDs.	EDLOS analyzed continuously, with no predefined cutoff.	In-hospital mortality.	After adjustment, EDLOS was not independently associated with in-hospital mortality.	Logistic regression adjusted for age, sex, race, comorbidities, arrival mode, vital signs, triage, diagnosis, shift, and crowding.	No specific cutoff was defined, preventing pooling with categorical meta-analyses.	No
Jain *et al.*[38], 2014	Single-center retrospective cohort.	190 patients with stroke treated at a US hospital.	Total EDLOS analyzed as a continuous variable.	In-hospital mortality and functional outcomes.	No independent association between longer EDLOS and mortality was observed after adjustment for neurological severity and baseline characteristics.	Logistic regression adjusted for age, sex, NIH Stroke Scale, thrombolytic treatment, comorbidities, and length of admission.	Highly specific population; the EDLOS definition did not allow estimates based on a comparable cutoff.	No
Akhtar *et al.*[39], 2016	Single-center retrospective cohort.	894 patients with stroke admitted to a tertiary hospital in Qatar.	EDLOS categorized using an 8-h cutoff.	In-hospital mortality, complications, and functional recovery.	Patients staying longer than 8 h had more complications, poorer recovery, and higher mortality.	Logistic regression adjusted for sex, vascular history, atrial fibrillation, smoking, and clinical complications.	Study focused exclusively on patients with acute stroke.	Yes
Chen HC *et al.*[40], 2016	Single-center retrospective cohort.	432 patients with ST-segment elevation myocardial infarction who underwent reperfusion in Taiwan.	EDLOS categorized using an 8-h cutoff.	In-hospital mortality and cardiovascular outcomes.	No independent association between EDLOS > 8 h and mortality was observed after adjustment for cardiovascular severity.	Models adjusted for age, sex, comorbidities, renal function, biomarkers, vital signs, door-to-balloon time, Killip class, TIMI, and complications.	Specific population with reperfused STEMI.	Yes
Byrne *et al.*[41], 2018	Single-center retrospective cohort.	106,788 emergency medical admissions at a UK university hospital.	EDLOS categorized using a 6-h cutoff.	In-hospital mortality.	After adjustment for severity and comorbidity, EDLOS > 6 h was not independently associated with higher mortality.	Logistic regression adjusted for age, sex, triage, severity, comorbidities, sepsis, and functional disability.	Large cohort of noncritical medical patients.	Yes
Paton *et al.*[42], 2019	Multicenter retrospective cohort.	24,746 patients with requests for hospital admission from three Australian hospitals.	Time from bed request to transfer; 4-h cutoff.	In-hospital mortality and length of admission.	Transfer times longer than 4 h were associated with poorer hospital outcomes after adjustment.	Logistic regression adjusted for age, sex, triage priority, ambulance transport, and origin.	Specifically assesses the delay after bed request.	Yes
Asheim *et al.*[43], 2019	Retrospective cohort based on a hospital registry.	165,183 adult non-ICU patients admitted in Norway.	EDLOS analyzed continuously, with no specific cutoff.	30-day mortality.	No independent association between longer EDLOS and mortality was observed after adjustment.	Logistic regression adjusted for age, sex, cardiovascular disease, infection, medical specialty, and ambulance arrival.	The initially observed effect disappeared after controlling for confounding factors.	No

(Continued)

Table 2. Details of the database search characteristics (Continue)

Study (ref.), year	Design	Population	EDLOS definition	Outcome	Main result	Adjustment/analysis	Observations	Included in MA
Thibon *et al.*[44], 2019	Single-center retrospective cohort.	15,496 adult non-ICU patients admitted from an ED in France.	EDLOS analyzed continuously, with no predefined cutoff.	In-hospital mortality.	Progressively longer EDLOS was associated with a higher risk of in-hospital mortality.	Models adjusted for age, sex, triage level, laboratory test results, and imaging examinations.	The absence of comparable categories prevented inclusion in the main meta-analysis.	No
Ashkenazi *et al.*[45], 2021	Single-center retrospective cohort.	28,108 adult patients admitted from an ED in Israel.	EDLOS categorized using a 4-h cutoff.	In-hospital mortality and length of hospitalization.	EDLOS ≥ 4 h was not independently associated with higher in-hospital mortality.	Logistic regression adjusted for age, sex, and hospital admitting specialty.	Care organization and clinical prioritization may explain the absence of an association.	Yes
Davis *et al.*[46], 2021	Multicenter retrospective cohort.	3,108 patients with acute intracerebral hemorrhage treated at US hospitals.	EDLOS categorized using a 3-h cutoff.	In-hospital mortality.	EDLOS longer than 3 h was associated with a significant increase in mortality after adjustment.	Logistic regression adjusted for age, sex, NIH Stroke Scale, and comorbidities.	Specific neurocritical population; delay may affect access to specialized treatment.	Yes
Wessman *et al.*[47], 2022	Retrospective cohort based on a hospital registry.	641,314 ED visits in Sweden, including analysis of hospitalized patients.	EDLOS analyzed continuously without establishing a specific cutoff.	Short-term mortality.	Longer EDLOS was associated with mortality; the finding was strongly influenced by case-mix and initial severity.	Models adjusted for age, sex, presenting complaint, triage, ambulance transport, hospitalization, and weekend presentation.	One of the largest registries included; no comparable cutoff provided.	No
Cheng *et al.*[48], 2022	Single-center retrospective cohort.	4,972 adults admitted from an ED in China.	Prolonged EDLOS and access block analyzed without a single comparable cutoff.	In-hospital mortality.	Prolonged EDLOS and access block were associated with higher mortality after adjustment.	Logistic regression adjusted for age, sex, arrival time, ambulance transport, destination, workload, diagnosis, and insurance.	The absence of comparable categories limited inclusion in the meta-analysis.	No
Hsuan *et al.*[1], 2023	Multicenter retrospective administrative study based on state data.	57,824,253 hospital discharges from 307 US hospitals.	Hospital crowding measured by daily percentiles; individual EDLOS was not assessed.	In-hospital mortality, length of admission, and 3-day readmission.	Mortality increased mainly in the highest crowding percentiles and in certain strata.	Models adjusted for admission type and hospital and patient characteristics.	Examines hospital crowding rather than individual EDLOS; cannot be pooled.	No
Harpenau *et al.*[19], 2022	Single-center retrospective cohort.	128 adults with sepsis or septic shock admitted from the ED in the United States.	EDLOS from triage to transfer to a ward or ICU.	In-hospital mortality, delay in the second antibiotic dose, and hospital/ICU length of stay.	14/99 (14.1%) with EDLOS < 6 h vs 1/29 (3.4%) with EDLOS ≥ 6 h; P = .19.	Bivariate comparisons; no mortality model adjusted for EDLOS was reported.	46.5% of the < 6-h group and 44.8% of the ≥ 6-h group were admitted directly to the ICU. Mortality was not stratified by admission destination, preventing a non-ICU-specific estimate.	No

(Continued)

Table 2. Details of the database search characteristics (Continue)

Study (ref.), year	Design	Population	EDLOS definition	Outcome	Main result	Adjustment/analysis	Observations	Included in MA
Limapichat *et al.*[20], 2022	Single-center retrospective cohort.	738 adults with NSTEACS hospitalized from an ED at a tertiary hospital in Thailand.	EDLOS < 4 h vs ≥ 4 h.	In-hospital mortality and adverse in-hospital cardiovascular events.	4.8% with EDLOS < 4 h vs 4.3% with EDLOS ≥ 4 h; P = .881.	Between-group event comparison using bivariate analyses; no mortality-specific adjusted OR for EDLOS was reported.	Published data do not allow a mortality estimate specific to the non-ICU population to be obtained separately.	No
Jones *et al.*[2], 2022	National retrospective cohort based on administrative registries.	7,472,480 admission episodes involving 5,249,891 patients; all type 1 hospital EDs in England.	Delay to admission: ≤ 4, 4–6, 6–8, and 8–12 h.	All-cause 30-day mortality.	SMR: ≤ 4 h, 0.94; 4–6 h, 1.06; 6–8 h, 1.14; 8–12 h, 1.16, showing a progressive gradient.	Standardization by patient and hospital characteristics.	Large national study showing a dose–response relationship.	Yes
Chiswell *et al.*[11], 2022	Retrospective state-level analysis of linked data.	43,248 visits (28,648 patients) originating from residential aged-care facilities; 136 Australian hospital EDs.	Prolonged EDLOS defined as ≥ 4 h.	All-cause 30-day mortality.	Adjusted HR, 1.10 (95%CI, 1.05–1.14) for EDLOS ≥ 4 h.	Adjustment for clinical and demographic characteristics.	Older and vulnerable population; not included in the meta-analysis according to the final study selection.	No
Dinh *et al.*[8], 2023	Retrospective state-level analysis of linked databases.	26,854 hospitalized adults with EDLOS ≥ 24 h in New South Wales, Australia.	Extremely prolonged stay ≥ 24 h.	All-cause 30-day mortality.	Identified predictors of mortality within the ≥ 24-h group, particularly older age and neoplasms, but did not directly compare ≥ 24 h vs < 24 h.	Multivariable logistic regression within the ≥ 24-h cohort.	Does not provide a direct comparison between different lengths of stay.	No
Habib y Sudaryo[15], 2023	Single-center retrospective cohort.	18,553 visits by adult patients in Indonesia.	EDLOS < 8 h, 8–24 h, and > 24 h; main analysis ≥ 8 vs < 8 h.	All-cause in-hospital mortality.	Adjusted RR for ≥ 8 h, 2.69; for 8–24 h, 2.36; for > 24 h, 3.13, with a temporal gradient.	Multivariable regression with analyses by age group.	Positive association and dose–response relationship.	Yes
Ramzee *et al.*[21], 2023	Single-center retrospective observational cohort.	7,026 trauma patients hospitalized in a level I trauma center in Qatar; included patients > 13 years and several hospital destinations, including ICU.	EDLOS from ED arrival to disposition; categories < 4 h, 4–12 h, 12–24 h, and > 24 h.	In-hospital mortality, hospital/ICU stay, and complications.	OR per additional hour, 0.985 (95%CI, 0.965–1.006).	Multivariable logistic regression adjusted for age, sex, ISS, EMS time, head injury, transfusion, trauma-team activation, shock index, and EDLOS.	Mixed cohort with different ED destinations, including ICU, without a separable mortality estimate for non-ICU patients. Also included patients > 13 years.	No
Wu *et al.*[13], 2023	Retrospective observational cohort with machine learning.	383,586 visits; 78,478 patients aged ≥ 60 years; Taiwan.	EDLOS and boarding time as continuous variables; age groups 60–74, 75–89, and ≥ 90 years.	In-hospital mortality.	EDLOS and boarding time contributed to mortality prediction, with variable importance by age and clinical profile.	Machine-learning models and stratified analyses.	No conventional comparable OR/HR reported.	No
Balen *et al.*[18], 2024	Retrospective cohort.	49,913 patients aged ≥ 15 years admitted to non-ICU units in France.	EDLOS by quartiles: < 303, 303–433, 434–612, and > 612 min.	30-day in-hospital mortality.	No significant overall association; the highest quartile showed a higher risk in patients aged ≤ 75 years and those triaged as nonurgent.	Multivariable logistic regression and subgroup analyses.	Possible heterogeneous effect by age and triage priority.	Yes

(Continued)

Table 2. Details of the database search characteristics (Continue)

Study (ref.), year	Design	Population	EDLOS definition	Outcome	Main result	Adjustment/analysis	Observations	Included in MA
Miró *et al.*[5], 2025	Multicenter registry-based observational study.	6,333 hospitalized patients aged ≥ 65 years; 52 Spanish hospital EDs.	Continuous/ nonlinear EDLOS using restricted cubic splines; 12-h reference.	In-hospital mortality and prolonged hospitalization > 7 days.	Nonlinear relationship; OR vs 12 h: 3 h, 1.22; 6 h, 1.11; 1 day, 1.00; 2 days, 1.18; 3 days, 1.39; 7 days, 2.70.	Multivariable adjustment for clinical and care-related variables.	Nonlinear relationship; estimates adapted for inclusion in the meta-analysis.	Yes
Fernández Castro *et al.*[6], 2025	Single-center retrospective cohort.	21,984 adults admitted to medical specialties in Spain.	EDLOS from triage to arrival on the ward; 6–12, 12–18, 18–24, and > 24 h.	In-hospital mortality.	Adjusted HR: > 6 h, 1.09; 6–12 h, 1.01; 12–18 h, 1.04; 18–24 h, 1.10; > 24 h, 1.23.	Cox model adjusted for clinical and organizational variables.	The increase in risk is concentrated in EDLOS > 24 h.	Yes
Chen CY *et al.*[9], 2025	Single-center retrospective cohort.	30,753 adults admitted to internal medicine; Taiwan.	EDLOS from arrival at the hospital ED until admission; > 48 h vs ≤ 48 h.	In-hospital and 30-day mortality; hospital and ICU length of stay.	Observed mortality was 6% with EDLOS > 48 h vs 8% with shorter EDLOS; adjusted models were presented.	Multivariable adjustment for age, comorbidity, and clinical characteristics.	Interpretation affected by clinical selection and potential survival bias.	Yes
Taghizadeh *et al.*[10], 2025	Multicenter administrative cohort.	1,358,935 adult visits; 14 hospital EDs in Alberta, Canada.	EDLOS < 6, 6–10, 10–19, and ≥ 19 h; also boarding time and time to physician.	All-cause mortality at 7 and 30 days.	At 7 days: OR, 1.3, 1.8, and 2.2. At 30 days: OR, 1.2, 1.5, and 1.9 for increasing EDLOS categories.	Multivariable administrative models.	Large population-based study showing a dose–response gradient.	Yes
Eidstø *et al.*[12], 2025	Single-center retrospective cohort.	58,440 visits resulting in admission; Finland.	Continuous EDLOS per additional hour; stratification by crowding.	All-cause 10-day mortality.	Adjusted OR per additional hour, 1.01 (95%CI, 0.99–1.04); no association.	Adjusted logistic regression and analysis by crowding.	Results did not change after stratification by crowded vs noncrowded hospital ED.	Yes
Ma *et al.*[17], 2025	Retrospective hospital-based study.	42,139 adults admitted through the ED; Taiwan.	EDLOS ≤ 2, 2–6, 6–24, 24–48, and ≥ 48 h.	In-hospital mortality, length and cost of admission.	OR vs ≤ 2 h: 2–6 h, 1.400; 6–24 h, 1.415; 24–48 h, 1.726; ≥ 48 h, 2.225.	Multivariable models adjusted for clinical and hospital variables.	Consistent gradient; length of stay and costs were also assessed.	Yes

EDLOS: emergency department length of stay; MA: meta-analysis; ED: emergency department; ICU: intensive care unit; NSTEACS: non-ST-elevation acute coronary syndrome; MI: myocardial infarction; BMI: body mass index.

whereas other studies found no association after multivariable adjustment.[35,37,38,40,41,43,45,48]

Detailed information on the 36 studies included in the systematic review is presented in Table 2.

Methodological quality

The methodological quality of the studies included in the quantitative synthesis (meta-analysis) was assessed using ROBINS-E25 (Table 3). Of the 22 studies assessed, 16 (72.7%) raised some concerns about risk of bias and 6 (27.3%) were classified as high risk. None was considered at low or very high risk. The main limitations concerned control of confounding, particularly baseline severity and clinical prioritization, and, in certain studies, participant selection. The remaining domains generally showed a lower risk of bias. Overall, the findings reflect relevant methodological limitations, although none of the studies assessed was identified as having a very high risk of bias.

Association between emergency department length of stay and in-hospital mortality

The meta-analyses conducted for each cutoff used to define prolonged stay showed no statistically significant association between EDLOS and in-hospital mortality (Figure 2). High between-study heterogeneity was observed in all analyses. The pooled estimates were as follows: < 4 hours: OR, 0.83 (95%CI, 0.29–2.35; I^2 = 89.2%); ≥ 4 hours: OR, 0.82 (95% CI, 0.46–1.46; I^2 = 97.8%); ≥ 5 hours: OR, 0.60 (95% CI, 0.21–1.70; I^2 = 87.7%); ≥ 6 hours: OR, 0.95 (95% CI, 0.75–1.21; I^2 = 97.3%); ≥ 8 hours: OR, 1.10 (95%CI, 0.73–1.65; I^2 = 96.1%); and ≥ 24 hours: OR, 0.78 (95% CI, 0.56–1.08; I^2 = 79.7%).

In the overall analysis, which included the 16 studies defining prolonged EDLOS as 6 hours or more, 5 studies showed prolonged EDLOS acting as a protective factor for in-hospital mortality, 4 showed it acting as a risk factor, and 7 found no significant differences. The overall meta-analysis of these studies likewise found no association between EDLOS and in-hospital mortality (OR, 1.02; 95% CI, 0.85–1.23), although heterogeneity remained very high (I^2 = 96.9%) (Figure 3). Visual inspection of the funnel plot for this overall analysis showed no obvious asymmetry, and Egger's regression test found no evidence of publication bias (Figure 3), suggesting a low risk of publication bias. Moreover, the sensitivity analysis excluding the 6 high-risk-of-bias studies showed no substantial changes in the estimate (OR, 0.96; 95% CI, 0.78–1.18) (Figure 3).

Certainty of the evidence

The overall certainty of the evidence was considered very low according to GRADE. The evidence, derived from observational studies, was downgraded because of risk of bias and high inconsistency between studies. No serious limitations due to indirectness or imprecision and no significant evidence of publication bias were identified (Table 4).

Discussion

This meta-analysis updates the available evidence on the association between EDLOS and in-hospital mortality in patients who ultimately require hospitalization. The addition of 16 studies published between 2022 and 2025, many with large sample sizes and based on national or multicenter registries, nearly doubles the evidence synthesized in the previous review by Lauque *et al.*[4] However, despite the substantial increase in the number of patients and the diversity of health care systems represented, the present findings do not change the fundamental conclusions of the original meta-analysis: no statistically significant and consistent association was observed between prolonged EDLOS and in-hospital mortality, regardless of the cutoff used to define exposure. The absence of an association persisted both in analyses stratified by time cutoff and in the overall analysis pooling studies with cutoffs of 6 hours or longer.

Although none of the analyses reached statistical significance, the results should be interpreted cautiously. The absence of an association does not necessarily mean that prolonged stay has no effect. In most individual studies, particularly those with larger samples, the direction of effect tended toward an increased risk associated with longer stays, although the magnitude was generally modest and highly variable across studies. This lack of consistency suggests that EDLOS probably does not act as an independent causal factor for mortality but rather as a complex marker simultaneously reflecting patient characteristics, care processes, and health care system performance.

The main explanation for this variability probably lies in the extraordinary heterogeneity observed. All meta-analyses yielded very high I^2 values, close to or above 90% in most analyses, indicating that differences between studies greatly exceeded the variability expected by chance. This heterogeneity was already noted by Lauque *et al.*,[4] but persists even after more recent and methodologically robust studies were incorporated. This suggests that it is not simply a problem arising from the small sample sizes of earlier studies but an inherent consequence of the nature of the exposure being investigated, EDLOS.

Potential sources of heterogeneity are numerous. First, the definition of EDLOS is far from standardized. Cutoffs used to define prolonged EDLOS vary considerably, from less than 4 hours to more than 48 hours. These conceptual differences make it difficult for studies to assess the same exposure and limit the combined interpretation of their findings. Second, it is unknown how much of EDLOS is attributable to the care process within the ED and how much occurs after the decision to admit the patient (boarding time). Third, health care systems are highly diverse, ranging from European studies in universal public health care systems to North American studies in which private health care plays a substantial role, and studies conducted in Asian countries with different levels of economic development and

Table 3. Methodological quality: ROBINS-E (Risk Of Bias In Non-randomized Studies – of Exposures)

Study	D1 Confounding	D2 Exposure measurement	D3 Participant selection	D4 Post-exposure interventions	D5 Missing data	D6 Outcome measurement	D7 Result selection	Overall
Jones *et al.*[2], 2022	Some concerns	Low	Low	Low	Low	Low	Some concerns	Some concerns
Miró *et al.*[5], 2025	Some concerns	Low	Low	Low	Some concerns	Low	Some concerns	Some concerns
Fernández Castro *et al.*[6], 2025	Some concerns	Low	Low	Low	Some concerns	Low	Some concerns	Some concerns
Chen *et al.*[9], 2025	High	Low	High	Low	Some concerns	Low	Some concerns	High
Taghizadeh *et al.*[10], 2025	Some concerns	Low	Low	Low	Some concerns	Low	Some concerns	Some concerns
Eidstø *et al.*[12], 2025	Low	Low	Low	Low	Low	Low	Some concerns	Some concerns
Habib y Sudaryo[15], 2023	High	Low	Low	Low	Some concerns	Low	Some concerns	High
Ma *et al.*[17], 2025	Some concerns	Low	Low	Low	Some concerns	Low	Some concerns	Some concerns
Balen *et al.*[18], 2024	Some concerns	Low	Low	Low	Low	Low	Some concerns	Some concerns
Diercks *et al.*[29], 2007	High	Low	Some concerns	Some concerns	Low	Low	Some concerns	High
Richardson *et al.*[30], 2009	Some concerns	Low	Some concerns	Low	Low	Low	Some concerns	Some concerns
Mowery *et al.*[31], 2011	Some concerns	Low	High	Low	Low	Low	Some concerns	High
Mitra *et al.*[33], 2012	Some concerns	Low	Low	Low	Low	Low	Some concerns	Some concerns
Chong *et al.*[34], 2013	High	Low	Low	Low	Some concerns	Low	Some concerns	High
Flabouris *et al.*[35], 2013	Some concerns	Low	Low	Low	Low	Low	Some concerns	Some concerns
Junhasavasdikul *et al.*[36], 2013	Low	Some concerns	Low	Low	Some concerns	Low	Some concerns	Some concerns
Akhtar *et al.*[39], 2016	Some concerns	Low	Low	Low	Some concerns	Low	Some concerns	Some concerns
Chen *et al.*[40], 2016	Some concerns	Some concerns	Low	Some concerns	Low	Low	Some concerns	Some concerns
Byrne *et al.*[41], 2018	Some concerns	Low	Low	Low	Low	Low	Some concerns	Some concerns
Paton *et al.*[42], 2019	Some concerns	Low	Low	Low	Low	Low	Some concerns	Some concerns
Ashkenazi *et al.*[45], 2021	High	Low	Low	Low	Some concerns	Low	Some concerns	High
Davis *et al.*[46], 2021	Some concerns	Low	Low	Low	Some concerns	Low	Some concerns	Some concerns

social circumstances on the use of health care services generally and EDs specifically. Furthermore, although health care context may contribute to this heterogeneity, the available information did not allow sufficiently homogeneous classification of studies into public/universal vs private or mixed systems, particularly considering the organizational variability that exists even within a single country, including ED organization and the dynamics of inpatient bed use.

Importantly, the included studies represent highly heterogeneous populations. Although this review specifically excluded studies including only patients admitted to ICUs, for whom the dynamics and timing of transfers from the ED involve specific features related to the severity of the underlying condition, the diversity among the studies ultimately included remains high. Some examined unselected medical patients,[6,9,17] whereas others included only older patients,[5,13] nursing home residents,[11] patients with stroke,[39] acute coronary syndrome,40 trauma,[21,30,31] or intracranial hemorrhage.[46] Unfortunately, the small number of studies focusing on each of these conditions and the use of

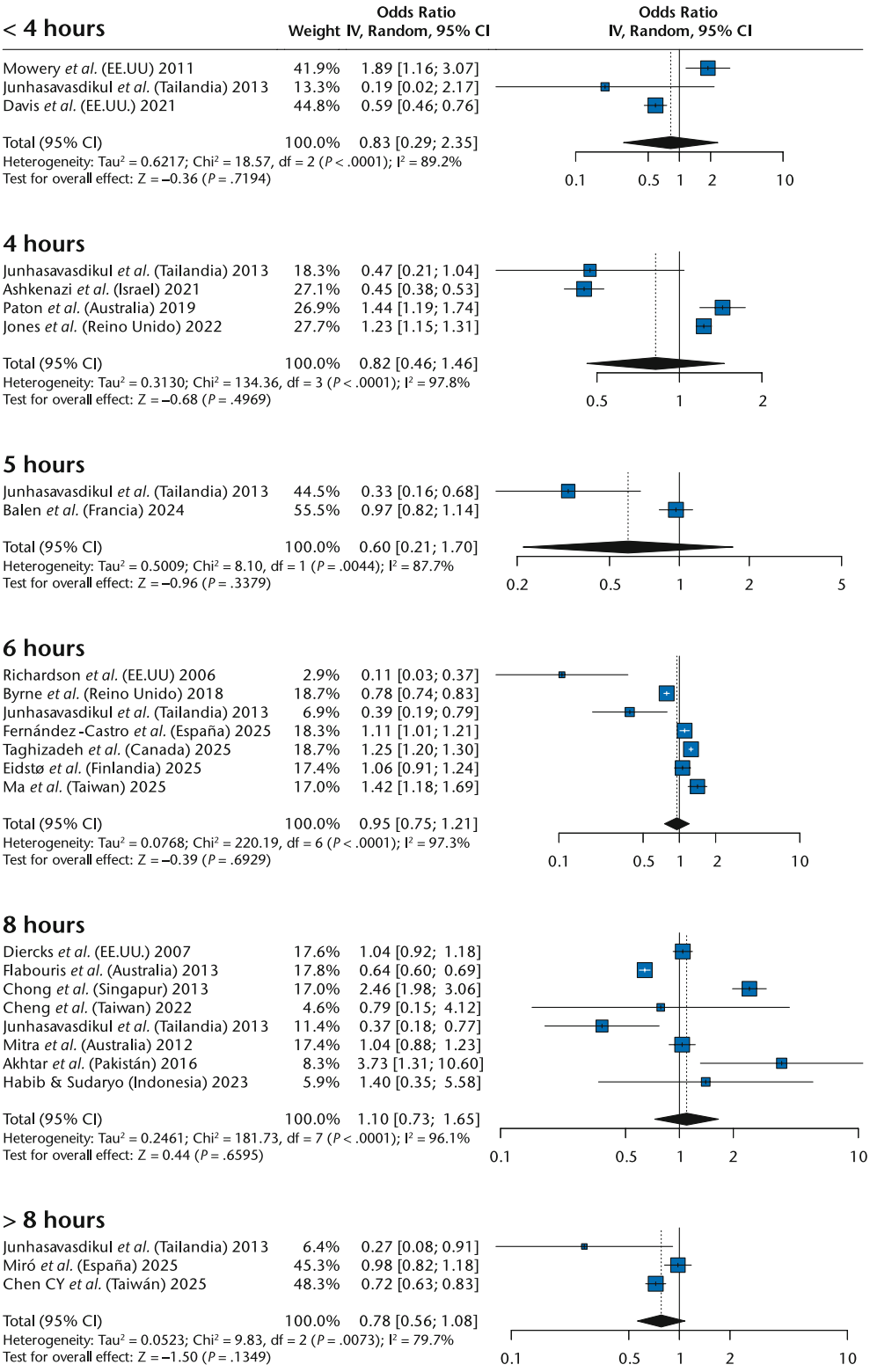


Figure 2. Association between emergency department length of stay and in-hospital mortality according to the cutoff used to define a prolonged stay.

different EDLOS cutoffs prevented diagnosis-specific subgroup analyses with a sufficient number of studies and comparable exposure definitions. Nevertheless, it is reasonable to assume that the potential impact of an ED delay is not equivalent across all these clinical situations. In clearly time-sensitive conditions, such as stroke or acute myocardial infarction, even relatively short delays may translate into worse prognosis,

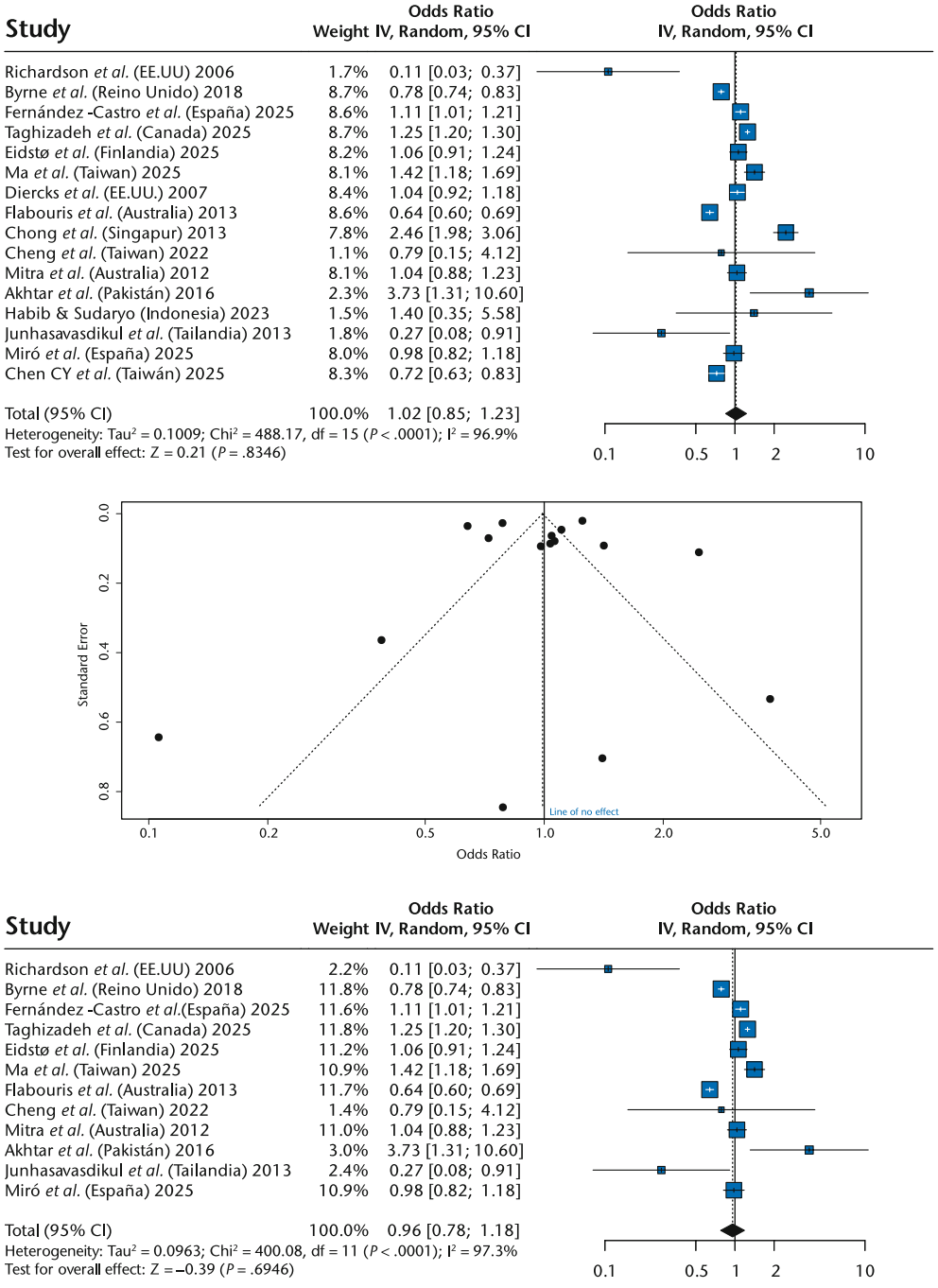


Figure 3. Association between emergency department length of stay and in-hospital mortality (top), corresponding funnel plot (middle), and sensitivity analysis excluding studies with high or very high risk of bias according to ROBINS-E (bottom), for the overall analysis including all studies defining prolonged stay using a cutoff of 6 hours or longer. For each study, only results using the longest cutoff were included.

whereas in less acute illnesses EDLOS may simply reflect diagnostic complexity or the need to complete additional tests before admission.

Another important aspect is that EDLOS is influenced by multiple organizational factors unrelated to the patient. The availability of inpatient beds, demand for care, hospital occupancy, differences in ED organization, and patient-flow management policies can substantially modify length of stay without necessarily implying poorer quality of care. In this respect, Hsuan *et al.* observed that ED overcrowding was associated with worse hospital outcomes, although they used crowding indicators other than individual EDLOS.[1] These findings support the idea that EDLOS is a complex indicator of overall system performance rather than an isolated variable, reflecting both the diagnostic and therapeutic

Table 4. GRADE assessment of certainty of evidence for the outcome of in-hospital mortality

Domain	Assessment	Rationale
Risk of bias	Serious	The ROBINS-E assessment raised some concerns in 16 of the 22 studies and found high risk in 6, with no studies classified as having an overall low risk. The main limitations concerned residual confounding due to baseline severity and participant selection.
Inconsistency	Serious	High between-study heterogeneity was observed, with I2 values frequently exceeding 75%, which could not be fully explained by the analyses performed.
Indirectness	Not serious	The population, exposure (EDLOS), and mortality outcome were directly relevant to the research question. Differences in the operational definition and EDLOS cutoffs were considered primarily a source of heterogeneity rather than a substantial limitation of applicability.
Imprecision	Not serious	The overall analysis included a very large sample and provided a relatively precise effect estimate (OR, 1.02; 95% CI, 0.85–1.23). Although some cutoff-based analyses had wider confidence intervals, the overall estimate was not compatible with effects of large magnitude.
Publication bias	Not detected	Visual inspection of the funnel plot and Egger's test did not suggest significant asymmetry.
Overall certainty of the evidence	Very low ⊗○○○	The evidence comes exclusively from observational studies and has important limitations due to risk of bias and high inconsistency between studies.

EDLOS: emergency department length of stay.

complexity of the episode and the system's ability to complete the care process and transfer patients to hospital beds. Thus, prolonged stay may reflect both clinical needs and impaired hospital flow, particularly access block and boarding time.

Furthermore, studies published since the review by Lauque *et al.* provide a more nuanced view of this relationship. The Spanish multicenter EDEN-18 study,[5] based on hospitalized patients older than 65 years, showed a nonlinear association between EDLOS and mortality, with risk increasing only with very long stays. Similarly, the study by Fernández Castro *et al.,* also conducted in Spain,[6] found that risk increased hardly at all for EDLOS shorter than 24 hours and only became clinically relevant among patients with exceptionally long stays. In contrast, Chen *et al.*[9] even reported lower mortality rates among patients with EDLOS longer than 48 hours, probably because of selection and survival effects. Other recent studies highlight the importance of the care context. Jones *et al.,* using national data from the British National Health Service, described a progressive increase in mortality with increasing delay to hospital admission.2 Conversely, Eidstø *et al.,*[12] analyzing EDLOS as a continuous variable, found no association between each additional hour of stay and adjusted mortality. Likewise, Wu *et al.,*[13] using machine-learning techniques, found that the effect of EDLOS varied according to age and other clinical characteristics, reinforcing the hypothesis that the association is not uniform across all patients. Taken together, these differences illustrate why the relationship between EDLOS and mortality can hardly be summarized by a single cutoff applicable to all patients and support examining this relationship using continuous and probably nonlinear models. Flexible models, such as restricted cubic splines,[49] may offer a more appropriate approach for future studies and reduce some of the heterogeneity observed.

From a clinical perspective, our findings must not be interpreted as justification for accepting prolonged EDLOS. Although no consistent association with mortality was demonstrated, abundant evidence shows that prolonged EDLOS is associated with other important outcomes, such as longer hospitalization, more complications, worse patient experience, and greater resource use. In addition, prolonged EDLOS is a recognized indicator of overcrowding and may compromise the system's capacity to respond to new patients. These potential sources of heterogeneity could not be formally evaluated by meta-regression because of the limited number of studies available and the lack of homogeneous information on certain study-level characteristics.

Strengths of this review include the comprehensive updating of the available evidence, the inclusion of recent studies with large sample sizes, the use of a search strategy based on the previous review, and adherence to PRISMA 2020 recommendations.[22] In addition, the separate analyses for each cutoff and the overall meta-analysis allowed consistency of the results to be explored from different perspectives.

Nevertheless, this study has limitations. First, all included studies were observational, so residual confounding cannot be excluded despite the adjustments performed. Second, the substantial clinical and methodological heterogeneity limits interpretation of the pooled estimates. Furthermore, differences in EDLOS definitions, adjustment models, and study populations hinder direct comparisons between studies. Third, the overall meta-analysis included only 16 studies, and several potentially important study-level characteristics, such as the proportion of geriatric patients or certain features of health care systems, were not consistently reported. These limitations prevented a sufficiently reliable multivariable meta-regression to explore sources of heterogeneity. Fourth, a particularly relevant limitation is the inability to distinguish consistently between time spent receiving care in the ED and boarding time. In many studies, EDLOS was reported only as the total interval from ED arrival to departure, without sufficient information to identify when the admission decision was made. Therefore, the pooled estimates should be interpreted as reflecting the effect of a composite indicator of the care process and hospital flow, not the isolated effect of a diagnostic or therapeutic delay in the ED. Finally, the absence of individual patient data prevented analyses stratified by severity, diagnosis, age, or

triage level, factors that probably substantially modify the association between EDLOS and mortality.

Overall, the present findings indicate that EDLOS, considered in isolation, probably does not constitute a universal predictor of in-hospital mortality. Rather, it appears to be a context-dependent indicator influenced by the clinical and organizational setting. The absence of a consistent overall association does not rule out possible nonlinear relationships or effects of exceptionally long stays, or an impact of EDLOS on other clinical and resource-use outcomes. Therefore, future research should move away from arbitrary cutoffs and toward models treating EDLOS as a continuous variable, with homogeneous adjustment for severity and exploration of potential differential effects in clinically relevant subgroups. Studies specifically examining the time elapsed between the admission decision and ED departure (boarding time), or overnight stays by patients for whom a hospitalization decision has already been made (overnight stay), might shed further light and yield different results. Only through methodological standardization will it be possible to determine more precisely the true impact of ED stays on the prognosis of hospitalized patients.

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