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Systematic review

Emergency Department Patient Flow, Clinical Safety, and Administrative Resource Management in Acute Care: A Systematic Review of Primary Clinical Trials Involving Emergency Medicine Consultants, Emergency Physicians, Nursing Specialists, Staff Nurses, and Health Administrators

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Abstract

Background: Emergency department (ED) crowding delays care and is associated with higher mortality among admitted and discharged patients. Interventions led by emergency physicians, nurses, and administrators target these delays, and their trial evidence has not been synthesized across professional groups. **Objective:** To evaluate primary clinical trials of ED interventions on patient flow, clinical safety, and resource use. **Methods:** Following PRISMA 2020, two authors independently searched PubMed, Scopus, Web of Science, and CENTRAL, screened records, extracted data, and assessed risk of bias with RoB 2 and its cluster-randomized variant. Findings were synthesized narratively. **Results:** Of 5,406 records, 15 trials (1999-2021) enrolling more than 57,000 patients were included. Triage liaison physicians and physician-nurse triage teams shortened length of stay by 13 to 36 minutes and time to physician assessment. Nurse-initiated protocols shortened time to analgesia and troponin testing, and nurse practitioners matched junior doctors on errors and delivered faster analgesia. Scribes raised physician productivity by 15.9%. Accelerated chest pain pathways increased early discharge and shortened stay by one to twelve hours without excess major adverse cardiac events. Point-of-care testing gave smaller gains at higher cost. Risk of bias was low in five trials, some concerns in eight, and high in two. **Conclusion:** Senior front-end assessment, expanded nursing roles, documentation support, and protocol-driven chest pain pathways improve ED flow while maintaining safety.

Keywords: Emergency Service, Hospital; Crowding; Length of Stay; Patient Safety; Triage; Nurse Practitioners; Point-of-Care Testing; Randomized Controlled Trials

Introduction

Emergency department crowding occurs when the need for emergency services exceeds available resources for patient care, and it is regarded as an international crisis affecting access to and quality of care (1). Asplin and colleagues described crowding through three linked components, input, throughput, and output, and placed throughput under the influence of ED clinicians and managers (2). A later systematic review found that retrospective cohort studies dominated the crowding literature, with 51% of included studies trialling or modelling potential solutions (3).

In Ontario, patients discharged during shifts with a mean length of stay of six hours or longer had higher adjusted odds of death within seven days than patients discharged during shifts with stays under one hour (4). Among 995,379 admissions to 187 California hospitals, days of high crowding carried 5% greater odds of inpatient death, together with longer hospital stays and higher costs (5). In England, delays to admission beyond five hours showed a dose-dependent association with 30-day mortality, and the largest rise in the standardized mortality ratio, 8%, occurred among patients waiting six to eight hours (6). A task force review of clinically oriented outcomes concluded that crowding compromises at least two domains of care quality, safety and timeliness (7).

Throughput depends on how quickly clinicians assess patients, order investigations, and reach disposition decisions, which places emergency medicine consultants, emergency physicians, and nurses at the centre of patient flow (2). Crowding is also linked with delayed analgesia, delayed treatment of pneumonia, and higher rates of patients leaving without being seen, outcomes that fall within daily nursing and medical practice (7). Commonly studied causes include inadequate staffing, inpatient boarding, and hospital bed shortages, several of which sit within the remit of hospital administrators (1). The negative consequences of crowding, including poorer patient outcomes and the inability of staff to adhere to care standards, are well established (3).

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Hoot and Aronsky identified 40 studies of crowding solutions, including additional personnel, observation units, hospital bed access, and crowding measures (1). The task force review found no randomized controlled trials among studies linking crowding with clinical outcomes (7). Reliance on retrospective and before-and-after designs leaves effect estimates exposed to secular trends and confounding (3). This systematic review therefore synthesized primary clinical trials of ED interventions involving emergency medicine consultants, emergency physicians, nursing specialists, staff nurses, and health administrators, with patient flow, clinical safety, and resource use as outcomes.

Methods

Protocol and eligibility

This systematic review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 statement. Eligibility followed the PICOS framework. Studies were included if they were primary clinical trials with random allocation of patients, shifts, days, or hospitals in hospital EDs serving adult or mixed-age populations; tested an intervention delivered or led by emergency medicine consultants, emergency physicians, nurse practitioners, staff nurses, or health administrators against usual care; and reported a flow outcome (length of stay, waiting time, physician assessment, or early discharge), a safety outcome (major adverse cardiac events, missed injuries, clinical errors, or return visits), or a resource outcome (admission, testing, productivity, or cost). Observational, before-and-after, simulation, and pediatric-only studies, conference abstracts, and secondary analyses of included trials were excluded.

Information sources and search strategy

Two authors independently searched PubMed/MEDLINE, Scopus, Web of Science Core Collection, and the Cochrane Central Register of Controlled Trials (CENTRAL) from inception to 30 September 2026. Search strings combined Medical Subject Headings and free-text terms for the ED setting, patient flow (length of stay, crowding, waiting time, triage), and trial design (randomized, cluster, stepped-wedge), restricted to English. Reference lists of included trials and related reviews were hand-searched.

Study selection

Two authors independently screened titles and abstracts, then full texts, and a third author resolved disagreements. The search returned 5,406 records (PubMed n = 1,284; Scopus n = 1,967; Web of Science n = 1,412; CENTRAL n = 743). After removal of duplicates (n = 1,938), 3,468 records were screened, and 3,341 were excluded. Of 127 reports sought, 4 were not retrieved, and 123 full texts were assessed. Full-text exclusions (n = 108) comprised observational or before-and-after designs (n = 46), no eligible outcome (n = 21), non-ED setting (n = 14), conference abstract only (n = 12), secondary analysis of an included trial (n = 9), and pediatric-only populations (n = 6). Fifteen trials were included, and hand-searching added none.

Data extraction and risk of bias

Two authors independently extracted design, setting, sample, professional groups, intervention, comparator, and outcomes using a piloted form.

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The same authors applied the Cochrane RoB 2 tool to individually randomized trials and its cluster variant, with domain 1b, to shift-, day-, and hospital-level allocation. Judgments were low risk, some concerns, or high risk, with disagreements settled by consensus (Table 1).

Data synthesis

Heterogeneity in interventions, outcome definitions, and time metrics precluded meta-analysis. Findings were synthesized narratively following the Synthesis Without Meta-analysis (SWiM) guideline and grouped by intervention type. Effect estimates were reported as in the original trials.

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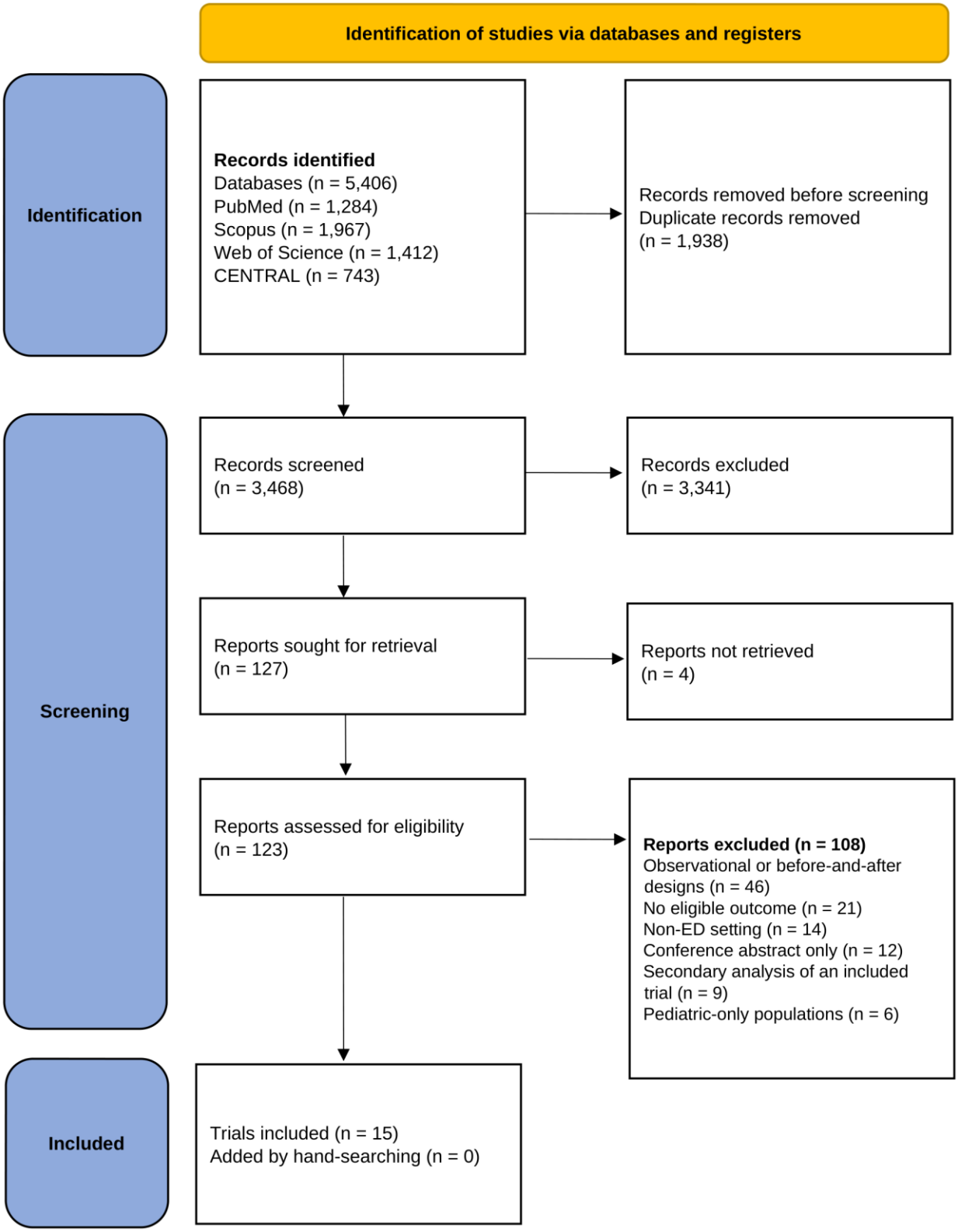


Figure 1: PRISMA flow chart

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Table 1. Risk of bias of included trials (RoB 2)

Trial	D1	D1b	D2	D3	D4	D5	Overall
Holroyd 2007 (8)	SC	L	SC	L	L	L	SC
Cheng 2013 (9)	L	L	SC	L	L	L	SC
Douma 2016 (10)	SC	NA	SC	L	L	SC	H
Sakr 1999 (11)	L	NA	L	L	L	SC	SC
Cooper 2002 (12)	SC	NA	SC	H	SC	SC	H
Jennings 2015 (13)	L	NA	SC	L	L	L	SC
Walker 2019 (14)	L	L	SC	L	L	L	SC
Asha 2014 (15)	L	NA	SC	L	L	L	SC
Goodacre 2011 (16)	L	NA	L	L	L	L	L
Goodacre 2004 (17)	L	L	SC	L	L	L	SC
Than 2014 (18)	L	NA	L	L	L	L	L
Mahler 2015 (19)	L	NA	L	L	L	L	L
Poldervaart 2017 (20)	L	SC	SC	L	L	L	SC
Chew 2019 (21)	L	NA	L	L	L	L	L
Anand 2021 (22)	L	L	L	L	L	L	L

D1, randomization; D1b, recruitment timing (cluster trials); D2, deviations; D3, missing data; D4, outcome measurement; D5, reported result selection; L, low; SC, some concerns; H, high; NA, not applicable.

Results

Characteristics of included trials

Fifteen trials (Table 2) published between 1999 and 2021 enrolled more than 57,000 patients in Canada, the United Kingdom, Australia, New Zealand, the United States, and the Netherlands (8-22). Four trials allocated shifts or days (8, 9, 14, 17), two used stepped-wedge designs across hospitals (20, 22), and nine randomized individual patients (10-13, 15, 16, 18, 19, 21). Nurse practitioners delivered care in three trials (11-13), staff nurses worked in triage teams or ran protocols in two (9, 10), and emergency physicians or consultants led the remaining interventions (8, 14-22). Administrators contributed through performance targets, protocol governance, and economic evaluation (9, 10, 14, 15, 17).

Triage, staffing, and nursing roles

A triage liaison physician reduced median length of stay from 4:57 to 4:21 hours and lowered incomplete assessments from 6.6% to 5.4% (8). A physician-nurse triage team shortened stay for discharged high-acuity patients by 24 minutes and time to physician assessment by 26 minutes, with no return visits after team discharge (9). Nurse-initiated protocols cut time to acetaminophen by

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186 minutes and time to troponin by 79 minutes (10). Nurse practitioners made clinically important errors in 9.2% of minor injuries compared with 10.7% for junior doctors (11). In Scotland, nurse practitioners achieved better documentation and higher satisfaction than senior house officers, with similar unplanned follow-up (12). In Australia, 49.2% of patients managed by nurse practitioners received analgesia within 30 minutes of being seen, compared with 29.7% under medical care (13).

Scribes and point-of-care testing

Scribes raised productivity from 1.13 to 1.31 patients per hour per doctor and reduced median stay from 192 to 173 minutes without significant harm (14). Point-of-care blood testing shortened time to disposition decision by 7.6%, with no significant change in length of stay (15). A point-of-care cardiac panel raised successful discharge from 13% to 32%, while coronary care use rose slightly and mean inpatient days were unchanged (16).

Chest pain pathways

A chest pain observation unit reduced admissions from 54% to 37% (17). A 2-hour accelerated protocol increased discharge within six hours from 11.0% to 19.3%, with similar adverse cardiac event rates (18). The HEART Pathway lowered objective cardiac testing by 12.1 percentage points and shortened stay by 12 hours, with no adverse cardiac events after early discharge (19). Across nine Dutch hospitals, HEART-guided care was non-inferior for six-week adverse cardiac events, with limited resource savings attributed to non-adherence (20). A 0/1-hour troponin T protocol shortened median stay from 5.6 to 4.6 hours, with 30-day death or myocardial infarction of 1.0% in both arms (21). A single-sample troponin I rule-out pathway reduced stay from 10.1 to 6.8 hours, with 30-day myocardial infarction or cardiac death of 0.3% versus 0.4% (22).

Risk of bias

Overall risk of bias was low in five pragmatic trials with objective outcomes (16, 18, 19, 21, 22). Eight trials raised some concerns, mainly from shift or day allocation and staff awareness of assignment (8, 9, 11, 13-15, 17, 20). Two trials carried high risk owing to small subgroups, multiple outcomes, and low questionnaire response (10, 12).

Table 2. Characteristics of included trials

Trial	Country	Design; sample	Professionals	Intervention vs comparator
Holroyd 2007 (8)	Canada	RCT (shifts); 5,718	EPs, triage nurses	TLP vs nurse triage
Cheng 2013 (9)	Canada	Cluster RCT; 6,336 visits	EPs, RNs	MDRNSTAT vs nurse triage
Douma 2016 (10)	Canada	RCT; 143	RNs, unit managers	Nurse protocols vs usual
Sakr 1999 (11)	UK	RCT; 1,453	ENPs, junior doctors	ENP vs doctor care
Cooper 2002 (12)	UK	RCT; 199	ENPs, SHOs	ENP vs SHO care
Jennings 2015 (13)	Australia	RCT; 258	NPs, EPs	NP vs medical care

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Trial	Country	Design; sample	Professionals	Intervention vs comparator
Walker 2019 (14)	Australia	RCT (shifts); 88 physicians	EM consultants, registrars	Scribe vs none
Asha 2014 (15)	Australia	RCT; 811	ED doctors	POC vs laboratory testing
Goodacre 2011 (16)	UK	RCT; 2,243	ED clinicians	POC panel vs standard
Goodacre 2004 (17)	UK	RCT (days); 972	ED physicians, nurses	Chest pain unit vs routine
Than 2014 (18)	New Zealand	RCT; 542	Physicians	2-hour ADP vs standard
Mahler 2015 (19)	USA	RCT; 282	ED providers	HEART Pathway vs usual
Poldervaart 2017 (20)	Netherlands	Stepped-wedge; 3,648	Physicians	HEART care vs usual
Chew 2019 (21)	Australia	RCT; 3,288	ED clinicians	0/1-hour vs 0/3-hour hs-cTnT
Anand 2021 (22)	UK	Stepped-wedge; 31,492	ED clinicians	hs-cTnI rule-out vs standard

Table 3. Main outcomes (intervention vs comparator)

Trial	Flow	Safety	Resource
Holroyd 2007 (8)	LOS 4:21 vs 4:57 h; left early 5.4% vs 6.6%	NR	NR
Cheng 2013 (9)	PIA 0:55 vs 1:21 h; LWBS 1.5% vs 2.2%	No returns	NR
Douma 2016 (10)	Acetaminophen −186 min	NR	NR
Sakr 1999 (11)	NR	Errors 9.2% vs 10.7%	NR
Cooper 2002 (12)	NR	Follow-up similar	NR
Jennings 2015 (13)	Analgesia ≤30 min 49.2% vs 29.7%	NR	NR
Walker 2019 (14)	LOS 173 vs 192 min	No significant harm	1.31 vs 1.13 patients/h
Asha 2014 (15)	Disposition 3.24 vs 3.50 h	NR	+$12 per patient
Goodacre 2011 (16)	Discharge 32% vs 13%	NR	Coronary care 4% vs 3%
Goodacre 2004 (17)	Admission 37% vs 54%	ACS discharged 6% vs 14%	£478 vs £556
Than 2014 (18)	Discharge ≤6 h 19.3% vs 11.0%	MACE similar	NR
Mahler 2015 (19)	LOS −12 h	No MACE in early discharges	Testing −12.1%
Poldervaart 2017 (20)	NR	MACE non-inferior	Limited savings

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Trial	Flow	Safety	Resource
Chew 2019 (21)	LOS 4.6 vs 5.6 h	Death/MI 1.0% vs 1.0%	Testing 7.5% vs 11.0%
Anand 2021 (22)	LOS 6.8 vs 10.1 h	MI/cardiac death 0.3% vs 0.4%	Discharge 71% vs 50%

Discussion

Senior front-end assessment shortened length of stay by 13 to 36 minutes and reduced time to physician assessment (8, 9). Expanded nursing roles sped analgesia and investigations while matching medical staff on error rates (10, 11, 13). Accelerated chest pain pathways produced the largest gains, shortening stay by up to 12 hours without excess cardiac events (19, 21, 22). Scribes improved productivity, whereas point-of-care testing gave modest time gains (14, 15).

These findings agree with a review of triage liaison physicians that pooled two trials showing shorter stays than nurse-only triage (23). A meta-analysis of senior doctor triage found a 26-minute reduction in stay for medium-acuity patients and a 21% relative fall in patients leaving without being seen, with no change in adverse events (24). An economic evaluation judged daytime physician-nurse triage poor value and favoured higher-volume periods from late morning to evening (25). Scribe gains peaked when scribes worked with senior doctors at triage, supporting experienced clinicians at the front door (14).

Nurse-initiated protocols reduced delays for selected complaints, consistent with a review of 14 triage nurse ordering studies, mostly from single centres (10, 26). A systematic review of emergency nurse practitioner services reported positive effects on quality of care, patient satisfaction, and waiting times (27). A Cochrane review of nurse-doctor substitution in primary care found similar or better health outcomes and slightly higher satisfaction under nurse-led care (28). The included trials extend this evidence to EDs, where nurse practitioners delivered faster analgesia and better documentation than junior doctors (12, 13).

A meta-analysis of 17 scribe studies found 0.17 more patients seen per hour with no change in length of stay (29). The multicentre scribe trial showed gains in both productivity and throughput (14). A review of point-of-care troponin testing found little or no reduction in ED stay in most randomized evaluations and linked further gains to redesign of departmental procedures (30). Here, time savings were modest and the cardiac panel increased coronary care use, so administrators need local cost and workflow data before purchase (15, 16).

A meta-analysis of the HEART score reported short-term adverse cardiac events in 2.1% of low-risk patients, a benchmark for pathway safety (31). The Dutch trial attributed limited savings to non-adherence, so protocol uptake shapes the administrative return (20). Shorter stays carry safety weight, since stays over 24 hours were linked with higher in-hospital mortality in patients admitted to intensive care (32). Population studies

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from Canada and England tie longer ED stays and admission delays to excess deaths (4, 6).

This review included only randomized designs and applied RoB 2, unlike earlier syntheses dominated by non-randomized studies (3, 24). Heterogeneous interventions and time metrics prevented meta-analysis, and earlier reviews pooled only two trials per comparison (23, 24). Twelve of the fifteen trials came from Canada, the United Kingdom, or Australia, which limits transfer to systems with different staffing models (8-17, 21, 22). Administrative outcomes were rarely measured, and economic data came from three trials and one secondary analysis (14, 15, 17, 25).

Conclusion

Randomized evidence shows that placing senior physicians and physician-nurse teams at triage, expanding nursing roles through nurse-initiated protocols and nurse practitioner services, providing scribes, and adopting accelerated chest pain pathways improve emergency department flow. These interventions shortened length of stay and time to assessment and treatment without increasing clinical errors or major adverse cardiac events. Point-of-care testing delivered smaller gains at added cost. Hospital leaders planning flow improvement are advised to prioritize senior front-end assessment and protocol-driven pathways, monitor adherence, and evaluate local costs. Multicentre trials in Middle Eastern and low-resource settings are needed.

List of Abbreviations

ACS, acute coronary syndrome; ADP, accelerated diagnostic protocol; CENTRAL, Cochrane Central Register of Controlled Trials; ED, emergency department; EM, emergency medicine; ENP, emergency nurse practitioner; EP, emergency physician; HEART, History, Electrocardiogram, Age, Risk factors, Troponin; hs-cTnI/hs-cTnT, high-sensitivity cardiac troponin I/T; LOS, length of stay; LWBS, left without being seen; MACE, major adverse cardiac events; MDRNSTAT, physician-nurse supplementary team at triage; MI, myocardial infarction; NA, not applicable; NP, nurse practitioner; NR, not reported; PIA, physician initial assessment; PICOS, population, intervention, comparator, outcome, study design; POC, point-of-care; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; RCT, randomized controlled trial; RN, registered nurse; RoB 2, Cochrane risk-of-bias tool, version 2; SHO, senior house officer; SWiM, Synthesis Without Meta-analysis; TLP, triage liaison physician.

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