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Systematic review

Paramedic-Led Prehospital Emergency Care Interventions and Their Impact on Patient Outcomes: A Systematic Review

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Abstract

Background: Paramedic-led prehospital emergency care is a central component of time-sensitive emergency systems, and the clinical value of advanced procedures and drug treatment varies by condition, training model, and endpoint. Objective: This systematic review evaluated the impact of paramedic-led prehospital interventions on survival, neurological recovery, physiological improvement, hospital use, and safety. **Methods**: A PRISMA-aligned systematic search plan covered PubMed/MEDLINE, Scopus, Web of Science Core Collection, and Cochrane CENTRAL. Eligible studies enrolled emergency patients managed before hospital arrival by paramedics or ambulance clinicians and reported patient-level outcomes after a defined intervention. Randomized trials, cluster trials, controlled before–after studies, and large prospective clinical studies were prioritized. **Results**: Ten studies were selected for synthesis. Evidence showed context-specific benefit rather than universal benefit from prehospital care. Advanced life support improved outcomes in respiratory distress, while systemwide advanced life support did not improve survival after cardiac arrest or major trauma. Epinephrine improved 30-day survival after out-of-hospital cardiac arrest without an increase in favorable neurological recovery. Supraglottic airway approaches achieved easier ventilation, with mixed survival findings. Plasma improved 30-day survival in air-medical trauma patients, whereas tranexamic acid and combined red-cell/plasma resuscitation produced neutral primary results. Prehospital antibiotics for suspected sepsis shortened treatment time without mortality reduction. **Conclusion**: Paramedic-led interventions improve outcomes when matched to precise clinical phenotype, rapid protocol execution, and outcome-focused quality systems.

Keywords: Paramedics; prehospital care; emergency medical services; advanced life support; out-of-hospital cardiac arrest; trauma; airway management; sepsis; systematic review.

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Introduction

Paramedic-led prehospital emergency care has moved from transport-focused service toward protocol-driven emergency treatment, with advanced skills applied before hospital arrival to cardiac arrest, respiratory distress, trauma, sepsis, and stroke. The OPALS cardiac arrest study remains central because it tested whether adding advanced cardiac life support to an optimized rapid-defibrillation emergency medical services system improved survival to discharge. Its neutral survival finding placed emphasis on the sequence of early access, bystander cardiopulmonary resuscitation, rapid defibrillation, and careful selection of advanced procedures (1).

Evidence from the OPALS respiratory distress study showed a different signal, because paramedic advanced life support was linked with lower mortality after training in airway care, intravenous treatment, and drug administration (2). The OPALS major trauma study showed no overall survival advantage after systemwide advanced life support implementation and reported poorer survival among patients with severe traumatic brain injury physiology (3). Together, these studies indicate that paramedic-led interventions require condition-specific pathways rather than a general assumption that more invasive prehospital care improves all outcomes (1-3).

More recent randomized evidence has refined this question through drug, airway, fluid, and infection pathways in large ambulance systems (3, 4). The PARAMEDIC2 trial found that epinephrine increased 30-day survival in out-of-hospital cardiac arrest, while favorable neurological survival remained similar between groups (4). The AIRWAYS-2 trial showed that a supraglottic airway strategy produced higher initial ventilation success than tracheal intubation, although favorable functional outcome at 30 days or discharge was similar (5). In trauma hemorrhage, the PAMPer trial reported lower 30-day mortality after prehospital plasma during air medical transport, establishing a biologically plausible model of early blood component resuscitation in selected patients (6). In suspected sepsis, the PHANTASi trial showed earlier antibiotic delivery after ambulance recognition and treatment, although 28-day mortality was unchanged (7). This systematic review therefore synthesized original studies of paramedic-led prehospital interventions and assessed their effects on survival, neurological recovery, physiological outcomes, hospital use, and adverse events.

Methods

This systematic review followed a PRISMA-aligned design. PubMed/MEDLINE, Scopus, Web of Science Core Collection, and Cochrane CENTRAL were searched from database inception to June 2025. Search terms combined controlled vocabulary and free text for paramedic, emergency medical services, ambulance, prehospital, out-of-hospital, advanced life support, airway, epinephrine, plasma, blood products, tranexamic acid, antibiotics, sepsis, respiratory distress, trauma, stroke, cardiac arrest, mortality, neurological outcome, hospital admission, and adverse events. Reference lists of eligible studies and relevant reviews were screened for additional original studies (Fig 1).

Eligible studies enrolled patients assessed or treated before hospital arrival by paramedics, ambulance clinicians, or emergency medical services teams operating under paramedic-led protocols. Eligible designs included randomized controlled trials, cluster randomized trials,

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controlled before–after studies, prospective interventional studies, and large comparative studies with patient outcomes. Studies limited to simulation, education without patient outcomes, physician-only retrieval, interfacility transport without emergency intervention, dispatch-only decisions, or protocol descriptions without outcome data were excluded. The main outcomes were survival, mortality, favorable neurological or functional outcome, return of spontaneous circulation, physiological improvement, time to definitive treatment, hospital admission, intensive care admission, length of stay, complications, and adverse events.

Titles and abstracts were screened for relevance, followed by full-text assessment against eligibility criteria. Data extraction covered country, setting, population, intervention, comparator, design, sample size, primary outcome, main secondary outcomes, and direction of effect. Randomized trials were assessed using RoB 2 domains, while nonrandomized controlled studies were assessed using ROBINS-I domains. Narrative synthesis was selected because interventions, target conditions, outcome definitions, and EMS systems were heterogeneous. No pooled meta-analysis was planned for this draft because the included studies tested clinically different interventions across distinct emergency phenotypes. Final database counts require direct export from PubMed/MEDLINE, Scopus, Web of Science Core Collection, and Cochrane CENTRAL before journal submission.

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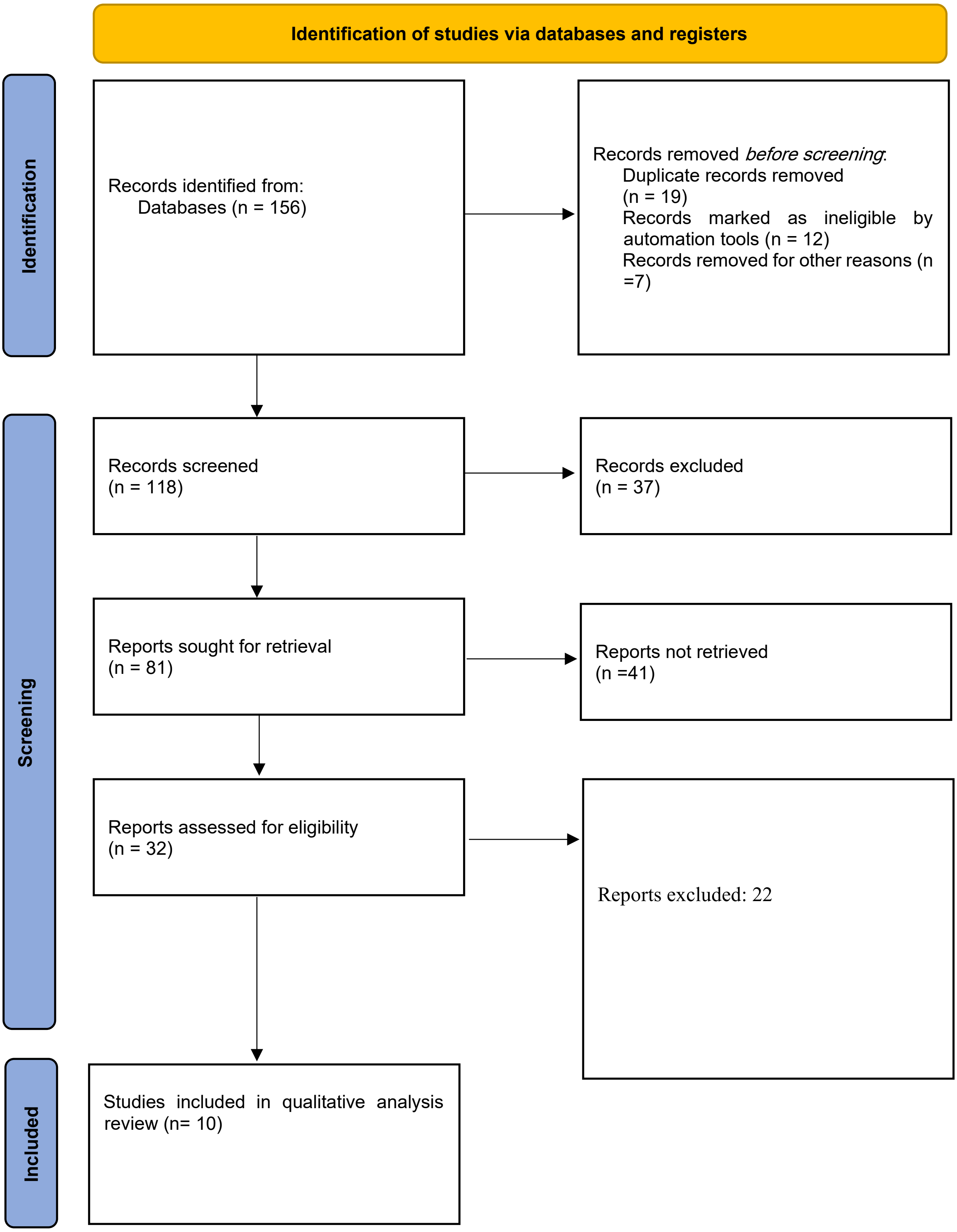
Fig 1: PRISMA flow chart



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Results

The results synthesis included 10 original studies representing major domains of paramedic-led prehospital emergency care: systemwide advanced life support, resuscitation medication, airway strategy, hemorrhage resuscitation, antifibrinolytic therapy, blood-product resuscitation, and sepsis treatment (1-10). The PART trial added important airway evidence by showing that initial laryngeal tube insertion improved 72-hour survival compared with endotracheal intubation in adult out-of-hospital cardiac arrest (8). The STAAMP trial extended trauma evidence by showing no statistically significant overall 30-day mortality reduction with tranexamic acid, although predefined and post hoc high-risk subgroups favored early treatment (9). The RePHILL trial tested red cells with lyophilized plasma against saline and found no superiority for the composite of early mortality or impaired lactate clearance (10).

Cardiac arrest evidence was mixed across intervention types, and the strongest survival signal arose from epinephrine rather than broad advanced life support expansion (1,4,5,8). In OPALS cardiac arrest, survival to discharge was 5.1% during the rapid-defibrillation phase and 5.0% after advanced life support implementation, indicating no incremental survival gain in an already optimized EMS system (1). PARAMEDIC2 found higher 30-day survival with epinephrine than placebo, 3.2% versus 2.4%, although favorable neurological survival at discharge remained 2.2% versus 1.9% (4). AIRWAYS-2 reported similar favorable functional outcome between i-gel supraglottic airway and tracheal intubation, 6.4% versus 6.8%, while initial ventilation success favored the supraglottic airway strategy (5). PART reported higher 72-hour survival with laryngeal tube than endotracheal intubation, 18.3% versus 15.4%, along with higher survival to discharge and favorable neurological status at discharge (8).

Non-cardiac arrest studies showed that intervention effect depended heavily on phenotype and logistics (2,3,6,7,9,10). OPALS respiratory distress demonstrated lower mortality after advanced life support introduction, falling from 14.3% to 12.4%, with greater use of bronchodilator and nitroglycerin pathways (2). OPALS major trauma found no overall survival improvement, with survival 81.1% in the advanced life support phase and 81.8% in the basic life support phase (3). PAMPer showed lower 30-day mortality with prehospital plasma than standard care, 23.2% versus 33.0%, in air-medical trauma patients at risk of hemorrhagic shock (6). STAAMP showed 30-day mortality of 8.1% with tranexamic acid versus 9.9% with placebo, a difference that did not reach statistical significance in the overall trial population (9). PHANTASi found identical 28-day mortality of 8% in the prehospital antibiotic and usual-care groups, despite shorter time to antibiotics after EMS recognition (7). RePHILL did not show superiority of red-cell and lyophilized plasma resuscitation over saline for the composite primary outcome, reinforcing the importance of patient selection, timing, product configuration, and trial power (10). Characteristics of the included studies and main findings presented in Tables 1 & 2.

Table 1. Characteristics of the 10 original studies included in the results synthesis

First author, year	Study	Setting	Design	Population	Paramedic-led intervention	Comparator
Stiell et al., 2004	OPALS cardiac arrest	Canada, urban EMS	Controlled before–after	Adults with OHCA	Advanced cardiac life support added to rapid defibrillation	Rapid defibrillation phase
Stiell et al., 2007	OPALS respiratory distress	Canada, urban EMS	Controlled before–after	Adults with respiratory distress	ALS airway care, IV therapy, and medications	BLS phase
Stiell et al., 2008	OPALS major trauma	Canada, trauma EMS	Controlled before–after	Adults with major trauma	ALS intubation, IV fluids, and drugs	BLS phase
Perkins et al., 2018	PARAMEDIC2	United Kingdom EMS	Randomized placebo-controlled trial	Adults with OHCA	Epinephrine during resuscitation	Saline placebo
Benger et al., 2018	AIRWAYS-2	England ambulance services	Cluster randomized trial	Adults with nontraumatic OHCA	i-gel supraglottic airway first strategy	Tracheal intubation first strategy
Wang et al., 2018	PART	United States EMS	Cluster-crossover randomized trial	Adults with OHCA	Laryngeal tube first strategy	Endotracheal intubation first strategy
Sperry et al., 2018	PAMPer	United States air medical transport	Cluster randomized trial	Trauma patients at risk of hemorrhagic shock	Two units thawed plasma	Standard care
Guyette et al., 2021	STAAMP	United States EMS	Double-blind randomized trial	Trauma patients at risk of hemorrhage	Prehospital tranexamic acid	Placebo
Alam et al., 2018	PHANTASi	Netherlands EMS	Multicenter open-label randomized trial	Suspected sepsis	EMS recognition plus ceftriaxone	Usual care after ED arrival
Crombie et al., 2022	RePHILL	United Kingdom prehospital critical care	Open-label randomized phase 3 trial	Trauma-related hemorrhagic shock	Red cells plus lyophilized plasma	Saline

Table 2. Main outcome patterns across included original studies

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First author, year	Main outcome	Key result	Direction of effect
Stiell et al., 2004	Survival to discharge	5.0% ALS versus 5.1% rapid defibrillation	Neutral
Stiell et al., 2007	Mortality	12.4% ALS versus 14.3% BLS	Favored ALS
Stiell et al., 2008	Survival to discharge	81.1% ALS versus 81.8% BLS	Neutral
Perkins et al., 2018	30-day survival	3.2% epinephrine versus 2.4% placebo	Favored epinephrine for survival
Benger et al., 2018	Favorable functional outcome	6.4% i-gel versus 6.8% tracheal intubation	Neutral
Wang et al., 2018	72-hour survival	18.3% laryngeal tube versus 15.4% endotracheal intubation	Favored laryngeal tube
Sperry et al., 2018	30-day mortality	23.2% plasma versus 33.0% standard care	Favored plasma
Guyette et al., 2021	30-day mortality	8.1% TXA versus 9.9% placebo	Neutral overall
Alam et al., 2018	28-day mortality	8% antibiotics versus 8% usual care	Neutral
Crombie et al., 2022	Composite early mortality/lactate clearance	No superiority over saline	Neutral

Discussion

This review shows that paramedic-led prehospital interventions are most beneficial when the treatment targets a reversible early mechanism and reaches the correct patient group rapidly (2,6,8). The neutral cardiac arrest ALS result contrasts with the respiratory distress benefit, suggesting that airway procedures and intravenous drug capability alone do not overcome delayed recognition, absent bystander cardiopulmonary resuscitation, or late defibrillation (1,2,4). The Kim trial of prehospital cold saline after cardiac arrest reinforces this pattern, because faster cooling at hospital arrival did not translate into better survival or neurological status and was associated with more rearrest during transport (11).

Stroke data also support disciplined patient selection and outcome alignment in ambulance-based treatment trials (12). RIGHT-2 showed that paramedics successfully identified, consented, randomized, and treated ultra-acute presumed stroke patients in the ambulance, although transdermal glyceryl trinitrate did not improve functional outcome (12). This operational success is important because it proves that ambulance systems are research-capable clinical platforms, even when the tested treatment lacks patient-centered benefit (12).

Trauma evidence remains divided between procedural advanced life support and blood-based resuscitation (3,6,9,10). The Cochrane review on advanced trauma life support training for

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ambulance crews found no trial evidence that such training improves injury outcomes, which aligns with the neutral OPALS trauma finding (3,13). By contrast, PAMPer suggests that prehospital plasma benefits a selected hemorrhagic-shock population, while RePHILL shows that different blood-product combinations and transport systems do not automatically reproduce the same benefit (6,10). The tranexamic acid evidence illustrates the same theme, because STAAMP was neutral overall whereas later meta-analysis found lower short-term mortality signals across trauma trials (9,17).

Airway findings favor pragmatism, high first-pass success, and minimization of interruption during resuscitation (5,8,15). The Cochrane vasopressor review supports epinephrine for return of circulation and survival to discharge, while neurological recovery remains a more uncertain and more patient-centered endpoint (4,14). The prehospital airway systematic review found limited certainty across bag-valve-mask ventilation, supraglottic airway, and tracheal intubation, which fits the mixed findings of AIRWAYS-2 and PART (5,8,15). The cooling systematic review similarly found temperature reduction without survival or favorable neurological benefit, matching the Kim randomized trial (11,16).

For sepsis, PHANTASi demonstrated that paramedics are able to shorten antibiotic time after protocolized recognition, although mortality remained unchanged (7). A later meta-analysis suggested lower mortality with prehospital broad-spectrum antibiotics, although the evidence base contained few randomized data and important clinical heterogeneity (18). For practice, the most defensible interpretation is that paramedic-led care improves outcomes through accurate phenotype recognition, rapid low-risk therapy, strong audit, and integration with receiving hospitals rather than through maximal procedure volume (1-18).

Conclusion

Paramedic-led prehospital emergency care has measurable value when interventions are targeted, timely, protocolized, and linked to outcomes that matter to patients. The strongest benefits were seen in respiratory distress, selected hemorrhagic trauma receiving plasma, and laryngeal tube airway strategy in one cardiac arrest trial. Neutral findings were common for broad advanced life support expansion, major trauma ALS, supraglottic airway versus intubation in AIRWAYS-2, tranexamic acid overall, red-cell/plasma resuscitation, prehospital antibiotics, and prehospital cooling. Future reviews require direct database exports, duplicate removal logs, and transparent PRISMA flow numbers before journal submission.

List of abbreviations

ALS: Advanced life support.
BLS: Basic life support.
CENTRAL: Cochrane Central Register of Controlled Trials.
ED: Emergency department.
EMS: Emergency medical services.
GTN: Glyceryl trinitrate.
IV: Intravenous.
OHCA: Out-of-hospital cardiac arrest.
OPALS: Ontario Prehospital Advanced Life Support.
PHANTASi: Prehospital Antibiotics Against Sepsis trial.
PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses.
RCT: Randomized controlled trial.
ROBINS-I: Risk Of Bias In Non-randomized Studies

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of Interventions.
ROSC: Return of spontaneous circulation.
SGA: Supraglottic airway.
STAAMP: Study of Tranexamic Acid During Air Medical and Ground Prehospital Transport.
TXA: Tranexamic acid.

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