

Supplementary materials

Table 1. Included studies.

Author(s) (Year)	Country / Setting	Design	Population	Crew composition / Comparison	Outcome	Main finding
Najafi H., Bahramali E., Bijan M., et al. (2022)	Iran – prehospital STEMI registry (FaRMI).	Analytical cross- sectional, population- based study (2015–2020).	2 244 patients with STEMI.	EMS transport (paramedics / technicians / nurses) vs non-EMS transport.	Mortality (OHCA, in- transport), successful CPR, VF shock response.	Lower death rate and higher ROSC for EMS group (p < 0.001).
Noergaard Bech C.L., Brabrand M., Mikkelsen S., Lassen A. (2017)	Denmark – Odense University Hospital EMS (MECU system).	Prospective observational cohort (2012–2014).	20 328 adult patients transported to ED by ambulance.	Physician-staffed MECU vs non-MECU ambulance (EMTs/paramedics).	7-day mortality.	15.4% in MECU vs 3.8% in non- MECU; adjusted OR 5.3 (95% CI 4.6–6.1). Higher mortality likely reflects case severity.
Strandqvist E., Olheden S., Bäckman A., Jörnvall H., Bäckström D. (2023)	Sweden – Stockholm Region, Rapid Response Vehicles (RRV).	Retrospective observational (registry- based, 2021).	11,283 dispatches involving physician- and nurse- staffed RRVs.	Physician + anesthesia/prehospital nurse (RRV) assisting standard EMS teams.	Dispatch characteristics, interventions performed, NACA scores (severity proxy for mortality), clinical impact.	RRVs contributed significantly to advanced care (airway, drugs, ultrasound, TXA), particularly in cardiac arrest and trauma, supporting improved prehospital outcomes.
Yamamoto R., Suzuki M., Yoshizawa J., Nishida Y., Sasaki J. (2021)	Japan – Nationwide EMS (Japan Trauma Data Bank 2004– 2019).	Retrospective cohort (propensity- weighted analysis).	14,652 hypotensive trauma patients (SBP ≤90 mmHg) transported from scene.	Physician-staffed vs. EMS personnel-staffed ambulance.	In-hospital mortality.	Physician-staffed ambulances associated with higher mortality (28.8% vs 17.5%) , longer prehospital times (+12 min); harm observed in persistently hypotensive patients only.
Gonsaga et al., 2012	Brazil	Retrospective observational study (2012)	850 adult trauma patients transported by SAMU or CB	SAMU-USB (paramedic + nurse), SAMU-USA (paramedic + nurse + physician) vs CB (firefighters/technicians)	Trauma severity (ISS, RTS, TRISS), mortality	No significant mortality difference (SAMU 1.5% vs CB 2.5%); CB had faster response; USA teams handled more severe trauma
Fukuda et al., 2018	Japan	Nationwide registry- based cohort	4382 traumatic OHCA from traffic collisions	Physician ALS vs EMS ALS vs BLS	1-month survival; ROSC; neurologic outcome	Physician-ALS doubled survival vs EMS-ALS; no benefit of EMS- ALS vs BLS

Franschman et al., 2012	Netherlands	Retrospective multicentre cohort (2003–2007)	497 severe TBI patients (GCS < 9)	Paramedic EMS vs Physician-based EMS (P-HEMS)	Prehospital run-time; intubation; observed mortality; 6-month GOS	P-HEMS greatly increased prehospital intubation (88% vs 35%); mortality similar (38% vs 44%); neurological outcome significantly better in P-HEMS group.
Endo A. et al. (2021)	Japan	Retrospective registry-based cohort with propensity score matching.	30,551 adult patients with severe blunt trauma (ISS ≥ 16) transported directly from the scene.	Physician-led prehospital management vs paramedic-led EMS care.	In-hospital mortality.	Physician-led prehospital management was associated with reduced in-hospital mortality compared with paramedic-led care (PS-matched OR 0.88, 95% CI 0.78–1.00; overall adjusted OR 0.85, 95% CI 0.74–0.97), with greater benefit in younger patients, those with ISS ≥ 25 , pelvic/lower limb severe injuries, and prehospital time <60 minutes.
Nabeta M. et al. (2021)	Japan – Kurume University Hospital EMS system	Retrospective cohort with propensity score matching	317 adult severe trauma patients (ISS ≥ 16) transported directly from scene	Physician-staffed HEMS vs paramedic-staffed GEMS	24-hour mortality; in-hospital mortality	No significant mortality difference between HEMS and GEMS across multiple PS-adjusted analyses (e.g., PS-matched OR 1.547, 95% CI 0.530–4.514). HEMS used for more distant scenes but achieved similar mortality despite longer transport times.
Den Hartog D. et al. (2015)	Netherlands — National EMS + physician-staffed HEMS	Retrospective cohort (2000–2013)	2,176 severely injured trauma patients (ISS >15)	Physician-staffed HEMS vs paramedic-staffed EMS	30-day mortality	Physician-staffed HEMS associated with significant survival benefit: +36 lives saved (5.33 per 100 dispatches) when adjusting for confounders
Borowicz A. et al. (2021)	Poland – Regional EMS	Retrospective cohort	717 STEMI patients transported	Physician-staffed ambulances vs	In-hospital mortality;	No difference in in-hospital mortality between

	(Silesian Voivodeship)		by EMS (2013–2016)	Paramedic/nurse-only ambulances	EMS delay intervals	crew types; physician presence not associated with survival benefit
Gunnarsson S.I. et al. (2017)	USA – Wisconsin/Mayo HEMS	Retrospective cohort	398 STEMI patients transferred by HEMS	Physician-staffed HEMS vs non-physician-staffed HEMS	In-hospital mortality; adverse in-hospital events	No significant difference in mortality (4.9% vs 9.9%); non-physician HEMS had higher adjusted risk of serious adverse in-hospital events (OR 2.91)
Akutsu T. et al. (2025)	Japan – Nationwide JTDB trauma registry	Retrospective cohort with propensity score matching	16,181 trauma patients (ISS >15); 3,508 matched pairs	Physician-staffed ground ambulance vs physician-staffed air ambulance	In-hospital mortality; prehospital timelines; interventions	Air ambulance associated with significantly lower in-hospital mortality (23.0% vs 25.4%; OR 0.88); GA patients received more prehospital procedures; AA had longer prehospital times but higher surgical intervention rates
Sato Y. et al. (2019)	Japan – JTDB national trauma registry	Retrospective cohort	Adult trauma patients with ISS ≥16	Physician–nurse HEMS vs non-physician ground EMS	Survival to hospital discharge	Physician-staffed HEMS associated with improved adjusted survival vs ground EMS; benefit persists after adjustment for injury severity and prehospital interventions
Abe T. et al. (2014)	Japan – Nationwide JTDB	Prospective multicenter observational	24,293 trauma patients (ISS >15)	Physician–nurse HEMS vs EMT–firefighter GEMS	Survival to hospital discharge	After adjustment and propensity matching, HEMS transport associated with significantly higher odds of survival (OR 1.23–1.45)
Enomoto Y. et al. (2020)	Japan – JTDB nationwide pediatric trauma registry	Retrospective cohort with SMR-weighted marginal structural model	5,947 pediatric trauma patients (<18 years) transported from scene (453 HEMS; 5,494 GEMS)	Physician-staffed HEMS vs non-physician ground EMS	In-hospital mortality	After adjustment, HEMS transport was not associated with reduced mortality (OR 0.82, 95% CI 0.42–1.58)

Maddock A. et al. (2020)	Scotland – National STAG registry	Retrospective registry-based cohort (2011–2016)	14,280 adult trauma patients with documented prehospital care (776 PHCCT; 13,504 standard EMS)	Physician-led prehospital critical care team (PHCCT: consultant + critical care nurse/paramedic) vs standard paramedic/EMT crews	30-day mortality	PHCCT care associated with significantly lower adjusted odds of 30-day mortality (OR 0.56, 95% CI 0.36–0.86) despite higher injury severity and complexity in PHCCT cohort
Moors X.R.J. et al. (2019)	Netherlands – National Trauma Registry (Level 1 trauma center catchment)	Retrospective cohort	308 severely injured pediatric trauma patients (ISS >15) (196 physician-based HEMS; 112 EMS only)	Physician-staffed HEMS (anesthesiologist/trauma surgeon + specialized nurse) vs paramedic EMS	30-day mortality	Custom regression model estimated 2.5 additional lives saved per 100 physician-based HEMS dispatches for severely injured pediatric patients
Osterwalder J.J. et al. (2003)	Switzerland – Level I trauma center	Prospective observational cohort	267 blunt polytrauma patients (ISS ≥8) directly admitted to trauma center	EMT-only crews (n=71) vs Emergency Physician + EMT/PM crews (n=196)	30-day mortality; actual vs ASCOT-predicted mortality	EMT group had higher-than-expected mortality (+34% vs predicted) while EP group had slightly lower-than-predicted mortality (–6%); adjusted analysis showed significantly higher mortality odds for EMT-only care (OR 37; 95% CI 2–749)
Ono Y. et al. (2021)	Japan – Community emergency department	Retrospective cohort with propensity score matching	1,020 injured patients requiring emergency surgery or TAE (295 matched pairs)	Emergency physician-staffed ambulance vs ELST-staffed ambulance	Prehospital LOS; ED LOS; time to definitive intervention; in-hospital mortality	EP involvement increased prehospital LOS and delayed definitive intervention; no mortality difference after matching (8.8% vs 9.8%); EP dispatch slightly reduced ED LOS
Smith C.A. et al. (2019)	UK – North East England (GNAAS + NEAS)	Retrospective registry cohort (TARN data, 2014–2017)	1,733 severe trauma patients (ISS ≥9); 531 ECT vs 1,202 non-ECT	Enhanced Care Team (prehospital doctor + critical care paramedic) vs paramedic-only EMS	30-day mortality (Ws statistic); morbidity (GOS)	ECT associated with significantly higher risk-adjusted survival (Ws +3.22 vs –2.97), equivalent to +3.22 survivors per 100 major trauma cases; no

						morbidity deterioration
Tsuboi M. et al. (2024)	Japan – Nationwide (JTDB)	Retrospective cohort	49,144 adult trauma patients (ISS \geq 16) transported from scene	Physician-staffed “doctor car” vs non-physician GEMS	In-hospital survival (adjusted OR)	Doctor car use associated with significantly higher adjusted survival (aOR 1.228; 95% CI 1.065–1.415); benefit strongest in high-volume trauma centers (HV \geq 50 pts/year; aOR 1.288)
Harrison J. et al. (2025)	USA – ESO national EMS database linked to Level I–II trauma centers	Retrospective propensity-matched cohort (2018–2022)	32,493 trauma encounters (30,735 ALS; 1,758 BLS); 1,154 matched pairs	Advanced Life Support (AEMT/Paramedic) vs Basic Life Support (EMR/EMT)	Combined ED + in-hospital mortality	ALS transport associated with significantly lower mortality (OR 0.40; 95% CI 0.18–0.88); benefit consistent in age >50 and high-risk mechanism; effect borderline in prolonged prehospital time
Hirano Y. et al. (2018)	Japan – Japan Trauma Data Bank	Nationwide retrospective cohort (2004–2015)	30,283 severe trauma patients (ISS \geq 16), physician group n=1,222; paramedic group n=29,061	Physician-staffed ambulance vs paramedic-only ambulance	Survival to ED discharge; survival to hospital discharge	No significant difference after adjustment (aOR 1.16; 95% CI 0.97–1.40); physician group had longer prehospital and CT times but earlier blood transfusion
Kashyap R. et al. (2016)	India – EMS trauma system	Prospective observational study	Adult severe trauma patients (ISS >15)	Physician-staffed ALS vs paramedic-only ALS	Mortality during hospital stay	Prehospital physician involvement associated with significantly lower mortality and improved ISS-adjusted survival compared with paramedic-only care

Table 2. Excluded studies.

Author(s) (Year)	Title	Country / Setting	Study Design	Population / Sample	EMS Crew Composition	Primary Outcome	Reason for Exclusion
Mann C.J., Guly H. (1997)	Paramedic interventions increase the rate of return of	United Kingdom – Ground EMS.	Retrospective study (1993–1995).	276 out-of-hospital cardiac arrests.	Technicians vs Paramedics.	Return of spontaneous circulation (ROSC), survival to discharge.	Published before 2000; data collected 1993–1995 (outside

	spontaneous circulation in out-of-hospital cardiac arrests						inclusion period).
Morgan O., Yarham E., Hudson A., Cole E. (2020)	Do pre-hospital physicians improve mortality in major trauma patients? A systematic review	Multinational (studies from Europe, Asia, and Australia).	Systematic review (PRISMA-guided, PROSPERO CRD42018087980).	14 studies, total 42,479 trauma patients.	Physicians vs Non-medical prehospital practitioners (paramedics, nurses, EMTs).	Mortality (in-hospital, early trauma mortality).	Systematic review / secondary source; not an original primary study.
Sullivent E.E., Faul M., Wald M.M. (2011)	Reduced mortality in injured adults transported by helicopter emergency medical services	United States – trauma centers (NTDB 2007).	Retrospective cohort (registry-based).	56,744 adult trauma patients transported by ground or air.	Not specified (comparison based on transport mode only).	In-hospital mortality.	Study compares transport mode (HEMS vs ground), not EMS crew composition.
Tsuchiya A., Tsutsumi Y., Yasunaga H. (2016)	Outcomes after helicopter versus ground emergency medical services for major trauma – propensity score and instrumental variable analyses: a retrospective nationwide cohort study	Japan – National Trauma Data Bank (2004–2014).	Retrospective nationwide cohort.	21,286 adult trauma patients (ISS ≥16).	Not specified (comparison based on transport mode only).	In-hospital mortality.	Comparison of transport mode (HEMS vs GEMS), not EMS crew composition.
Valentin G., Jensen L.G. (2019)	What is the impact of physicians in prehospital treatment for patients in need of acute critical	Multinational (overview of 10 systematic reviews, 217 studies).	Overview of systematic reviews (umbrella review).	Not applicable (secondary synthesis).	Physician-based vs non-physician-based prehospital care.	Mortality, survival, intubation success.	Overview of reviews (secondary synthesis), not a primary study.

	care? – An overview of reviews						
van Lieshout E.J., Binneka de J., Reussien E., et al. (2016)	Nurses versus physician-led interhospital critical care transport: a randomized non-inferiority trial	Netherlands – Interhospital mobile ICU (secondary transport).	Randomized controlled non-inferiority trial.	298 ventilated critical-care patients transferred between hospitals.	Nurse + paramedic vs nurse + physician.	Critical events during transport (no mortality data).	Interhospital (intra-hospital) transport setting; not prehospital EMS.
Nguyen-Van Tam J.S., Dove A.F., Bradley M.P., Pearson J.C.G., Durston P., Madeley R.J. (1997)	Effectiveness of ambulance paramedics versus ambulance technicians in managing out-of-hospital cardiac arrest	United Kingdom – Nottinghamshire EMS.	Retrospective cohort (1992–1994).	508 OHCA patients.	Paramedic crew vs technician crew.	ROSC, hospital admission, survival to discharge.	Study period 1992–1994 (before inclusion timeframe ≥ 2000).
van Schuppen H., Bierens J. (2015)	Understanding the prehospital physician controversy. Step 2: analysis of on-scene treatment by ambulance nurses and helicopter emergency medical service physicians	Netherlands – HEMS vs ambulance prehospital care,	Prospective observational .	78 patients managed by HEMS physicians and ambulance nurses.	Physician (HEMS) vs nurse (ambulance).	Frequency of physician-specific procedures and perceived usefulness (no mortality data).	No mortality or survival outcome; confounded by transport mode (HEMS vs ground EMS)
Yasunaga H., Horiguchi H., Tanabe S., Akahane M., Ogawa T., Koike S.,	Collaborative effects of bystander-initiated CPR and prehospital advanced cardiac life support by physicians	Japan – Nationwide EMS registry (2005–2007).	Retrospective registry-based analysis.	95,072 bystander-witnessed OHCA patients.	Physician-staffed vs non-physician EMS (with/without bystander CPR).	1-month survival and neurological outcome.	Population limited to out-of-hospital cardiac arrest; outcome confounded by bystander CPR; not focused on trauma or

Imamura T. (2010)	on survival of out-of-hospital cardiac arrest: a nationwide population-based observational study						prehospital mortality.
Yeguiayan J.-M. et al. (2011)	Medical pre-hospital management reduces mortality in severe blunt trauma: a prospective epidemiological study	France – National EMS (SAMU/SMUR vs Fire Brigades).	Prospective multicenter cohort (FIRST Study).	2,703 severe blunt trauma patients admitted to ICU.	Physician-staffed SMUR vs Fire Brigade (BLS only).	30-day mortality.	Comparison involves EMS vs non-EMS (fire brigade), not different EMS crew configurations; unbalanced sample (93% vs 7%).
Samdal M., Thorsen K., Græsli O., Sandberg M., Rehn M. (2021)	Dispatch accuracy of physician-staffed emergency medical services in trauma care in south-east Norway: a retrospective observational study	Norway – national trauma registry, south-east region.	Retrospective registry-based observational study.	19,028 trauma incidents (2,506 with P-EMS involvement).	Physician-staffed (HEMS, SAR, RRC) vs ground EMS.	Dispatch accuracy (undertriage / overtriage rates).	Excluded: outcome unrelated to mortality; focus on dispatch accuracy and system organization rather than clinical outcomes.
Frandsen F., Nielsen J.R., Gram L., et al. (1991)	Evaluation of Intensified Prehospital Treatment in Out-of-Hospital Cardiac Arrest: The Odense Ambulance Study	Denmark – Odense municipal EMS	Prospective (Phase II–III) and retrospective (Phase I) observational study	393 OHCA patients (1986–1989)	Basic EMS vs Intermediate EMS vs Advanced EMS (physician-staffed)	Survival to discharge, cerebral prognosis	Excluded: published before 2000; outside inclusion timeframe; historical EMS models
Schultz B.V., Doan T.N., Bosley	Prehospital study of survival outcomes from out-	Australia – Queensland Ambulance Service	Retrospective cohort (2013–2017)	287 paramedic-witnessed OHCA in	Paramedics only (no comparison between different	Survival to event and survival to discharge	Excluded: OHCA-only population; no EMS crew

E., Rogers B., Rashford S. (2020)	of-hospital cardiac arrest in ST-elevation myocardial infarction (PRAISE study)			STEMI patients	EMS crew configurations)		composition comparison; outcome unrelated to prehospital crew configuration
Lapidus O., Rubenson Wahlin R., Bäckström D. (2023)	Trauma patient transport to hospital using helicopter emergency medical services or road ambulance in Sweden: a comparison of survival and prehospital time intervals	Sweden – National Trauma Registry (SweTrau)	Retrospective observational cohort (2012–2022)	74,032 trauma patients	Comparison based on transport mode (HEMS vs EMS), no analysis of crew configuration	30-day mortality, neurological outcome	Excluded: outcome associated with transport mode rather than EMS crew composition; no physician vs nurse or advanced vs basic crew comparison
Mathiesen W.T., Bjørshol C.A., Kvaløy J.T., Søreide E. (2018)	Effects of modifiable prehospital factors on survival after out-of-hospital cardiac arrest in rural versus urban areas	Norway – Stavanger EMS	Retrospective observational cohort (2006–2015)	1138 OHCA patients (non-EMS-witnessed)	EMS physician attendance studied as present/absent, no comparison of crew configuration	Survival at hospital admission, discharge, and 1 year	Excluded: OHCA population only; outcome unrelated to crew composition; no comparison of EMS team types
Mikkelsen S., Krüger A.J., Zwisler S.T., Brøchner A.C. (2015)	Outcome following physician supervised prehospital resuscitation: a retrospective study	Denmark – MECU (Mobile Emergency Care Unit)	Retrospective descriptive study (2006–2012)	701 “life-saving missions” among 25,647 EMS contacts	Only physician-staffed MECU evaluated; no comparator crew	Survival to discharge, sequelae	Excluded: no comparison between different EMS crew configurations; outcome limited to physician life-saving interventions.
Hamilton A., Steinmetz J.,	Association between prehospital	Denmark – Nationwide EMS	Retrospective registry-based cohort (2005–2012)	21,165 OHCA patients	Physician involvement yes/no; no comparison	30-day survival, ROSC, 1-year survival	Excluded: OHCA-only population; exposure =

Wissenberg M., et al. (2016)	physician involvement and survival after out-of-hospital cardiac arrest: A Danish nationwide observational study				of EMS crew configurations		physician involvement (not crew configuration); outcome unrelated to EMS team composition
Haner A., Örnings P., Khorram-Manesh A. (2015)	The role of physician-staffed ambulances: the outcome of a pilot study	Sweden – Gothenburg EMS	Retrospective descriptive study (2013)	1381 physician-staffed ambulance missions	Descriptive evaluation of physician-staffed ambulance; no comparator crew	Number/type of missions; interventions performed	Excluded: descriptive pilot study; no mortality outcomes; no comparison between EMS crew configurations.
Jouffroy R., Saade A., Philippe P., Carli P., Vivien B. (2019)	Impact of Prehospital Mobile Intensive Care Unit Intervention on Mortality of Patients with Sepsis	France – SAMU (prehospital EMS)	Retrospective cohort (2011)	140 suspected sepsis patients	MICU (physician + nurse) vs EMT (non-physician)	28-day mortality	Excluded: population limited to sepsis; outcome not prehospital; comparison not aligned with EMS crew configuration for general prehospital mortality.
Kirves H., Handolin L., Niemelä M., Pitkaniemi J., Randell T. (2010)	Paramedics' and pre-hospital physicians' assessments of anatomic injury in trauma patients: a cohort study	Finland – Helsinki EMS	Retrospective observational cohort (12 months)	422 trauma patients met by trauma team	Physician-staffed vs paramedic-only units	Diagnostic accuracy (PPV, NPV, Kappa agreement)	Excluded: no mortality outcome; comparison limited to diagnostic accuracy rather than survival; not aligned with Q1 concept.
Garner A.A., Lee A., Weatherall A., Langcake M., Balogh Z. (2016)	Physician-staffed helicopter emergency medical service case identification – a before and	Australia – NSW Ambulance / P-HEMS	Before/after registry-based system evaluation	197 severely injured children (ISS >15) across two dispatch periods	Physician teams vs paramedic teams, but comparison based on dispatch system , not crew	Case identification rate; time to Paediatric Trauma Centre	Excluded: no mortality outcome; study evaluates dispatch system, not EMS crew composition

	after study in children				configuration		
Garner A.A., Lee A., Weatherall A. (2012)	Physician staffed helicopter emergency medical service dispatch via centralised control or directly by crew – case identification rates and effect on the Sydney paediatric trauma system	Australia – Sydney HEMS	Retrospective registry-based before/after system evaluation	99 paediatric trauma patients (ISS >15)	Exposure = dispatch system (HEMS crew vs RLTC), not crew composition	Case identification rate; time to PTC	Excluded: organisational dispatch comparison; no mortality outcome; no comparison of EMS crew configurations.
Frischknicht Christensen E., Berlac P.A., Nielsen H., Christensen C.F. (2016)	Diagnosis and mortality in prehospital emergency patients transported to hospital	Denmark – Regional EMS (Aarhus/Denmark)	Retrospective cohort (2011–2013)	148,757 prehospital emergency patients	Not stratified; physician-staffed MECU, paramedic units and ambulances all mixed; no comparison of crew configurations	1-day and 30-day mortality (by diagnosis category only)	Excluded: no comparison of EMS crew configurations; mortality reported by diagnosis rather than team type; population too broad and heterogeneous.
Falk A.C., Alm A., Lindström V. (2014)	Has increased nursing competence in the ambulance services impacted on pre-hospital assessment and interventions in severe traumatic brain-injured patients?	Sweden – Stockholm EMS	Retrospective pre/post observational (2000–2009)	651 severe TBI patients (GCS < 8)	Pre–2005: EMT+EMT ; Post–2005: EMT+RN (not concurrently compared)	In-hospital mortality; ICU length of stay	Excluded: pre/post design; no direct comparison between EMS crew configurations; outcome not focused on prehospital mortality.

von Vopelius-Feldt J., Coulter A., Benger J. (2015)	The impact of a pre-hospital critical care team on survival from OHCA	UK – Southwest England EMS	Retrospective cohort (2011–2013)	1851 non-traumatic OHCA	ALS paramedics vs ALS + Critical Care Team (no comparison between different EMS crew types)	Survival to hospital discharge	Excluded: OHCA-only; exposure = CCT addition (not crew configuration); outcome not aligned with Q1
Wolthers S.A., Blomberg S.N.F., Breindahl N., et al. (2023)	Association between using a prehospital assessment unit and hospital admission and mortality	Denmark – Region Zealand	Matched cohort (2021–2022)	10,849 low-acuity EMS patients	PAU (single paramedic) vs standard ambulance; no comparison between EMS crew types	48h hospital admission; 30-day mortality	Excluded: low-acuity population; exposure not crew configuration; outcomes unrelated to prehospital mortality.
Yeguiayan J.-M. et al. (2011)	Medical pre-hospital management reduces mortality in severe blunt trauma: a prospective epidemiological study	France – National prehospital system	Multicenter prospective cohort (FIRST study).	2,703 adult patients with severe blunt trauma requiring ICU admission within 72 hours or managed by university-hospital SMUR units.	SMUR teams (emergency physician + nurse + ambulance driver) vs non-SMUR basic prehospital care by fire brigades (BLS only).	30-day mortality (secondary: 72-hour mortality).	Comparison between physician-staffed EMS (SMUR) and non-medical fire brigade responders rather than between different EMS crew configurations; groups markedly unbalanced (≈93% vs 7%); not fully aligned with the review focus on mortality by EMS team composition.
Nagawa H. et al. (2023)	Outcomes of prehospital traumatic cardiac arrest managed by HEMS personnel in Japan	Japan – Nationwide HEMS registry (JSAS-R)	Retrospective cohort (2015–2020)	722 traumatic cardiac arrest patients managed by HEMS	Single model: HEMS physician + nurse; no comparison with other EMS crew types	28-day mortality; ROSC	No comparison between different EMS team compositions; TCA-only population; stratification based on arrest timing rather than

							crew configuration.
Breindahl N. et al. (2024)	Prehospital drowning resuscitation performed by the Danish Helicopter Emergency Medical Service	Denmark — National HEMS	Retrospective registry-based cohort	Drowning patients treated by Danish HEMS (2016–2021)	Single model: physician–nurse HEMS crew; no comparison between EMS crew types	30-day mortality	Population limited to drowning; no comparison of EMS crew configuration; not aligned with the review’s focus on mortality by EMS team composition
Saviluoto A. et al. (2025)	Association of mortality and physician experience in prehospital anaesthesia: a registry study on new physicians in Finnish HEMS	Finland — National HEMS system	Registry-based observational study	1,638 patients undergoing prehospital anaesthesia by new HEMS physicians	Single crew type: physician-led HEMS; exposure = cumulative physician experience (no crew comparison)	30-day mortality	No comparison of EMS crew configurations; exposure is physician experience only; not aligned with the review’s focus on team composition driving mortality
Olasveengen T.M. et al. (2009)	Out-of-hospital advanced life support with or without a physician: Effects on quality of CPR and outcome	Norway – Oslo EMS system	Prospective registry-based observational cohort (2003–2008)	977 adult non-traumatic OHCA patients treated by physician-manned vs paramedic-manned ambulances	Physician-manned ambulance (anaesthesiologist + paramedics) vs paramedic-manned ambulances	Survival to hospital discharge; ROSC; ICU admission; neurological outcome (CPC)	Population limited to out-of-hospital cardiac arrest; outcomes focused on ROSC/survival after OHCA rather than general prehospital/trauma mortality; not aligned with the review question on EMS crew composition and prehospital mortality in broader

							emergency populations
Roberts K. et al. (2009)	Influence of air ambulance doctors on on-scene times, clinical interventions, decision-making and independent paramedic practice	United Kingdom – West Midlands HEMS (WNAA and CAA)	Prospective observational comparison over 18 months	5,275 HEMS activations (mixed trauma, medical and leisure emergencies) attended by doctor-paramedic vs paramedic-only air ambulance crews	Doctor-paramedic HEMS crew vs paramedic-only HEMS crews, with occasional support from land-based prehospital doctors	On-scene time; use of RSI and invasive procedures; decisions to discharge at scene or declare death	No mortality or survival outcome reported; study focuses on on-scene time, procedures and decision-making rather than prehospital mortality by EMS crew configuration; not aligned with Q1 concept
Björkman J. et al. (2021)	Impact of HEMS involvement on traumatic brain injury management in a physician-based EMS system	Finland — Physician-based HEMS and EMS	Retrospective cohort study	Adult traumatic brain injury patients transported by EMS or HEMS	Single physician-based HEMS model; no comparison between EMS crew types	ICU admission, interventions, neurosurgical care (mortality not linked to crew)	No analysis of EMS crew configuration; no mortality comparison by team type; focus on TBI management pathways
Ackermann N. et al. (2024)	A scenario-based approach to optimizing cost-effectiveness of physician-staffed HEMS compared to ground EMS in Finland	Finland – National EMS/HEMS	Scenario-based economic model	Hypothetical mixed EMS population	Not applicable (no actual crew comparison; model-based)	Cost-effectiveness	No primary clinical data; no comparison of EMS crew configurations; modeling study only
Chocron R. et al. (2018)	Impact of on-scene physician presence during out-of-hospital cardiac arrest	France – SAMU/Fire Brigade	Retrospective cohort	Out-of-hospital cardiac arrest	Single physician response model; no comparison of EMS crew types	ROSC; survival	OHCA-only population; no analysis of EMS crew configuration; mortality not

							evaluated by team type
Floer M. et al. (2021)	Out-of-hospital sepsis recognition by paramedics improves the course of disease and mortality	Germany – Northheim EMS	Retrospective cohort	263 sepsis patients transported by EMS	Single paramedic-based EMS model; no crew comparison	In-hospital mortality	No comparison of EMS team configurations; mortality relates to diagnostic accuracy rather than crew type
Funder K.S. et al. (2016)	Prehospital physician involvement in emergency medical services in Denmark	Denmark – National EMS	Retrospective registry study	Prehospital emergency patients attended by EMS and physician response units	Single physician-response model; no comparison between EMS crew types	Rate of physician involvement; interventions	No mortality data; no analysis of EMS crew configuration; outcomes unrelated to team composition
Andrusz kow H. et al. (2013)	Survival benefit of helicopter emergency medical services compared to ground emergency medical services in traumatized patients	Germany – National trauma registry	Retrospective cohort	13,220 trauma patients (ISS ≥ 9)	Both HEMS and GEMS physician-staffed; no comparison of crew types	In-hospital mortality	No EMS crew configuration analysis; comparison limited to transport mode (helicopter vs ground)
Abe T. et al. (2019)	Factors associated with prehospital medical interventions provided by physicians among non-trauma patients	Japan – Single physician-staffed car system	Retrospective observational	1,058 non-trauma patients examined by physician-staffed prehospital unit	Single physician-nurse crew; no comparison between EMS team types	Physician-only interventions (POIs)	No mortality data; no analysis of EMS crew configuration; outcomes unrelated to team composition
Cassan S. et al. (2019)	Early inter-hospital transfer of myocardial infarction patients without a	France – RESURCOR network	Retrospective observational	591 intermediate-risk ACS patients transferred between hospitals	Transfers performed by ambulance drivers only; no comparison of EMS crew types	Death within 48 h; need for urgent repeat PCI	Inter-hospital transfer model; no EMS crew configuration analysis; mortality not

	doctor, paramedic or nurse on board						compared by team type
Bieler D. et al. (2017)	Does the presence of an emergency physician influence pre-hospital time, interventions and mortality of severely injured patients?	Germany – TraumaRegister DGU	Retrospective matched-pair analysis	2,470 trauma patients (ISS \geq 16)	Mixed system: physician vs non-physician presence at scene; no EMS crew model comparison	24-h and in-hospital mortality	Not a comparison of EMS crew configurations; mixed on-scene physician presence only; no prehospital mortality analysis
Ishikura K. et al. (2021)	The evaluation of helicopter emergency medical services with a physician for acute myocardial infarction in Japan	Japan – JHEMS national registry	Retrospective registry-based cohort	1,399 AMI patients (605 HEMS; 794 GEMS)	Physician-staffed HEMS vs non-physician GEMS	Time to angiography; ROSC; prognosis	AMI population; focus on time-to-PCI metrics; mortality not evaluated as EMS crew configuration effect; outside Q1 trauma/EMS mortality scope
Ohbe H. et al. (2019)	Physician-manned prehospital emergency care in tertiary emergency centers in Japan	Japan – National inpatient database	Retrospective nationwide descriptive study	497,911 EMS-transported emergency patients (mixed medical/trauma)	Physician-manned EMS vs non-physician EMS	In-hospital mortality; incidence rates	Epidemiologic description; no comparative mortality analysis by crew type; mixed non-trauma population; not aligned with Q1 scope
Roudsari B.S. et al. (2007)	International comparison of prehospital trauma care systems	Nine countries (ALS vs Doc-ALS systems)	Multicenter international registry-based comparison	15–55 y/o trauma patients, ISS $>$ 15, directly transported from scene	System-level ALS vs Doc-ALS (no patient-level crew analysis)	ED shock; early trauma fatality	Ecological/system-level comparison; no crew-type analysis; not aligned with Q1 prehospital crew composition

							and mortality
Ackermann A. et al. (2024)	The Estimated Cost-Effectiveness of Physician-Staffed HEMS Compared to Ground-Based EMS in Finland	Finland – National HEMS	Health economic modelling study	Model-based estimates; no clinical patient cohort	Not applicable (model-based comparison ; no real EMS crews compared)	Incremental cost-effectiveness (ICER), modelled 30-day mortality	No patient-level mortality data; no crew configuration analysis; modelling-only study, not aligned with Q1
Goto Y. et al. (2019)	Impact of physician-led CPR on neurologically intact survival after OHCA	Japan – National Utstein Registry	Nationwide observational cohort	613,251 OHCA patients (2011–2015)	Physician-led CPR vs paramedic-led CPR	1-month neurologically intact survival (CPC 1–2)	Non-trauma population (OHCA); outcome not aligned with Q1 trauma-related prehospital mortality
Knapp J. et al. (2019)	Influence of prehospital physician presence on survival after severe trauma: Systematic review and meta-analysis	International	Systematic review & meta-analysis	22 included primary studies	Physician-staffed EMS vs paramedic EMS	Mortality	Secondary research (not a primary study); excluded per protocol
van Lieshout E.J. et al. (2016)	Nurses versus physician-led interhospital critical care transport: a randomized non-inferiority trial	Netherlands – interhospital ICU transfers	Randomized non-inferiority trial	298 critically ill ICU patients (not trauma)	Nurse+paramedic vs nurse+physician	Critical events during transport	Not trauma; interhospital transport; no mortality outcome → outside Q1 scope