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The Impact of Ambulance Crew Communication on Patient Safety and Prehospital Care Quality: A Systematic Review

تأثير اتصالات طاقم الإسعاف على سلامة المرضى وجودة الرعاية قبل دخول المستشفى: مراجعة منهجية

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Abstract

Background

Ambulance care depends on rapid and accurate information exchange within crews, between field teams and dispatchers, and at the interface with emergency departments (EDs). Incomplete verbal reports, interruptions, uncertain leadership, inconsistent communication formats, and delayed pre-alerts may undermine situational awareness and continuity of care. Although communication improvement is widely recommended, its effect on measured patient safety and prehospital quality requires careful differentiation between communication-process outcomes and patient outcomes.

Objective

To critically synthesize original research published from 2019 through 2025 on ambulance crew communication, examining information completeness, teamwork, clinical handover, patient safety indicators, and timeliness or quality of prehospital care.

Methods

A structured, PICOS-informed literature synthesis was developed from traceable primary articles identified through targeted checks of PubMed-indexed records and original journal publications. Seventeen relevant primary reports were organized into crew teamwork, ambulance-to-ED handover, dispatch and pre-arrival alerts, and communication-supported care pathways. A narrative approach was used because study designs, settings, interventions, and outcomes varied markedly. The 17 reports form a verified, curated evidence set rather than the documented yield of a fully audited database search. Therefore, unverified PRISMA record counts and formal risk-of-bias ratings are not presented.

Results

Structured communication approaches improved several immediate handover measures. In a Canadian trauma-centre implementation study, IMIST-AMBO was used in 80 of 140 reviewed handovers (57%), and mean handover duration was shorter than during the preimplementation comparison (1 min 58 s versus 2 min 47 s). A German ISOBAR implementation trial involving 651 handovers found significantly better key-information transfer and an increase in information retained by receiving physicians and nurses. In a 2025 United States quality-improvement evaluation, team-based EMS handoff was associated with a 55-minute shorter mean interval to patient disposition, but not a significant difference in ED departure time. Qualitative and survey studies from Iceland, Norway, the United Kingdom, and Saudi Arabia identified interruptions, mismatched expectations, role ambiguity, and limited training as recurrent problems. Direct reductions in medication errors, mortality, or other adverse events were seldom demonstrated.

Conclusion

Ambulance communication is a plausible and modifiable component of safe, high-quality prehospital care. The strongest available evidence supports improvements in information transfer, team coordination, and selected care-process times rather than a universal proven reduction in patient harm. Shared structured reports, protected listening time, explicit transfer of responsibility, reciprocal confirmation, and context-sensitive training should be implemented with objective safety monitoring.

Keywords: Ambulance crew; Prehospital emergency care; Emergency medical services; Communication; Patient safety; Clinical handover; Teamwork; ISBAR; ISOBAR; IMIST-AMBO; Pre-alert; Quality of care; Systematic review.

الملخص

الخلفية

تعتمد الرعاية الإسعافية على التبادل السريع والدقيق للمعلومات داخل فرق الإسعاف، وبين الفرق الميدانية ومراكز توجيه وإرسال الإسعاف، وكذلك عند نقطة التواصل مع أقسام الطوارئ في المستشفيات. وقد يؤدي عدم اكتمال التقارير الشفهية، والمقاطعات أثناء التواصل، وعدم وضوح القيادة، وعدم اتساق نماذج الاتصال، وتأخر التنبيهات المسبقة إلى إضعاف الوعي بالموقف واستمرارية الرعاية. وعلى الرغم من التوصية الواسعة بتحسين التواصل، فإن تقييم أثره في مؤشرات سلامة المرضى وجودة الرعاية قبل الوصول إلى المستشفى يتطلب التمييز بدقة بين نتائج تحسين عمليات التواصل والنتائج المتعلقة بالمرضى أنفسهم.

الهدف

إجراء توليف نقدي للدراسات البحثية الأصلية المنشورة خلال الفترة من 2019 إلى 2025 بشأن التواصل بين أفراد فرق الإسعاف، مع دراسة اكتمال المعلومات، والعمل الجماعي، وتسليم الحالات السريرية، ومؤشرات سلامة المرضى، ومدى سرعة الرعاية المقدمة قبل الوصول إلى المستشفى وجودتها.

المنهجية

أُعدّت مراجعة منظمة للأدبيات مسترشدة بإطارPICOS ، استناداً إلى مقالات بحثية أصلية قابلة للتحقق، جرى تحديدها من خلال عمليات بحث واستقصاء موجهة في السجلات المفهرسة ضمن قاعدة بيانات PubMed والمنشورات الأصلية للمجلات العلمية. ونُظّمت سبعة عشر تقريراً بحثياً أولياً ذا صلة ضمن أربعة محاور، هي: العمل الجماعي داخل فرق الإسعاف، وتسليم الحالات من سيارات الإسعاف إلى أقسام الطوارئ، والتوجيه والتنبيهات السابقة لوصول المرضى، ومسارات الرعاية المدعومة بالتواصل. واعتمدت الدراسة أسلوب التوليف السردي نظراً للتباين الكبير بين الدراسات من حيث التصاميم والبيئات والتدخلات والنتائج. وتمثل التقارير السبعة عشر مجموعة أدلة منتقاة وموثقة وقابلة للتحقق، وليست حصيلة موثقة لعملية بحث شاملة ومدققة بالكامل في قواعد البيانات. وبناءً على ذلك، لم تُعرض أعداد سجلات غير متحقق منها وفق مخططPRISMA ، كما لم تُقدّم تقييمات رسمية لمخاطر التحيز.

النتائج

أظهرت أساليب التواصل المنظمة تحسناً في عدد من المؤشرات المباشرة المتعلقة بتسليم الحالات. ففي دراسة تطبيقية أُجريت في أحد مراكز الإصابات بكندا، استُخدم نموذج IMIST-AMBO في 80 حالة من أصل 140 عملية تسليم جرى استعراضها (57%)، وكان متوسط مدة تسليم الحالة أقصر مقارنة بفترة ما قبل تطبيق النموذج (دقيقة واحدة و58 ثانية مقابل دقيقتين و47 ثانية). وفي تجربة لتطبيق نموذج ISOBAR في ألمانيا، شملت 651 عملية تسليم للحالات، تبيّن وجود تحسن ذي دلالة إحصائية في نقل المعلومات الأساسية، إلى جانب زيادة كمية المعلومات التي احتفظ بها الأطباء والممرضون المستقبِلون للحالات. وفي تقييم لتحسين الجودة أُجري في الولايات المتحدة عام 2025، ارتبط تطبيق نموذج تسليم الحالات الإسعافية القائم على العمل الجماعي بانخفاض متوسط الفترة الزمنية اللازمة لاتخاذ قرار بشأن مصير المريض بمقدار 55 دقيقة، دون تسجيل فرق ذي دلالة إحصائية في وقت مغادرة المريض لقسم الطوارئ. كما كشفت الدراسات النوعية ودراسات المسح التي أُجريت في آيسلندا والنرويج والمملكة المتحدة والمملكة العربية السعودية عن تكرار عدد من المشكلات، من أبرزها المقاطعات أثناء التواصل، وتباين التوقعات، وغموض الأدوار، ومحدودية التدريب. وفي المقابل، نادراً ما أثبتت الدراسات وجود انخفاض مباشر في الأخطاء الدوائية أو معدلات الوفيات أو غيرها من الأحداث الضارة.

الاستنتاج

يمثل التواصل بين أفراد فرق الإسعاف عنصراً قابلاً للتعديل، ومن المرجح أن يسهم في تعزيز سلامة الرعاية المقدمة قبل الوصول إلى المستشفى وتحسين جودتها. وتدعم أقوى الأدلة المتاحة حدوث تحسن في نقل المعلومات والتنسيق بين أعضاء الفرق وبعض المؤشرات الزمنية المتعلقة بعمليات تقديم الرعاية، أكثر مما تثبت وجود انخفاض شامل ومؤكد في الأضرار التي قد تلحق بالمرضى. ويوصى بتطبيق تقارير موحدة ومنظمة، وتوفير وقت مخصص للاستماع دون مقاطعة، والتحديد الصريح لمسؤولية تسليم الحالة، واعتماد التأكيد المتبادل للمعلومات، إلى جانب التدريب المراعي لخصوصية السياقات المختلفة، مع متابعة موضوعية لمؤشرات السلامة.

الكلمات المفتاحية :فرق الإسعاف؛ الرعاية الطارئة قبل الوصول إلى المستشفى؛ خدمات الطوارئ الطبية؛ التواصل؛ سلامة المرضى؛ تسليم الحالات السريرية؛ العمل الجماعي؛ISBAR ؛ISOBAR ؛IMIST-AMBO ؛ التنبيه المسبق؛ جودة الرعاية؛ المراجعة المنهجية.

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Introduction

Prehospital emergency medical services (EMS) operate within a narrow window for assessment, stabilization, clinical decisions, treatment, and transport. During a single mission, information may move from the emergency caller to a dispatcher, from the dispatcher to the responding ambulance crew, between crew members at the scene, from paramedics to remote clinical advisers, and finally to an emergency department or specialist team. Each transition requires the receiver to understand the patient's current state, the course of deterioration or improvement, interventions already performed, and the action that is needed next. Because care is often delivered in noisy, mobile, crowded, or emotionally demanding circumstances, even experienced teams can lose clinically significant information.

Communication does more than transfer facts. It creates a shared understanding of priorities, clarifies who is leading, permits clinicians to challenge unsafe assumptions, and allows receiving teams to anticipate the resources required on arrival. Equally, an overly lengthy report can obscure urgency, and a checklist delivered without mutual attention can convey information without ensuring that it was understood. Contemporary ambulance communication research has therefore moved beyond the simple question of whether a mnemonic is used toward a broader examination of timing, hierarchy, interruptions, listening, documentation, and closed-loop confirmation (Cowan et al., 2023; Myhr et al., 2024; Nuernberger et al., 2025).

In a prospective multicentre observational study from Germany, Ehlers et al. (2021) evaluated 721 prehospital-to-ED handovers and found major deficits in structure and scope when assessed against established reporting frameworks. A Canadian video-review implementation study by Elliott et al. (2023) showed that better handover organization could be achieved with IMIST-AMBO, yet adherence was incomplete and the process remained vulnerable to distractions. The difference between knowing a standard and making it work during real patient care is a central challenge for ambulance services.

Clinical communication may also influence system efficiency. Prehospital alerts permit stroke, trauma, or cardiac teams to prepare equipment, diagnostic pathways, and clinical personnel before a patient arrives. Bladin et al. (2022) evaluated a digital cross-service communication application and reported faster transfer from ambulance stretcher and selected hospital assessment steps, although overall door-

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to-treatment times were not consistently improved. This illustrates why communication quality must be judged using endpoints at several points in the pathway, without treating every process-time reduction as evidence of better survival.

For ambulance services in Saudi Arabia, these issues have direct operational relevance. Mixed-language environments, high emergency demand, differences between basic and advanced practice, and transitions across organizational boundaries make standardized but flexible communication important. In a 2025 survey of 219 paramedics and nurses in the Eastern Province of Saudi Arabia, Al Haliq and AlShammari documented different perceptions of missed vital signs, interruptions, and the utility of ISBAR. The study supplies regionally pertinent evidence while remaining a survey of perceptions rather than a measurement of adverse patient outcomes.

Problem Statement

Clinical risk arises when prehospital personnel possess information that the next decision-maker does not receive, retain, or act upon. Vital-sign trends may be omitted when a patient seems stable; medication administration may be summarized without dose or time; allergy status may be left uncertain; and the receiving team may begin bedside procedures before listening to the report. Within the ambulance, implicit assumptions between familiar colleagues may be efficient in routine calls but problematic during unexpected deterioration or when staff have not previously worked together.

The evidence base is also difficult to interpret. Investigators measure different aspects of the same communication process: reported satisfaction, mnemonic adherence, number of interruptions, clinical details recalled, time to laboratory orders, ambulance offload time, or time to emergency treatment. Comparisons often lack patient-level adjustment or independent controls. A short report can be efficient but incomplete; a complete report can be poorly retained; and a faster handover can occur without a shorter overall ED stay. Accordingly, the problem is not merely poor communication but the limited and uneven evidence connecting communication improvements to safety and care quality.

Research Gap

1. Few studies directly connect ambulance crew communication training to objectively adjudicated medication errors, missed diagnoses, preventable deterioration, mortality, or subsequent patient-reported harm.
2. Research frequently concentrates on ambulance-to-ED handover while communication within the two-person ambulance crew, with dispatch, and with remote medical control is measured less consistently.
3. Most implementation investigations are single-centre, observational, or before-and-after studies in which workload, case mix, patient acuity, and hospital crowding can confound reported improvements.
4. Comparative studies seldom measure both fidelity to a handover tool and independent evidence that the receiver correctly understood and used the message.
5. Context-specific evidence from Saudi Arabia and comparable emergency medical systems remains limited; existing local work emphasizes professional perceptions rather than clinical safety endpoints.

Aim of the Study

To evaluate how communication among ambulance crew members and between EMS and collaborating healthcare professionals affects patient safety and the quality and continuity of prehospital emergency care, based on primary studies published between 2019 and 2025.

Research Objectives

1. Identify forms of ambulance communication examined in original studies, including crew coordination, dispatch messaging, pre-alerts, clinical consultation, and EMS-to-ED handovers.
2. Describe the main communication failures and human factors that may threaten safety, including interruptions, unclear accountability, and incomplete information.
3. Evaluate measured effects of structured handovers, training, digital communication, and team-based reporting on information transfer and clinical workflow.
4. Distinguish objective patient-level outcomes from staff perceptions and intermediate process indicators.
5. Assess the methodological strengths and limitations of the available evidence and derive practical recommendations for ambulance services, including the Saudi Red Crescent Authority.

Research Questions

1. What communication barriers and facilitators are described in contemporary ambulance and prehospital emergency care research?
2. How do structured handover formats and crew communication training influence information completeness, retention, interruptions, and teamwork?
3. Are improvements in communication associated with greater timeliness, continuity, or objectively measured patient safety?
4. What implementation conditions and evidence limitations affect transferability to ambulance services in Saudi Arabia?

Significance of the Study

Theoretical Significance

This review integrates a human-factors view of teamwork with a patient-pathway view of prehospital communication. It treats the ambulance mission as a succession of information and responsibility transfers rather than a single vehicle-based treatment episode. It also distinguishes the quality of transmitted content from its reception, clinical interpretation, and resulting action. These distinctions help explain why communication tools may improve some intermediate indicators while leaving broader outcomes unchanged.

Practical Significance

For EMS leaders, field educators, dispatch managers, trauma teams, and ED nursing leaders, the review identifies low-complexity practices that can be audited: a consistent opening statement of clinical concern, clear recording of objective vital signs and treatments, a protected interval for handover,

confirmation of the receiving clinician, and shared documentation for higher-risk cases. A balanced approach also calls for escalation when a patient deteriorates or a standard communication script would delay urgent intervention.

Rationale for the Review and PRISMA Reporting

The PRISMA 2020 statement provides reporting principles for a transparent review question, eligibility criteria, search reporting, study selection, and synthesis (Page et al., 2021). The present manuscript follows these organizational principles and uses individually traceable primary publications. However, complete database exports, reproducible date-stamped search logs, independent dual-review screening records, deduplication files, and full-text exclusion records were not available. The review therefore does not claim to have completed a fully reproducible PRISMA search or registration process, and it does not assign unsupported numerical flowchart values. A candidate search strategy is provided in Appendix A to support a future audited update.

Literature Review

Communication as a Core Non-Technical Clinical Skill

Effective ambulance teamwork depends on cognitive and interpersonal skills as well as technical competence. Crew members must announce important findings, keep a common picture of patient risk, distribute tasks, question unexpected observations, and ensure critical instructions are acknowledged. Communication that is excessively implicit can generate uncertainty in new partnerships, whereas unnecessary verbal traffic may disrupt concentration. Myhr et al. (2024), through focus groups before and after a Norwegian ambulance team-training programme, identified communication, leadership, situational monitoring, mutual support, and team structure as interconnected dimensions. Participants especially valued ISBAR for giving a predictable structure to consultation and handover, although the study did not directly measure reductions in adverse patient events.

The team process changes during the journey. At the scene, communication may focus on immediate safety, rapid assessment, and assignment of roles. During transport, the crew may need shared plans for monitoring, treatment, changes in destination, and contact with medical control. Near hospital arrival, information must be translated into a concise report that helps the receiving team continue care. A reliable system therefore requires common communication principles but adaptable content according to patient acuity and available time.

Structured EMS-to-Emergency Department Handover

Handover tools aim to make high-priority information predictable. MIST ordinarily prioritizes mechanism or medical complaint, injuries or illness findings, clinical signs, and treatment; IMIST-AMBO extends the structure to patient identity, allergies, medications, background, and other information. ISBAR/ISOBAR offer related sequences centered on identification, situation, background, observations or assessment, and recommended action. Mnemonics are intended to support professional judgement rather than substitute for clinical understanding.

Maddry et al. (2021; first available online in 2020) surveyed receiving ED professionals before and after a regional MIST implementation and found improvements in several perceived information-transfer elements, including prehospital treatment details. Because the study relied on staff reports collected at different times, it supports acceptability and perceived improvement but does not prove

that fewer patients were harmed. Ehlers et al. (2021) documented more than 700 handovers and found major variation in reported clinical content, providing an objective rationale for standardization.

Elliott et al. (2023) examined 140 video-recorded trauma handovers after implementing IMIST-AMBO and found fewer interruptions and shorter reports compared with a prior local evaluation. Only 57% of recorded handovers used the tool, and adherence was stronger for the initial IMIST elements than for later AMBO components. The results indicate that both effectiveness and implementation fidelity require measurement. In a randomized simulation study involving 27 trauma handover scenarios, Cowan et al. (2023) found that the choice of mnemonic alone did not significantly determine subjective handover quality. Leadership, objective vital signs, avoidance of interruptions, and summarization by the receiving team were more influential.

The later COPTER implementation trial by Nuernberger et al. (2025), encompassing 651 handovers across alternating phases, found improved information-transfer efficiency with ISOBAR and increased retention of key information by physicians and nurses. Nevertheless, strict adherence to the mnemonic did not independently explain outcome differences. The study therefore reinforces a practical conclusion: structured communication must be combined with attention, shared expectations, and a safe listening environment.

Information Loss, Interruptions, and Responsibility Transfer

Several observational studies reveal communication failures that are difficult to detect through documentation alone. In an Icelandic qualitative study, Dúason et al. (2021) interviewed 17 EMTs, nurses, and physicians and identified uncertainty about when responsibility for patients was transferred. Their participants also described the importance of professional competence, respect, and shared procedures. Golling et al. (2022) developed and tested an ED Human Factors in Handover instrument, showing that the quality of a transfer includes both information content and the conduct of the professionals involved.

Pediatric resuscitation handovers offer particularly clear evidence that essential details may disappear at transition. Cheetham et al. (2023) reviewed video recordings of 156 EMS-to-pediatric-ED encounters and observed that vital signs were communicated for fewer than one-third of patients; ED clinicians interrupted or requested repeated information in nearly half of the encounters. The findings concern communication completeness rather than observed injury, but absent vital-sign trends could plausibly hinder assessment of deterioration. Receiving-team behavior must therefore be part of any communication intervention.

Pre-alert Communication and Preparedness

Pre-alerts allow the receiving ED to prepare specialist personnel, monitoring, resuscitation space, or urgent diagnostic pathways. Their value depends on an actionable clinical headline, reliable estimated time of arrival, and clear identification of the caller and recipient. Sampson et al. (2025) analyzed interviews with 74 ambulance and ED clinicians and 156 hours of observation across three ambulance services and six EDs in the United Kingdom. They found that mismatched formats, interruptions, and insufficient training undermined pre-alert communication, even when professionals agreed that concise communication was essential.

Better pre-alert communication can be associated with faster care. In a United States retrospective stroke cohort, Kimbrell et al. (2025) assessed 1,053 EMS-transported patients and reported shorter adjusted door-to-CT and treatment times among those with prehospital notification. In Norway, Leto

et al. (2025) found that accurate dispatcher suspicion of stroke conveyed to ambulance teams was associated with shorter median prehospital and treatment intervals, as well as higher thrombolysis rates. These findings demonstrate practical value in disease-specific pathways but cannot by themselves establish a general ambulance communication effect across all conditions.

Digital and Synchronous Communication Pathways

Paper and voice-only reports can be supplemented by secure messaging, digital alerts, and shared patient information. Bladin et al. (2022) evaluated a multidisciplinary communication application for 604 suspected stroke and 247 STEMI cases in Australia. The application was associated with faster ambulance stretcher offload and some assessment steps, while main door-to-treatment endpoints remained similar. Digital communication should therefore be judged by the actual clinical steps improved, not by adoption or transmission speed alone.

Gross et al. (2025) evaluated an alternative to fragmented, opportunity-based EMS handover in a United States academic ED. Their team-based reporting approach brought receiving clinicians together for a single report. Mean time to patient disposition declined from 338 to 283 minutes, and several laboratory process intervals improved; the difference in time to final ED departure was not significant. The distinction is important: a synchronized report can accelerate clinical decisions while downstream congestion and bed availability continue to constrain final departure.

Saudi Arabia and Regional Evidence

The survey by Al Haliq and AlShammari (2025) is particularly relevant for regional applicability because it compared 219 nurses and paramedics working in emergency and prehospital settings in the Eastern Province of Saudi Arabia. Nurses reported stronger awareness of missing vital signs and greater perceived benefit from ISBAR; paramedics reported more frequent interruptions. These results suggest that education should be shared across professional boundaries rather than focused solely on ambulance crews. However, the cross-sectional sample cannot demonstrate that one profession provides systematically safer handovers or that use of ISBAR reduces actual adverse events.

Jallad et al. (2025) surveyed emergency nurses and paramedics in Palestinian emergency care. Participants perceived effective EMS-to-ED communication as important for patient outcomes, clinician readiness, and ED waiting time. Although such perceptions reflect practical experience, they should not be treated as measured reductions in mortality, medication error, or length of stay. Together the regional studies support collaborative training and receiver-inclusive communication audits.

Safety Outcomes Versus Communication Proxies

A major interpretive issue is the tendency to label communication improvements as patient-safety improvements without directly measuring patient harm. Information retention, interruption counts, and clinician satisfaction are important mechanistic indicators. Yet the chain from improved handover to fewer adverse events may be modified by patient acuity, treatment availability, ED crowding, documentation quality, and independent clinical checks. No single communication metric is sufficient to establish a safety benefit. The review therefore classifies findings as direct clinical outcomes, clinical process outcomes, or communication-process and perception outcomes.

Methodology

Study Design

This manuscript is a structured review and critical narrative synthesis of original empirical research, organized with a systematic-review question and explicit PICOS eligibility criteria. Its evidence matrix was assembled by verifying titles, publication dates, designs, and key reported findings in indexed records and original journal webpages. It is not presented as a fully audited, prospectively registered systematic review because original duplicate-removal and screening records were not retained.

Eligibility Criteria (PICOS Framework)

Population (P)

Ambulance professionals, paramedics, emergency medical technicians, dispatch personnel, emergency nurses, trauma teams, and patients receiving prehospital emergency care or transitioning from ambulance to hospital emergency care.

Intervention or Exposure (I)

Crew communication and teamwork; structured verbal handover; ISBAR, ISOBAR, MIST, or IMIST-AMBO tools; prehospital alerts; dispatch-to-crew messaging; digital shared communication; team-based reporting; or observed barriers and facilitators of information exchange.

Comparison (C)

Usual practice; unstructured handover; preintervention periods; alternative training or reporting formats; non-notified patient groups; or descriptive observational and qualitative evidence where a formal control group was absent.

Outcomes (O)

Primary review outcomes were directly reported patient-safety indicators and prehospital/transition-care quality, including adverse events where measured, information completeness and retention, interruptions, handover efficiency, readiness, and clinical decision timeliness. Secondary outcomes included ambulance offload, ED processing, staff perception, and implementation feasibility. Staff satisfaction and time savings were not counted as direct proof of reduced patient harm.

Study Designs (S)

Original observational studies, controlled or quasi-experimental evaluations, implementation trials, prospective video-based studies, validated measurement studies, qualitative interviews or focus groups, and service improvement reports with primary data. Simulation experiments were included as indirect evidence of communication mechanisms and identified as simulations. Secondary systematic reviews, discussion articles, and editorials were not counted as primary evidence.

Inclusion Criteria

1. English-language empirical reports published or first available between 1 January 2019 and 31 December 2025.
2. Explicit ambulance, paramedic, EMT, or emergency dispatch involvement in communication before hospital arrival or during ambulance-to-ED transfer.

3. An identifiable original dataset or qualitative sample, study design, and analyzable finding about communication or care processes.
4. A traceable publisher record, PubMed record, journal full text, or persistent DOI.

Exclusion Criteria

1. Editorials, conceptual pieces, clinical guidelines, secondary reviews, and reports without original data.
2. Studies of hospital-only ward handovers without an identifiable prehospital or ambulance communication component.
3. Technology studies without a communication exposure or relevant emergency-care process outcome.
4. Publications outside the defined year interval or with outcomes too poorly specified for responsible interpretation.

Information Sources

Targeted verification used PubMed, PubMed Central, journal publisher pages, and DOI-linked original publications. Search concepts included emergency medical services, ambulance crew, paramedics, prehospital, communication, teamwork, patient handover, handoff, pre-alert, emergency department, patient safety, ISBAR, MIST, ISOBAR, IMIST-AMBO, dispatcher, and quality improvement. These were combined using Boolean operators and limited conceptually to 2019–2025. This manuscript does not claim comprehensive searches of Scopus, Embase, Web of Science, or CINAHL, or that every database search was saved for independent replication.

Study Selection Process

Seventeen distinct and verifiable original reports were retained in the evidence matrix. This count describes the assembled studies in this document, not the result of an independently auditable title/abstract screening cascade. No numerical claims are made for records identified, duplicates removed, records excluded, full texts requested, or reports excluded for specified reasons. A complete PRISMA 2020 diagram would require a dated exported search set, deduplication records, individual screening decisions, and full-text exclusion documentation.

Data Extraction

For each included report, the review recorded study author and publication year, country and clinical setting, design and reported sample size, communication exposure, key communication or clinical process findings, and major limits to causal interpretation. The publication year used in the matrix refers to the cited publication, not necessarily the year in which data were collected. Numbers are reported in the same units and comparator direction as the original sources where verified.

Quality Assessment and Risk of Bias

Critical appraisal was performed descriptively by study design and was not represented as completed item-level JBI or Cochrane RoB 2 assessments. The primary concerns were convenience sampling and recall bias in staff surveys, interviewer reflexivity and contextual transferability in qualitative work, secular and concurrent changes in before-and-after projects, case-mix and selection bias in observational cohorts, and imperfect fidelity or contamination in implementation trials. Simulation

findings were explicitly separated from clinical outcome evidence. The proposed domain appraisal worksheet in Appendix B can support formal assessment after complete full-text appraisal and independent reviewer records are available.

Data Synthesis

A narrative synthesis was used because patient populations, clinical settings, communication tools, denominators, and outcome definitions varied substantially. Information retention percentages, handover seconds, disposition minutes, staff perceptions, and stroke treatment times were not pooled into a meta-analysis. Results were organized around crew teamwork, information transfer, receiver behavior, pre-alert and dispatch communication, and downstream clinical processes; conflicting and null results were retained.

Ethical Considerations

This review used published study-level findings and did not collect identifiable patient information or recruit participants. Formal ethics approval for the review itself is generally unnecessary, while ethical approval and consent arrangements for the original studies remain the responsibility of their authors.

Table 1. Characteristics and Key Findings of Included Primary Studies (2019–2025)

Study	Design / setting / sample	Communication exposure and principal finding	Interpretation
Maddry et al. (2021; online 2020)	USA; pre/post ED-staff survey; 208 total survey respondents	MIST format; respondents reported better communication of treatments, alert criteria, and overall experience.	Perception; no patient harm measure
Dúason et al. (2021)	Iceland; qualitative interviews; 17 EMTs, nurses and physicians	Role ambiguity, unclear responsibility transfer and insufficient shared handover procedures emerged.	Qualitative mechanism
Ehlers et al. (2021)	Germany; prospective multicentre observation; 721 handovers	Most observed reports had structural/content deficiencies by ISBAR, MIST and BAUM criteria.	Objective content audit
Golling et al. (2022)	Germany; instrument development/field validation; 38 handovers	ED-HFH measure showed reliability and relation to overall quality judgment (Cronbach alpha 0.83).	Measurement validation
Bladin et al. (2022)	Australia; quasi-experimental digital-app evaluation; 604 stroke, 247 STEMI cases	Faster ambulance stretcher offload and selected assessment metrics; door-to-treatment broadly similar.	Clinical process; confounding
Cheetham et al. (2023)	USA; prospective pediatric video study; 156 handovers	Vital signs given in fewer than one-third; interruptions or repeated requests in nearly half.	Information omission

Study	Design / setting / sample	Communication exposure and principal finding	Interpretation
Elliott et al. (2023)	Canada; prospective trauma-bay video study; 140 recordings	IMIST-AMBO used in 80 handovers; shorter duration and fewer interruptions versus earlier baseline.	Before/after comparison
Cowan et al. (2023)	Canada; randomized simulation; 27 handover scenarios	Mnemonic category alone not significant; leadership, vitals and avoiding interruptions shaped quality.	Simulation, not patients
Myhr et al. (2024)	Norway; qualitative focus groups; 7 ambulance stations	ISBAR and closed-loop communication valued after training; adoption affected by team culture.	Qualitative experience
Evans & Da'Costa (2024)	UK; two-phase service improvement	60-minute handover delays fell 32% in phase one and 97% in phase two.	Bundled system intervention
Nuernberger et al. (2025)	Germany; alternating-phase implementation trial; 651 handovers	ISOBAR associated with better KITE and 18–19% more information retained by receivers.	Handover retention; not harm
Sampson et al. (2025)	UK; interviews with 74 staff, 143 observed pre-alerts	Lack of shared headlines, format mismatch, technology and unclear responses hindered pre-alerts.	Qualitative mechanisms
Al Haliq & AlShammari (2025)	Saudi Arabia; cross-sectional survey; 219 nurses and paramedics	Different reported omissions/interruptions and perceived usefulness of ISBAR.	Regional perceptions
Gross et al. (2025)	USA; prospective ED quality improvement	Team-based reporting: disposition 338 to 283 min; ED departure difference not significant.	Clinical processes; nonrandomized
Kimbrell et al. (2025)	USA; retrospective stroke cohort; 1,053 patients	EMS notification associated with shorter adjusted door-to-CT and door-to-treatment time.	Condition-specific association
Leto et al. (2025)	Norway; registry observational cohort; 771 stroke patients	Accurate dispatch suspicion linked to shorter on-scene and treatment times, higher thrombolysis.	Case-mix/recognition confounding
Jallad et al. (2025)	Palestine; cross-sectional clinician survey; 350 sampled clinicians	Clinicians perceived EMS-ED communication to influence readiness, waiting time and outcomes.	Perceptions, not patient data

Abbreviations: BAUM, German situation/history/examination/measures handover format; ED, emergency department; ED-HFH, Emergency Department Human Factors in Handover; KITE, Key Information Transfer Efficiency; MIST, Mechanism/Injuries/Signs/Treatment; STEMI, ST-elevation myocardial infarction. Numerical results are study-specific and are not pooled.

Results

Study Selection

Seventeen original reports published or available within the 2019–2025 eligibility interval were included in the structured evidence matrix. The set spans observational field studies, qualitative investigations, cross-sectional staff surveys, instrument validation, randomized simulation, an alternating-phase implementation trial, retrospective clinical cohorts, and quality-improvement evaluations. These represent contrasting forms of evidence rather than a statistically representative census of all studies published in the period.

Characteristics of Included Studies

Research originated in North America, Europe, Australia, and the Middle East. Several studies directly observed handovers through checklists or video; others captured ambulance professionals' experiences through interviews and surveys, or evaluated clinical process times in specific stroke and ED pathways. The presence of both high-fidelity observational material and real-world clinical cohorts improves the range of the synthesis, while differences in design prevent a single summary effect.

Completeness and Structure of Handover Information

Observed handovers frequently omitted data expected by receiving teams. Ehlers et al. (2021) found deficiencies in almost every observed report under the frameworks they examined, while Cheetham et al. (2023) reported that fewer than one-third of pediatric resuscitation handovers included vital signs. These findings should not be confused with a claim that every absent element was clinically important for every patient. They do, however, demonstrate that teams cannot assume essential information has been transmitted solely because a verbal report took place.

Structured formats offered measurable benefits in selected settings. Maddry et al. (2021) found more favorable staff perceptions following MIST implementation. Elliott et al. (2023) reported a reduction in mean handover duration from 2 minutes 47 seconds at a prior comparison point to 1 minute 58 seconds during IMIST-AMBO implementation, along with fewer interruptions and parallel conversations. The COPTER trial (Nuernberger et al., 2025) reported a KITE-score difference of 0.12 (95% CI 0.02–0.22) favoring ISOBAR, as well as gains in correctly retained key information among physicians (+18%) and nurses (+19%).

Teamwork, Leadership, and Interruptions

The relationship between report content and handover quality was strongly shaped by team behavior. Dúason et al. (2021) described uncertainty about whether EMTs or receiving clinicians were responsible at specific points of transfer. Myhr et al. (2024) reported that team members valued closed-loop and structured communication but also wanted explicit discussion when working with unfamiliar colleagues. Cowan et al. (2023) identified a clear receiving-team leader, objective observations, few interruptions, and a brief team summary as more consistently important than the specific mnemonic selected.

In the Canadian IMIST-AMBO implementation, mean interruption count was approximately 3.05 before and 1.50 during implementation, while simultaneous conversations and informal reports also declined (Elliott et al., 2023). In the pediatric observations, nearly half of handovers featured an interruption or repeat request from ED personnel (Cheetham et al., 2023). Thus the receiving team's listening practice is part of the intervention, not merely a background condition.

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Communication at Dispatch and Before Arrival

Sampson et al. (2025) identified the importance of early communication of the main clinical concern, mutual recognition of urgency, timely estimated arrival, and a single shared report format. Their findings suggest that a technically delivered pre-alert may still fail if the ED does not understand why the ambulance crew is concerned or if the crew does not understand the ED's response. Pre-alert training should therefore involve both sides of the call.

Condition-specific clinical cohorts offer evidence of practical associations. In the retrospective stroke study by Kimbrell et al. (2025), prehospital notification was associated with adjusted median door-to-CT times of approximately 18 versus 21 minutes and, among thrombolysis recipients, adjusted treatment times of approximately 52 versus 63 minutes. Leto et al. (2025) found that Norwegian dispatchers correctly suspected stroke in 481 of 771 included cases; the alerted cohort had shorter median on-scene time (11 versus 15 minutes) and door-to-needle time (23 versus 31 minutes). Differences in patient presentation and triage priority prevent attribution of the entire observed benefit to communication alone.

Downstream Measures of Care Quality and Efficiency

Bladin et al. (2022) reported faster ambulance stretcher offload and door-to-CT times for suspected stroke patients when a digital coordination app was used, but did not establish consistent improvement in the main door-to-treatment outcomes. Gross et al. (2025) found shorter mean time to laboratory ordering, sample collection, laboratory result, and patient disposition after implementing one synchronous handoff; mean time to ED departure changed from 541 to 525 minutes, but the difference was not significant ($p=0.71$). These results support viewing communication as one component of a longer emergency-care system whose downstream capacity may determine final throughput.

Evans and Da'Costa (2024) reported substantial reductions in prolonged ambulance handover delays after a two-phase organizational programme, including a 97% reduction in 60-minute delays during the second phase. The intervention addressed capacity, policies, and cross-team collaboration together. It is therefore evidence that coordinated operations can reduce handover delays, but not an isolated estimate of the causal effect of crew communication techniques alone.

Evidence Directly Addressing Patient Safety

Few included studies measured adverse patient events attributable to communication failures or improvements. Better retention of medication and vital-sign information is safety-relevant, as is more timely specialist preparation, but these outcomes remain intermediate. The reviewed reports do not provide a consistent controlled estimate of communication-related mortality, diagnostic error, medication injury, or unplanned return visits. Claims of improved safety should therefore be framed as stronger information continuity and reduced potential failure points rather than established reductions in preventable harm.

Regional Findings

The Saudi study by Al Haliq and AlShammari (2025) included 219 completed questionnaires from 250 distributed (87.6% response). Compared with nurses, paramedics more frequently reported interruptions ($p=0.036$), while nurses more frequently recognized missed vital-sign reporting ($p=0.006$) and endorsed ISBAR benefit for safety ($p=0.019$). These are statistically different professional perceptions, not verified group differences in actual error rates. They indicate an opportunity for shared Saudi EMS–ED training, including feedback from both crews and receivers.

Overall Pattern of Findings

The clearest and most reproducible direction of evidence concerns the mechanisms of communication: explicit structure, objective content, fewer interruptions, attentive receipt, documented responsibility, and pre-arrival coordination. Effects on the clinical workflow are promising but not uniform. Evidence of better patient safety in the strict sense of fewer adverse events is still indirect. The mixed findings argue against mandating one unmodified mnemonic for every clinical scenario or treating compliance alone as proof of success.

Table 2. Design-Sensitive Methodological Appraisal

Design group	Representative studies	Principal appraisal concerns	Evidentiary contribution
Observational handover audits	Ehlers; Cheetham; Elliott	Observer criteria, site effects, selection of handovers, lack of clinical outcome linkage	Useful for actual behavior; limited for harm causality
Implementation/QI comparisons	Maddry; Evans & Da'Costa; Nuernberger; Gross	Concurrent workflows, secular trends, nonblinding, uneven protocol adoption	Suggest process response; weaker causal attribution
Qualitative studies	Dúason; Myhr; Sampson	Purposive sampling, researcher interpretation, setting transferability	Rich account of mechanisms and context
Surveys and scale validation	Al Haliq & AlShammari; Jallad; Golling	Self-report, nonresponse, recall and construct validity	Perceptions or instrument performance, not patient harm
Clinical observational cohorts	Bladin; Kimbrell; Leto	Confounding by acuity, triage, treatment access and selection	Demonstrate association with timeliness
Randomized simulation	Cowan	Small scenario sample, simulated behavior, subjective ratings	Controlled mechanism test, not real patient outcomes

This is a transparent design-based assessment, not a completed JBI, ROBINS-I, or Cochrane RoB 2 item-level rating.

Discussion

Principal Findings

The review indicates that ambulance communication contributes to care quality through several linked mechanisms rather than a single direct pathway. First, clinical information must be selected and organized so that high-priority facts are not hidden. Second, receivers must attend, understand, and confirm the message. Third, responsibilities for patient care must transfer unambiguously. Fourth, the message must lead to timely decisions, prepared resources, and appropriate clinical action. Each mechanism can fail even when the others are functioning.

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The evidence supports purposeful standardization but cautions against checklist-only implementation. Nuernberger et al. (2025) found meaningful increases in information transfer and retention associated with ISOBAR without a simple dose-response link to formal adherence. Cowan et al. (2023) similarly found that the type of handover mnemonic was not the decisive feature in simulated trauma transfers. These studies imply that the shared mental model, respectful listening, and explicit control of interruptions may be as important as a memorized sequence.

Comparison With Existing Secondary Literature

The 2020 systematic review by Troyer and Brady described EMS-to-ED information transfer as a vulnerable step and summarized barriers involving information omission, retention and staff perspectives. That secondary evidence was used for context and was not counted among the primary studies. The present review extends the communication interface to within-crew teamwork, dispatch and pre-alert communication, and digital coordination, while keeping the stronger claims limited to directly measured outcomes. It also incorporates later observational and intervention studies that report more precise information-retention and throughput metrics.

Implications for Crew-to-Crew Communication

Two-person ambulance teams need a shared mental model during resuscitation and transport. A brief initial role allocation can clarify who leads patient assessment, manages the airway, records treatment times, communicates with dispatch, and prepares the receiving-team report. Closed-loop confirmation is particularly relevant when administering medication, interpreting a changing vital-sign trend, or making a change in transport priority. A well-practiced team may work with few spoken instructions during routine tasks, but sudden deterioration and unfamiliar crew composition require greater explicit communication.

A practical crew briefing should include the leading clinical concern, immediate risks, anticipated treatment decisions, transport destination, and a trigger for escalation. A short update after any meaningful change reduces reliance on assumptions. These steps are reasonable applications of the reviewed human-factors findings; they are not a validated intervention package shown to reduce adverse outcomes in the included clinical studies.

Implications for Ambulance-to-ED Handover

The receiver-inclusive nature of handover is a consistent finding. Information delivery while the patient is being physically moved, when multiple conversations take place, or while the receiving team performs unrelated tasks can reduce shared understanding. For stable patients, a protected interval of focused listening, followed by targeted questions and confirmation of the receiving clinician, may be feasible. For unstable patients, necessary lifesaving interventions must not be delayed; the report can instead be delivered in short critical segments as treatment proceeds.

Essential handover content should include patient identity or identifiers, the presenting problem and timeline, objective vital signs and trends, relevant allergies and medication information, care already delivered with dose/time/response, unresolved concerns, and a concise recommendation or risk statement. Trauma and time-critical medical cases may legitimately prioritize different elements. What matters is that the chosen sequence is known to both ambulance and receiving clinicians and does not hide critical exceptions.

Dispatch, Pre-Alert, and Digital Communication

Pre-alerts should provide a headline reason for concern, essential findings, current intervention needs, and a realistic estimated arrival time. The receiving team should acknowledge the alert and clarify what preparation is possible. Sampson et al. (2025) demonstrated that a lack of shared expectations about a pre-alert may cause friction and information loss even where a clinical format exists. Dispatcher-to-crew diagnostic suspicions can help direct attention to time-critical pathways, but the interpretation must remain open to reassessment as new patient information becomes available.

Digital systems may strengthen time-stamped exchange and reduce fragmented communication if they are secure, interoperable, and integrated into clinical workflow. The Bladin et al. (2022) feasibility results illustrate selected gains in offload and diagnostic processing, not universal improvements in definitive treatment. A digital tool should therefore be evaluated alongside network reliability, data protection, duplicate-entry burden, acknowledgement processes, and its usefulness when connectivity is lost.

Practical Relevance to the Saudi Red Crescent Authority

For the Saudi Red Crescent Authority, the most transferable strategy is a coordinated communication pathway rather than a form distributed to ambulance staff in isolation. Shared training with ED triage nurses, emergency physicians, dispatch teams, and ambulance educators could agree on essential clinical data, pre-alert thresholds, identification of the responsible receiving clinician, and procedures for immediate escalation. Bilingual or multilingual service environments may also benefit from agreed terminology for clinical concern, medication, vital signs, and transfer of responsibility.

An operational pilot could begin with a small number of stations and receiving hospitals in Jeddah and Makkah, using the same core communication fields across formats. Auditors could observe a sample of handovers, record whether core data were transmitted and repeated, document interruptions, and review selected clinical time measures. Safety balancing indicators might include medication discrepancies identified at handover, missing critical observations, unplanned return to ambulance care, and documented near misses. These are proposed local measures rather than outcomes proven by the present evidence set.

Quality Measurement and Balanced Scorecards

Communication quality is multidimensional. A report may be brief but incomplete, complete but poorly retained, or well delivered but delayed by lack of ED capacity. A meaningful dashboard should separate structure adherence, important information completeness, acknowledgement, interruption burden, transfer-of-care clarity, and patient-level outcome measures. The ED-HFH instrument developed by Golling et al. (2022) is one research example of human-factors measurement and may inform local adaptation after permissions and validation considerations.

Quality teams should examine trends rather than relying on single-event blame. Reviews of near misses are most useful when they identify mismatched expectations or system conditions. For example, failure to communicate medication timing may reflect an overly complicated reporting template, incomplete field documentation, or lack of time to finish a report. Improving safety requires changes across sender, receiver, documentation system, and operational environment.

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Strengths of the Review

The review uses a consistent ambulance-centered question, draws on traceable primary studies from multiple healthcare systems, preserves null findings, and distinguishes simulated scenarios and subjective perceptions from patient-level outcomes. It also includes recent Saudi evidence and studies of both sending and receiving teams. By separating communication metrics from downstream clinical effects, the synthesis avoids assuming that every faster or more satisfying report is safer.

Limitations

The main limitation is methodological completeness: original database exports, independent screening logs, complete full-text eligibility decisions, and prospective registration were not available, so the paper does not establish exhaustiveness and cannot present a defensible PRISMA record-flow count. In addition, some included reports were checked through abstracts and accessible publisher records rather than uniform full-text dual extraction. No formal JBI or RoB 2 ratings were assigned. Most direct handover studies are from single clinical settings, and samples range from small qualitative groups to large clinical cohorts. Publication and reporting bias are possible.

The interventions and outcomes were heterogeneous. Important communication improvements were measured through staff opinion, observations, or process time rather than verified adverse events. Disease-specific pre-alert studies may not generalize to all ambulance call types. Before-and-after organizational interventions could reflect ED staffing, crowding, or concurrent quality initiatives. Accordingly, conclusions concern plausible and documented mechanisms, with cautious statements about patient-level benefit.

Recommendations for Future Research

Future multicentre ambulance studies should prospectively compare a defined sender-and-receiver communication package with usual practice. They should record baseline handover quality, patient acuity, dispatch and ED workload, team composition, clinical outcomes, and real-world intervention fidelity. A cluster-randomized or stepped-wedge rollout may be feasible when communication training is introduced across stations and receiving hospitals in stages.

Researchers should use reliable, blinded assessment of key information transmission and retention and include safety endpoints such as medication errors, missed critical findings, unplanned clinical deterioration during transfer, and treatment delays. Qualitative studies can explain whether failures arise from hierarchy, environmental noise, language, technology, or unclear accountability. Formal cost and training burden analyses are also needed, especially in geographically large EMS systems.

Table 3. Proposed Ambulance Communication and Safety Framework

Transition	Safety-relevant content	Proposed communication action	Audit indicator
Dispatch to crew	Caller information, priority, suspected time-critical condition	Dispatcher verbalizes concern and key uncertainties; crew reads back priority	Acknowledgement, dispatch errors, updated priority
Scene assessment	Team role allocation, evolving observations, treatment plan	Lead states priorities; partner repeats critical orders and treatment details	Closed-loop completion, missing observations, medication near misses
Transport and consultation	Changes in patient status, required support, destination	Brief status updates, time-stamped interventions, confirmation of destination	Unacknowledged change, delay to consultation, diversion process
ED pre-alert	Headline concern, objective findings, estimated arrival	Structured alert plus response/clarification from receiving clinician	Pre-alert completeness, ETA accuracy, receiver readiness
Ambulance-to-ED handover	Identity, complaint, signs/trends, treatments, allergies, unresolved risks	Single focused report, protected listening, questions, receiver identified	Omissions, interruptions, information retention, transfer clarity
Feedback and learning	Outcome and near-miss communication	Joint EMS–ED case review and supportive audit	Trend in discrepancies, training uptake, safety signals

Table 3 proposes a practical framework based on thematic interpretation; it has not been directly tested as a single intervention in the included studies.

Conclusion

The available original literature shows that ambulance communication is essential to the continuity, timeliness, and coordination of prehospital emergency care. Direct observations reveal frequent information omissions, interruptions, and poorly defined transfer responsibilities. Structured tools such as MIST, IMIST-AMBO and ISOBAR, combined with team-based reporting, can improve aspects of information exchange and receiver retention. Pre-alert and dispatcher communication may also help accelerate selected time-critical care pathways.

Nevertheless, the evidence does not justify claiming that every communication intervention reduces mortality, medication errors, or other patient harm. In several studies the clearest measurable changes

were in handover timing, staff experience, or intermediate clinical processes, and broader throughput effects were sometimes null. The most defensible conclusion is that communication quality improves when tools, training, role clarity, listening conditions, and feedback are addressed as an integrated system. Future controlled clinical research should test whether these improvements translate into reliably safer patient outcomes.

Recommendations

Recommendations for Clinical Practice

1. Adopt a common, adaptable ambulance-to-ED communication format agreed jointly by EMS and receiving hospital teams.
2. Require explicit communication of objective vital signs and their trends, relevant allergies, medication treatments and times, response to treatment, and outstanding concerns.
3. Provide a protected listening interval for clinically stable patient handovers, with no avoidable parallel conversations or interruptions.
4. Use closed-loop confirmation for high-risk medication orders, destination changes, critical findings, and dispatch priority updates.
5. Document the identity or role of the clinician accepting responsibility and provide a clear escalation path when immediate transfer is not possible.

Recommendations for Education and Training

1. Conduct shared simulation and case-review training involving paramedics, EMTs, dispatch personnel, ED nurses, emergency physicians, and trauma teams.
2. Include scenarios involving high workload, unfamiliar crew partners, language differences, communication breakdown, and unstable patients.
3. Evaluate competence through direct observation and information-retention checks rather than relying only on attendance or checklist completion.

Recommendations for Organizational Policy

1. Develop shared EMS–hospital standard operating procedures for pre-alerts, electronic handover, interruption management, and transfer of accountability.
2. Establish a non-punitive feedback process for missing or misunderstood critical information and track patterns across stations and receiving facilities.
3. Measure patient safety alongside process efficiency; do not reward shorter handover duration if information completeness deteriorates.

Recommendations for Future Research

1. Conduct prospective multicentre controlled trials that measure both communication-process outcomes and patient-level safety indicators.
2. Perform design-specific JBI or Cochrane risk-of-bias evaluations using independently documented full-text assessments.

3. Retain full search exports, deduplication logs, dual-screening decisions, reasons for exclusion, and a verifiable PRISMA 2020 flow for updated reviews.

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Appendix A. Candidate Search Strategy and Review Documentation

Suggested PubMed Search String

(("Emergency Medical Services"[MeSH] OR ambulance*[tiab] OR paramedic*[tiab] OR "emergency medical technician*"[tiab] OR prehospital[tiab] OR pre-hospital[tiab]) AND (communication[tiab] OR handover[tiab] OR handoff[tiab] OR "patient transfer"[tiab] OR teamwork[tiab] OR "closed-loop"[tiab] OR prealert[tiab] OR "pre-alert"[tiab] OR ISBAR[tiab] OR ISOBAR[tiab] OR MIST[tiab] OR "IMIST-AMBO"[tiab]) AND ("patient safety"[tiab] OR quality[tiab] OR completeness[tiab] OR retention[tiab] OR interruptions[tiab] OR "emergency department"[tiab])) AND ("2019/01/01"[Date - Publication] : "2025/12/31"[Date - Publication])

This is a candidate strategy for a future reproducible update, not an assertion that a saved search was run exactly as written. PubMed field tags and medical subject headings should be tested and adapted. Equivalent strategies should be translated for CINAHL, Embase, Scopus, and Web of Science. Search dates, database versions, exact exports, and a deduplication method must be retained before reporting PRISMA identification counts.

Documentation Needed for a Full PRISMA 2020 Update

1. Record exact database search dates, search strings, filters, and exported citation files.
2. Record a unique record identifier and deduplication decision for every citation.
3. Retain independent title/abstract and full-text screening decisions with reasons for excluding full texts.
4. Create a verifiable list of all included reports linked to the original screening file.
5. Prepare an accurate PRISMA flow diagram from the recorded counts, without inferred or back-calculated screening totals.

Appendix B. Critical Appraisal Plan

For future full-text appraisal, use JBI design-specific checklists for cross-sectional, qualitative, quasi-experimental, and cohort studies, and an appropriate trial tool for randomized interventions. Two independent reviewers should document each question as Yes, No, Unclear, or Not Applicable, with a quote or page reference supporting the rating and a reconciliation record. A simulated trial should be assessed separately from clinical-effect studies. The table below is a planning checklist, not a retrospective claim that formal scoring has been completed.

Domain	Key questions to verify
Selection and eligibility	Were participants/episodes selected consecutively or with transparent inclusion rules?
Exposure definition	Was the communication format or training condition defined and delivered consistently?
Comparator/confounding	Were workload, baseline differences, patient acuity, staff experience and parallel changes addressed?
Outcome measurement	Were communication completeness and clinical outcomes reliably, validly, and preferably blindly assessed?
Missing data	Were unavailable recordings, unreturned questionnaires and incomplete clinical records documented?
Analysis and reporting	Were appropriate statistics, uncertainty estimates, all prespecified endpoints and null findings reported?

Appendix C. Proposed Ambulance-to-ED Communication Audit Template

Audit field	Suggested recording approach
Mission / handover identifier	Pseudonymized encounter identifier; date and facility; no names in shared audit
Clinical urgency	Routine, urgent, resuscitation; note changes in priority
Sender and receiver	Role of sender; role of clinician accepting care; documented acceptance
Critical content	Complaint, timeline, vital-sign trends, allergies, medication/treatment doses and times, response, unresolved risks
Communication process	Mnemonic used; audible report; interruptions; competing conversations; questions; closed-loop confirmation
Pre-alert	Reason, dispatch-to-crew update, receiving acknowledgement, estimated time of arrival
Balanced outcome	Time to clinical decision; discrepancies; near misses; unexpected escalation; follow-up if available
Learning action	Owner, corrective training or workflow change, due date, and subsequent review

The proposed audit template should be adapted to local data-protection requirements, clinical governance, patient acuity, and existing ambulance records. It is a practical recommendation derived from the evidence, not a validated research instrument or an official policy of the Saudi Red Crescent Authority.