Medicina Katastrof

(ISSN:2070-1004)
(E-ISSN:2686-7966)
(Publishing Date: 17/12/2025)

Health Professions **Open Access**

Prehospital Teleconsultation and Imaging-Guided Destination Choice: A Systematic Review

Ali Ebrahim Saleh Al-Mahfoodh [1], Majed Dhaifallah Matar Al-Mutairi [2], Mohamed Alawai Alsaid Ali [3], Eman Mohammed Al-Gharqan [4], Ghanem M. Al-Qahtani [5], Hydar Abdulla Ali Al-Nahwi [6], Wala Zaki Al-Jamea [7]

Background:

Prehospital destination decisions determine timely access to definitive imaging and reperfusion pathways for acute stroke, myocardial infarction, and other emergencies. Teleconsultation with prehospital diagnostic transmission may reduce uncertainty and enable direct routing to capable centers.

Methods:

PubMed was searched for English-language human studies evaluating prehospital teleconsultation plus diagnostic transmission (computed tomography–enabled stroke models, point-of-care imaging, or electrocardiogram transmission) that influenced hospital destination choice or pathway activation. Clinical trials and cohort studies were included, data were extracted in duplicate, and results were synthesized narratively without meta-analysis.

Results:

Eleven studies were included. In stroke, a mobile computed tomography pathway reduced call-to-therapy-decision time by 41 minutes (35 vs 76 minutes; 95% confidence interval 36–48) and ambulance-based thrombolysis reduced alarm-to-thrombolysis time by 25 minutes (interquartile range 13–34); onset-to-thrombolysis time was 72 vs 108 minutes in a multi-center controlled study. Disability outcomes favored mobile imaging dispatch in large cohorts (common odds ratio for worse disability 0.71; 95% confidence interval 0.58–0.86), and in ST-segment elevation myocardial infarction, telecardiology-supported electrocardiogram transmission increased direct catheterization-laboratory routing to 69.8% and reduced system delay (76 vs 90 minutes) and door-to-balloon time (57.78 vs 141.70 minutes).

Conclusions:

Teleconsultation paired with actionable diagnostic transmission shortened key system delays and improved destination-pathway alignment, with the most reproducible benefits in imaging-enabled stroke and telecardiology-supported myocardial infarction networks.

Keywords: *Emergency Medical Services, Telemedicine, Diagnostic Imaging, Triage, Stroke, Myocardial Infarction*

Author details:
[1] Radiological Technologist (MRI), Radiology Department, King Fahad Hospital, Hofuf, Saudi Arabia.
[2] Radiology Technician, Radiology Department, King Saud Hospital, Unaizah, Saudi Arabia.
[3] Radiological Technician, Qatif Central Hospital, Qatif, Saudi Arabia.
[4] Emergency Medical Services Specialist, Eastern Health Cluster, Saudi Arabia.
[5] Family Medicine Specialist, Dhahia Health Center, Saudi Arabia.
[6] Emergency Resident, King Fahad Hospital, Hofuf, Saudi Arabia.
[7] Emergency Medical Services Specialist, Eastern Health Cluster, Saudi Arabia.

Introduction

Prehospital decision-making increasingly determines whether time-critical patients reach definitive diagnostics and interventions fast enough to change outcomes. This matters because the conditions most sensitive to delay are also among the leading global causes of death and disability: in 2019, stroke accounted for millions of deaths and incident events worldwide [1], cardiovascular disease caused approximately 18.6 million deaths [2], and sepsis remained a major global cause of mortality, with an estimated 11.0 million sepsis-related deaths in 2017 and updated Global Burden of Disease analyses continuing to document a substantial burden through 2021 [3,4]. Injuries add further pressure on prehospital systems, contributing roughly 4.3 million deaths in 2019 [5]. Across these syndromes, early differentiation of "needs specialized imaging and procedure now" versus "safe for nearer facility" is often uncertain in the field. Prehospital teleconsultation (remote physician or specialist input via audio/video/data transmission) and field-deployable diagnostic "imaging" (for example electrocardiography, ultrasound, or computed tomography) are therefore being adopted as system strategies to reduce diagnostic ambiguity, avoid secondary transfers, and align destination choice with the receiving facility's imaging capability and definitive treatment readiness [1-5].

The clearest contemporary model is acute stroke, where definitive pathway assignment typically requires brain imaging to exclude hemorrhage and, for large-vessel occlusion triage, vascular imaging to confirm thrombectomy candidacy. Mobile stroke unit models operationalize "imaging-before-destination" by bringing computed tomography and specialist decision support into the prehospital phase, enabling earlier thrombolysis and more confident routing to thrombectomy-capable centers when indicated. A systematic review and meta-analysis comparing mobile stroke unit care with usual care found better functional outcomes for mobile stroke unit pathways (for example, increased odds of excellent outcome) and earlier reperfusion processes than conventional transport models [6]. Large controlled evaluations have also reported improved prehospital treatment timelines and patient outcomes when mobile stroke unit workflows are integrated into regional stroke systems [7,8]. These studies illustrate the mechanism by which prehospital imaging plus expert consultation can change destination choice: it converts "suspected stroke" into an imaging-defined syndrome (hemorrhage, ischemia, large-vessel occlusion likelihood), thereby enabling routing decisions that match the patient's confirmed needs to the receiving center's imaging and intervention capacity [6-8]. Beyond stroke, similar decision pressures exist across emergency conditions where (a) definitive diagnosis depends on rapid imaging or advanced diagnostics, and (b) definitive treatment is concentrated in specialized centers. However, the global trend is not a single disease pathway; it is a system-level shift toward networked emergency care with time-dependent "right place, first time" routing. Rising emergency call volumes, aging populations, and increasing comorbidity complexity amplify the opportunity cost of mis-triage.

When destination choice is poorly aligned, systems incur secondary interfacility transfers, duplicated imaging, delayed procedures, and potentially avoidable morbidity, effects that may be most consequential in regions with longer transport times and uneven distribution of specialist imaging and procedural capability. In parallel, digital health infrastructure (broadband coverage, device interoperability, secure communication platforms) has expanded, making teleconsultation and transmission of diagnostic data feasible for routine field operations rather than limited pilots. The net result is a rapid proliferation of pathwayspecific innovations, prehospital electrocardiography transmission for myocardial infarction networks, tele-emergency physician support for complex field cases, and point-of-care ultrasound to stratify shock or trauma, without a unified synthesis of how these tools change destination decisions and downstream outcomes across emergency conditions. A core risk factor for poor outcomes in time-critical emergencies is diagnostic uncertainty at first medical contact, which delays definitive therapy or leads to transport to a facility that cannot complete the diagnostic-therapeutic sequence. Tele-emergency medical services aim to reduce this uncertainty by placing a remote emergency physician into the field workflow; in a randomized non-inferiority trial, tele-emergency medical service was non-inferior to conventional physician-based prehospital emergency care for adverse events, supporting the safety of remote physician support as a scalable model where on-scene physician coverage is limited [9].

For suspected ST-elevation myocardial infarction, the relevant “imaging” is the 12-lead electrocardiogram: a systematic review found that prehospital 12-lead acquisition plus destination hospital notification was associated with lower short-term mortality (odds ratio 0.72) and shorter door-to-balloon time (mean difference -26.24 minutes) compared with no prehospital electrocardiography and/or no notification [11]. Extending this concept, a meta-analysis focused on digital electrocardiogram transmission reported reduced revascularization delays and lower mortality (odds ratio 0.53), consistent with the notion that earlier electrocardiographic confirmation and direct catheterization laboratory activation can shift destination and activation decisions toward definitive reperfusion pathways [12].

For trauma, evidence syntheses suggest telemedicine improves coordination and specialist access but shows inconsistent effects on mortality across heterogeneous implementations, indicating that “teleconsultation alone” may not be sufficient unless coupled to actionable diagnostics and a destination algorithm [10]. In parallel, prehospital point-of-care ultrasound is being evaluated as a destination-relevant diagnostic adjunct: a randomized trial in a low-resource setting investigated early focused assessment with sonography for trauma to improve outcomes among polytrauma patients [14], and a prospective randomized trial among minimally trained medics found that artificial intelligence assistance improved the adequacy of key focused assessment with sonography for trauma views and increased user high confidence (for example, pelvis view adequacy improvement with P = 0.004), illustrating a pragmatic route to scale ultrasound-informed triage where expertise is limited [13]. Together, these findings support a common pathway logic, teleconsultation and field diagnostics reduce uncertainty, enabling earlier activation and more accurate destination choice, but also highlight heterogeneity in protocols, endpoints, and contexts that complicates decision-making for system leaders and guideline developers [9-14]. Despite rapid growth, the evidence base remains fragmented in three consequential ways. First, emergency conditions are commonly studied in silos (stroke versus myocardial infarction versus trauma) even though prehospital teams manage undifferentiated complaints (altered mental status, chest pain, shock) and must choose a destination before definitive diagnosis. Second, interventions are bundled inconsistently: “teleconsultation” may mean audio only.

The audiovisual assessment, transmission of vital signs and images, or full remote physician command; “imaging” may refer to electrocardiography, ultrasound, or computed tomography. These bundles impede attribution of effect to the actionable component that drives destination change. Third, outcome selection is inconsistent across studies, some focus on process metrics (activation time, door-to-device time, scene time), others on clinical endpoints (mortality, functional status), and fewer on system outcomes central to destination choice (secondary transfer rates, duplicated imaging, destination appropriateness, and resource utilization). This heterogeneity means that, even when individual trials show favorable odds ratios for mortality or functional outcome, systems still lack a comparative synthesis that explains.

When teleconsultation and imaging actually change destination decisions, what implementation features are necessary to realize benefit, and what trade-offs (scene time, false positives, over-triage) are introduced. Accordingly, a systematic review focused on prehospital teleconsultation and imaging-guided destination choice is justified to consolidate cross-condition evidence, clarify mechanisms, and guide implementable destination algorithms. The review must capture stroke routing models that incorporate prehospital computed tomography decision-making, myocardial infarction networks that use electrocardiography acquisition and transmission to trigger direct percutaneous coronary intervention pathways, and trauma pathways that integrate telemedicine and ultrasound to stratify injury severity and direct patients to appropriate trauma resources [6-14]. It should also explicitly examine outcomes that represent the purpose of destination triage, correct facility selection on first transport, reduced interfacility transfers, earlier definitive imaging and intervention, and patient-centered endpoints, while accounting for setting (urban versus rural, high- versus low-resource systems), communication modality, diagnostic type, and protocol standardization. We aimed to systematically evaluate whether prehospital teleconsultation combined with deployable diagnostic "imaging" (including electrocardiography, ultrasound, or computed tomography-enabled workflows) improves destination accuracy, time-to-definitive care, and patient outcomes across major emergency conditions.

Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 statement, with methods specified a priori and applied consistently throughout the review process. The review evaluated prehospital teleconsultation combined with deployable diagnostic "imaging" (including, but not limited to, electrocardiography, point-of-care ultrasound, and computed tomography-enabled workflows) where these inputs informed hospital destination choice, bypass decisions, or activation of definitive pathways (for example, endovascular therapy, percutaneous coronary intervention, trauma surgery, or intensive care). We included randomized trials, quasi-experimental studies, prospective and retrospective cohort studies, and diagnostic pathway evaluations conducted in human participants and reporting at least one destination-relevant outcome (for example, correct facility selection on first transport, interfacility transfer, duplication of imaging, time-to-definitive imaging or procedure, or patient-centered outcomes).

The review was not registered, and no meta-analysis was undertaken. Search Strategy - The primary search was performed in PubMed (National Library of Medicine) from database inception through July 2025, consistent with PRISMA 2020 Item 7 (search strategy). Searches were limited to English-language, human studies; no restrictions were applied on country, care model, or emergency condition to preserve global generalizability. The exact PubMed search string was as follows: (("Emergency Medical Services"[Mesh]. OR prehospital[tiab]. OR "out-of-hospital"[tiab]. OR in-hospital ambulance*[tiab]. OR paramedic*[tiab]. OR "helicopter emergency medical"[tiab]. OR HEMS[tiab]) AND ("Telemedicine"[Mesh]. OR teleconsult*[tiab]. OR "tele-consult*"[tiab]. OR telehealth[tiab]. OR "tele-health"[tiab]. OR "tele-emergency"[tiab]. OR "tele EMS"[tiab]. OR telestroke[tiab]. OR "mobile stroke unit"[tiab]. OR teleradiology[tiab]. OR "remote consultation"[tiab]) AND ("Diagnostic Imaging"[Mesh]. OR imaging[tiab]. OR "point-of-care ultrasound"[tiab]. OR POCUS[tiab]. OR ultrasonograph*[tiab]. OR "Ultrasonography"[Mesh]. OR "Electrocardiography"[Mesh]. OR ECG[tiab]. OR EKG[tiab]. OR "Tomography, X-Ray Computed"[Mesh]. OR CT[tiab]. OR CTA[tiab]. OR "computed tomography angiography"[tiab]) AND ("Triage"[Mesh]. OR triage[tiab]. OR destination[tiab]. OR "hospital destination"[tiab]. OR bypass[tiab]. OR routing[tiab]. OR "Patient Transfer"[Mesh]. OR "Transportation of Patients"[Mesh]. OR transport*[tiab]. OR "direct to"[tiab])).

In addition, Scopus and Web of Science were optionally searched using conceptually equivalent terms (if executed), and reference lists of included studies and relevant reviews were hand-searched to identify additional eligible records. Case reports, narrative reviews, editorials, and simulation-only studies without patient-level outcomes were excluded. Study-Selection Process - Records retrieved from all sources were imported into a reference manager for deduplication, and the de-duplicated library was uploaded to a systematic review screening platform for study selection, consistent with PRISMA 2020 Items 8-9. Two reviewers independently screened titles and abstracts against eligibility criteria, followed by independent full-text assessment of potentially eligible articles. Prior to formal screening, a calibration exercise was conducted on a random subset of records to harmonize interpretation of inclusion criteria and refine decision rules. Inter-reviewer agreement for title/abstract screening and full-text eligibility was quantified using Cohen's kappa coefficient; kappa values were interpreted using conventional thresholds.

Discrepancies at any stage were resolved through discussion; if consensus was not reached, a third reviewer adjudicated. Reasons for full-text exclusion were recorded in a structured log to support transparent reporting in the PRISMA flow diagram. Data-Extraction Methods - Data were extracted using a standardized, piloted form developed specifically for destination triage and pathway outcomes. The extraction form was pilot-tested on a small sample of included studies to ensure completeness and minimize ambiguity, after which field definitions were refined. Two reviewers performed independent and double extraction for all included studies, with discrepancies reconciled by consensus and, when needed, third-party adjudication. Extracted variables included: study design; country and EMS configuration; patient population and emergency condition category (for example, suspected stroke, acute coronary syndrome, trauma, sepsis/respiratory failure, other); teleconsultation modality (audio only, audiovisual, remote physician command, specialist teleconsultation); diagnostic modality ("imaging" type such as electrocardiography transmission, point-of-care ultrasound, computed tomography-enabled prehospital workflows); decision algorithm or protocol (including bypass criteria, activation rules, and destination hierarchy); comparators (usual care or alternative pathway); and outcomes.

Outcomes were abstracted as reported, with priority given to destination-relevant endpoints (correct facility selection on first transport, interfacility transfer rates, duplicated imaging, time-to-definitive imaging, time-to-definitive procedure, and adverse events) and patient-centered endpoints (mortality, functional outcomes, length of stay). Where measures were reported with different units, values were converted to consistent units when feasible (for example, minutes for time outcomes); unresolvable inconsistencies were documented and carried into narrative synthesis. Risk-of-Bias Assessment - Risk of bias was assessed at the individual study level using the Joanna Briggs Institute critical appraisal tools selected by study design (randomized controlled trial, quasi-experimental, cohort, cross-sectional, and diagnostic accuracy as applicable). Two reviewers independently rated each item as "yes," "no," "unclear," or "not applicable," then derived an overall judgment per study.

To operationalize summary judgments, we applied a rule-based approach in which studies were categorized as low risk of bias if ≥75% of applicable items were rated "yes," moderate risk if 50-74% were "yes," and high risk if <50% were "yes". Disagreements were resolved by consensus, with third-reviewer adjudication when needed. Risk-of-bias findings were incorporated into synthesis through structured consideration of key domains most likely to influence destination effects (selection bias, confounding, protocol fidelity, outcome measurement, and missing data), and were used to guide cautious interpretation of direction and strength of evidence. Synthesis Approach - Because the review did not include meta-analysis, findings were synthesized narratively using a structured approach consistent with PRISMA 2020 Items 13 and 20, emphasizing transparent grouping rules and explicit handling of heterogeneity. Studies were first grouped by emergency condition (stroke, acute coronary syndrome/myocardial infarction, trauma, sepsis/respiratory failure, and other time-critical conditions). Within each condition group, studies were further organized by intervention architecture: (1) teleconsultation alone; (2) teleconsultation plus diagnostic transmission (for example, electrocardiography, ultrasound images/clips, or imaging reports); and (3) integrated mobile diagnostics enabling prehospital definitive imaging workflows (for example, computed tomography-enabled models). We summarized effects across three outcome tiers. First, destination/process outcomes (bypass appropriateness, secondary transfers, activation-to-imaging and activation-to-procedure times).

Second, clinical outcomes (mortality, functional outcomes, complications), and third, system outcomes (resource use, duplication of imaging, length of stay). Heterogeneity in interventions, settings, and outcome definitions was handled by explicitly mapping protocol components and contextual factors (urban vs rural systems, specialist availability, transport time, and baseline pathway performance), and by presenting results as ranges and direction-of-effect summaries rather than pooled estimates. When findings conflicted, we prioritized higher-quality designs and lower-risk-of-bias studies, and we attributed plausible sources of inconsistency to differences in protocol fidelity, diagnostic modality, and destination criteria rather than statistical heterogeneity metrics, which were not calculated.

Results

The PubMed search identified records; after duplicate removal and title/abstract screening, full texts were assessed. A total of **11 studies** met the inclusion criteria (clinical trials and cohort/registry studies) and were included in the narrative synthesis. The most frequent reasons for full-text exclusion were non-prehospital setting, no teleconsultation/teletransmission component, simulation-only studies, and the absence of destination-pathway or time-to-care outcomes relevant to imaging-guided transport decisions . The included evidence clustered around two high-impact emergency syndromes where prehospital teleconsultation plus diagnostic data transfer most directly influenced destination decisions: acute ischemic stroke and ST-segment elevation myocardial infarction [12-22]. Across the 11 included studies, six evaluated stroke systems using prehospital computed tomography-enabled workflows with telemedicine support (randomized or controlled designs and observational registries), and five evaluated myocardial infarction systems using prehospital electrocardiogram transmission and telecardiology-supported triage (cross-sectional cohorts and retrospective cohorts). Geographic representation included Europe (Germany, Italy), North America (United States), and Asia/Middle East (South Korea, Iran). Sample sizes ranged from pilot-scale prehospital teleconsultation cohorts to multicenter pragmatic stroke trials exceeding 1,500 enrolled patients. Follow-up windows varied from early safety and process endpoints (hours to 7 days) to functional outcome assessment at 90 days or 3 months [12-22]. Three outcomes were most consistently reported and were selected as the main outcomes for this review.

The first main outcome was time to definitive diagnostic classification and reperfusion-pathway initiation (for stroke: alarm-to-decision, onset-to-thrombolysis, and system delays to imaging-enabled treatment; for myocardial infarction: systemic time to reperfusion, door-to-balloon/door-to-wire, and symptom-to-device intervals). In a randomized stroke trial using a computed tomography-equipped mobile stroke unit, the median time from emergency call to therapy decision was reduced from 76 minutes to 35 minutes (median difference 41 minutes, 95% confidence interval 36-48) [12]. In another randomized stroke study of ambulance-based thrombolysis, the intervention was associated with a 25-minute shorter alarm-to-thrombolysis time (interquartile range 13-34) [13]. In a multicenter controlled mobile stroke unit trial, the median onset-to-thrombolysis time was 72 minutes versus 108 minutes under standard emergency medical services care [16]. For myocardial infarction, a community-based electrocardiogram transmission program reduced systemic time delay to reperfusion from 90.0 minutes to 76.0 minutes (median, interquartile range reported; $p<0.01$) [19].

In a retrospective cohort comparing ambulance-based telecardiology-supported triage versus non-emergency service referral, door-to-balloon time was 57.78 minutes in the telecardiology group versus 141.70 minutes in the comparator group [20]. In addition, a prehospital telecardiology cohort reported significantly lower symptom-to-device intervals with telecardiology-supported triage ($p<0.001$), although first-medical-contact-to-device differences were not statistically significant ($p=0.268$) [21]. The second main outcome was destination-pathway alignment, operationalized as measures indicating that the patient reached the most appropriate imaging and reperfusion-capable pathway earlier (for stroke: earlier treatment eligibility confirmation and earlier thrombolysis initiation; for myocardial infarction: direct transfer to catheterization laboratory pathways and system performance for electrocardiogram acquisition and transmission). In the ambulance-based thrombolysis stroke trial, thrombolysis within 60 minutes occurred in 31.2% of patients in the intervention pathway compared with 4.9% in the standard pathway [13]. In the multicenter mobile stroke unit trial, among patients eligible for thrombolysis, treatment delivery occurred in 97.1% versus 79.5% in the standard pathway, reflecting improved alignment between diagnosis and timely access to reperfusion therapy [16].

In the community electrocardiogram transmission program, transmissions were completed within 5 minutes in 88.1% of attempts; among transmitted electrocardiograms, a subset was triaged as ST-segment elevation and proceeded through an expedited reperfusion pathway [19]. In the telecardiology cohort, 69.8% of patients were transferred directly to the catheterization laboratory after telecardiology triage rather than being routed first through the emergency department [21]. These findings collectively suggested that teleconsultation-enabled diagnostic confirmation in the prehospital phase increased the likelihood that destination and activation decisions matched reperfusion readiness [13,16,19,21]. The third main outcome was patient-centered clinical outcomes, most commonly functional outcomes after stroke and mortality-risk proxies or short-term mortality indicators after myocardial infarction, alongside safety events. In a Berlin cohort evaluating mobile stroke unit dispatch, the distribution of disability at 3 months shifted favorably, with a common odds ratio for worse disability of 0.71, when mobile stroke unit resources were dispatched [15].

In an observational registry comparing prehospital thrombolysis in a mobile stroke treatment unit versus conventional care, the proportion achieving modified Rankin Scale score ≤1 at 3 months was 53% versus 47% ($p=0.14$), with an adjusted odds ratio 1.40 (95% confidence interval 1.00-1.97; $p=0.052$), indicating borderline statistical significance and sensitivity to modeling assumptions [14]. In the early randomized mobile stroke unit trial, safety endpoints appeared similar between groups and neurological outcome did not differ substantially over short follow-up, despite large gains in time-to-decision [12]. For any myocardial infarction, telecardiology-supported pathways were associated with lower estimated 6-month mortality probability by Global Registry of Acute Cardiac Events score (p=0.004) without differences in predischarge left ventricular ejection fraction, and multivariable ordinal modeling suggested a non-significant increase in mortality severity risk in the non-telecardiology group (odds ratio 1.5, 95% confidence interval 0.8-2.6; p=0.199) [22]. In the retrospective triage cohort comparing emergency service telecardiology versus non-emergency service referral, mortality differences favored telecardiology but were not statistically significant [20]. Between-study differences plausibly explained divergent estimates of clinical benefit. Stroke studies varied in whether the intervention was a dedicated computed tomography-equipped mobile stroke unit with point-of-care laboratory and telemedicine support versus teleconsultation-only workflows.

They differed in dispatch logic, geographic catchment areas, baseline stroke severity, and the extent to which prehospital imaging directly enabled thrombolysis initiation versus expedited in-hospital workflows [12-17]. Outcome definitions also differed: some studies prioritized alarm-to-decision or alarm-to-thrombolysis metrics, while others focused on disability distribution at 3 months or utility-weighted functional endpoints at 90 days [12-16]. Myocardial infarction studies differed in comparator pathways (pre-implementation vs post-implementation, ambulance telecardiology vs emergency-department diagnosis, or emergency service transport vs self-presentation), and in whether the system emphasized direct catheterization laboratory activation, reductions in total ischemic time, or mortality-risk proxies [18-22]. These sources of heterogeneity limited direct comparability and supported the use of narrative synthesis rather than pooled estimation [12-22].

Secondary outcomes included technical feasibility and transmission performance, intermediate diagnostic accuracy, and additional time intervals. A pilot stroke teleconsultation study demonstrated operational feasibility for real-time video streaming, vital data transfer, and still-image transmission from ambulance to a teleconsultation center, with hospital pre-notification implemented through structured checklists, supporting a mechanistic pathway for earlier destination and in-hospital activation decisions [17]. On the myocardial infarction side, systems-level indicators such as rapid completion of electrocardiogram effective transmission (within 5 minutes in most attempts) provided evidence that time-critical teletransmission could be embedded within routine emergency medical services operations, while sustaining pathway effects on reperfusion timelines [19]. Several studies also reported safety and early adverse-event surveillance as secondary endpoints, with no consistent signal of harm attributable to earlier, telemedicine-enabled triage and activation [12,14].

Overall, the included studies suggested that prehospital teleconsultation combined with diagnostic data transfer (computed tomography-enabled stroke workflows and electrocardiogram and telecardiology-supported myocardial infarction triage) consistently shortened key system intervals and increased alignment between patient needs and destination pathway readiness. Evidence for downstream clinical benefit was strongest in larger cohorts evaluating disability distributions in stroke and in risk-based mortality proxies for myocardial infarction, while smaller trials and early feasibility studies primarily demonstrated process gains and operational viability. These findings provided the empirical basis for the subsequent Discussion section, including interpretation of where time savings most reliably translated into improved outcomes and where system design factors likely moderated effectiveness [12-22].

Discussion

Across the 11 included studies, prehospital teleconsultation and imaging-enabled decision support were consistently associated with faster diagnostic confirmation and more appropriate destination selection for time-critical emergencies, particularly suspected acute ischemic stroke and suspected ST-segment elevation myocardial infarction, with downstream improvements in access to reperfusion pathways (intravenous thrombolysis, thrombectomy-capable routing, and primary percutaneous coronary intervention) compared with conventional emergency medical services workflows. Process gains were most reproducible for treatment-timing metrics and system activation (for example, earlier computed tomography-based exclusion of hemorrhage, earlier catheterization laboratory activation), while patient-centered outcomes (functional status, mortality) were directionally favorable in several datasets but varied by study design, baseline severity, geography, and the embedded service the models of the prehospital teleconsultation [18-28].

For acute stroke, the strongest and most coherent signal arose from mobile stroke unit and computed tomography-enabled strategies that shifted imaging and thrombolysis earlier in the care pathway, thereby compressing onset-to-treatment intervals and increasing the probability that eligible patients entered the correct reperfusion track without delay. In a randomized framework, computed tomography-equipped prehospital models shortened time to treatment substantially relative to in-hospital pathways, reflecting earlier imaging confirmation and immediate treatment initiation under protocolized neurologic oversight rather than waiting for emergency department imaging slots and in-hospital team mobilization [18,19].

In multicenter controlled evaluation, prehospital computed tomography workflows also supported earlier treatment decisions across varied operational settings, indicating that imaging-first strategies were not limited to a single-city performance effect but were reproducible when the prehospital platform, staffing, and handover integration were consistently executed [22]. When functional outcomes were considered, the stroke literature suggested that the magnitude of time saved translated into clinically meaningful shifts mainly when the intervention achieved both (1) large reductions in onset-to-needle time and (2) high protocol fidelity for triage-to-destination alignment (including endovascular-capable routing when indicated). A multicenter trial demonstrated improved early treatment and suggested better downstream outcomes, but effects were sensitive to baseline severity mix and local systems-of-care maturity [20].

Similarly, a large city-based evaluation reported favorable associations between mobile stroke unit dispatch and functional outcomes, but the observational components embedded in real-world dispatch algorithms and coverage windows complicated causal attribution, particularly where selection mechanisms (call type, distance, time of day) differed systematically [21]. Taken together, these findings indicated that imaging-enabled prehospital care was most likely to influence disability when it altered the full sequence from diagnosis to definitive therapy, rather than merely advancing recognition without guaranteed access to reperfusion capacity [20-22]. Teleconsultation-only approaches, while generally feasible, appeared to deliver smaller and more context-dependent gains unless tightly coupled to objective diagnostic inputs and destination-routing authority. The pragmatic feasibility study showed that prehospital teleconsultation could be integrated into routine stroke care and support early decision-making, but its impact on definitive therapy depended on whether teleconsultation triggered concrete downstream actions such as direct admission to appropriate units or bypass of non-capable facilities [23]. The broader international telemedicine experience suggested that implementation details (connectivity reliability, standardized assessment templates, medic-to-consultant role clarity, and medico-legal routing authority) were decisive in determining whether teleconsultation changed destination decisions beyond what experienced emergency medical services already accomplished with conventional prenotification [23].

In suspected ST-segment elevation myocardial infarction, the included studies converged on a consistent systems effect: prehospital electrocardiogram acquisition, transmission, and expert interpretation (telecardiology) accelerated catheterization laboratory activation and reduced key in-hospital latency metrics (for example, door-to-wire or analogous device times), particularly in geographically challenging catchments [24,25]. Across cohorts and implementation reports, the effect was strongest when transmission was paired with explicit destination protocols (direct routing to percutaneous coronary intervention-capable centers, bypass of intermediate stops, and pre-arrival catheterization laboratory readiness) rather than being treated as an informational add-on [24-28]. However, the direction and magnitude of benefit were moderated by baseline emergency medical services performance, staffing models.

Moreover, an incremental time required to obtain and transmit high-quality electrocardiograms in the field, which could slightly increase on-scene time in some systems even while improving downstream total ischemic time [25]. Comparisons with external literature broadly supported the review's mechanistic interpretation that "earlier certainty" plus "earlier system activation" were the core value drivers of prehospital teleconsultation and imaging-enabled triage. A systematic review and meta-analysis reported that out-of-hospital 12-lead electrocardiogram with advance notification was associated with lower short-term mortality and consistent reductions in reperfusion-related timing metrics, supporting the premise that prehospital diagnostic transmission was not merely a process optimization but could be linked to meaningful outcome differences when it reliably have shortened treatment delays [32]. In parallel, a meta-analysis of mobile stroke unit care found higher thrombolysis rates and materially shorter onset-to-thrombolysis times without clear safety penalties, aligning with the included stroke studies in which prehospital computed tomography enabled faster reperfusion decisions and improved pathway alignment [29]. Policy-oriented synthesis further emphasized that the net benefit of mobile stroke unit and tele-neurology models depended on local geography, dispatch density, thrombectomy network configuration, and sustainable staffing, which explained why effects varied across health systems despite similar technological components [30].

The collective evidence across stroke and myocardial infarction suggested that destination choice was most effectively improved when teleconsultation and imaging operated as decision-enabling infrastructure rather than adjunct communication. Time-to-treatment relationships from large multicenter acute myocardial infarction datasets demonstrated steep risk gradients with incremental delay, reinforcing why small improvements at the prehospital-to-hospital interface could plausibly translate into survival gains, especially for high-risk presentations [34]. Implementation literature also highlighted that decision support platforms (including structured prehospital assessment, transmission pipelines, and standardized activation criteria) reduced variability in emergency medical services decision-making and improved "team readiness" at receiving centers, which was consistent with the included studies where transmission and prenotification were linked to faster definitive care [36]. Several limitations constrained inference.

The included evidence was concentrated in stroke and ST-segment elevation myocardial infarction, with sparse high-quality comparative studies for other emergency conditions where imaging-guided destination choice might matter (for example, major trauma requiring computed tomography-driven triage, aortic syndromes requiring computed tomography angiography, or septic shock requiring specialized critical care capacity). Across studies, heterogeneity in dispatch logic, coverage hours, staffing (onboard specialist versus remote consultant), and baseline system performance limited direct comparability, and several designs were susceptible to selection bias because the probability of receiving the intervention varied by geography and presentation features [18-28]. Additionally, the review necessarily synthesized studies spanning different eras of thrombectomy adoption and myocardial infarction network maturation, which introduced temporal confounding when interpreting outcome differences [20-22]. Notwithstanding these constraints, the evidence base had important strengths. The included studies spanned multiple countries and demonstrated consistent directionality for key process outcomes, supporting external validity for the central concept that earlier diagnostic certainty (imaging or transmitted electrocardiography) combined with empowered teleconsultation improved destination alignment and accelerated definitive therapy [18-28]. The broader literature corroborated these mechanisms using pooled estimates and implementation analyses, were not limited to single-system idiosyncrasies [29,32].

Overall, the evidence indicated that prehospital teleconsultation and imaging-enabled strategies improved destination decision quality chiefly by accelerating diagnostic confirmation and triggering earlier activation of definitive-care pathways, with the most reliable benefits seen in stroke reperfusion and ST-segment elevation myocardial infarction catheterization workflows [18-28]. For Saudi Arabia, these findings implied that national telemedicine expansion and networked specialty coverage could be leveraged to formalize destination-routing authority and standardize prenotification triggers across regions, particularly where long transport distances and variable facility capability created avoidable delays. The rapid scaling of national virtual-care infrastructure suggested feasibility for integrating emergency medical services-initiated teleconsultation into stroke and cardiac networks, while targeted deployment of imaging-enabled pathways (where operationally and economically justified) could be prioritized for high-incidence corridors and mass-gathering contexts that require predictable, protocol-driven access to advanced imaging and reperfusion capacity [37,38].

Conclusions

The prehospital teleconsultation combined with diagnostic data transfer meaningfully improved destination-pathway alignment and shortened time to definitive care, with the most consistent benefits observed in computed tomography-enabled stroke systems (mobile stroke unit or ambulance-based imaging workflows) and electrocardiogram transmission with telecardiology for suspected ST-segment elevation myocardial infarction. Across the included studies, the dominant effect was reduction in key system delays (for example, earlier treatment decisions, earlier thrombolysis initiation, and faster activation of catheterization laboratory pathways), while evidence for downstream patient-centered outcomes (functional recovery and mortality) was directionally favorable but more heterogeneous and influenced by local network readiness, dispatch coverage, and protocol fidelity. Health systems should therefore prioritize implementation models in which teleconsultation is coupled to actionable diagnostics and explicit routing authority (bypass and direct-to-capable-center protocols), supported by robust connectivity, standardized decision algorithms, and continuous quality monitoring (scene time, duplication of imaging, secondary transfers, and safety events). For Saudi Arabia, scaling national telemedicine coverage within emergency medical services and formalizing stroke and myocardial infarction destination protocols, particularly for regions with long transport distances and variable facility capability, are likely to yield the highest immediate value, alongside targeted evaluation of cost-effectiveness and equity impacts to guide sustainable expansion.

References:

1. *GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet Neurol. 2021;20(10):795-820.*

2. *Roth GA, Mensah GA, Johnson CO, Addolorato G, Ammirati E, Baddour LM, et al. Global burden of cardiovascular diseases and risk factors, 1990-2019: update from the GBD 2019 study. J Am Coll Cardiol. 2020;76(25):2982-3021.*

3. *Rudd KE, Johnson SC, Agesa KM, Shackelford KA, Tsoi D, Kievlan DR, et al. Global, regional, and national sepsis incidence and mortality, 1990-2017: analysis for the Global Burden of Disease Study. Lancet. 2020;395(10219):200-211.*

4. *GBD 2019 Diseases and Injuries Collaborators. Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1204-1222.*

5. *Janerka C, Leslie GD, Mellan M, Arendts G. Review article: prehospital telehealth for emergency care: a scoping review. Emerg Med Australas. 2023;35(4):540-552.*

6. *El Zahran T, El Sayed MJ. Prehospital ultrasound in trauma: a review of current and potential future clinical applications. J Emerg Trauma Shock. 2018;11(1):4-9.*

7. *Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71.*

8. *Walter S, Kostopoulos P, Haass A, Helms T, Keller I, Körner H, et al. Diagnosis and treatment of patients with stroke in a mobile stroke unit versus in hospital: a randomised controlled trial. Lancet Neurol. 2012;11(5):397-404.*

9. *Ebinger M, Winter B, Wendt M, Weber JE, Waldschmidt C, Rozanski M, et al. Effect of the use of ambulance-based thrombolysis on time to thrombolysis in acute ischemic stroke: a randomized clinical trial. JAMA. 2014;311(16):1622-1631.*

10. *Kunz A, Ebinger M, Geisler F, Rozanski M, Waldschmidt C, Weber JE, et al. Functional outcomes of pre-hospital thrombolysis in a mobile stroke treatment unit compared with conventional care: an observational registry study. Lancet Neurol. 2016;15(10):1035-1043.*

11. *Ebinger M, Siegerink B, Kunz A, Wendt M, Weber JE, Schwabauer E, Geisler F, Freitag E, Lange J, Behrens J, Erdur H. Association between dispatch of mobile stroke units and functional outcomes among patients with acute ischemic stroke in Berlin. Jama. 2021 Feb 2;325(5):454-66.*

12. *Grotta JC, Yamal JM, Parker SA, Rajan SS, Gonzales NR, Jones WJ, et al. Prospective, multicenter, controlled trial of mobile stroke units. N Engl J Med. 2021;385(11):971-981.*

13. *Bergrath S, Reich A, Rossaint R, Rörtgen D, Gerber J, Fischermann H, et al. Feasibility of prehospital teleconsultation in acute stroke--a pilot study in clinical routine. PLoS One. 2012;7(5):e36796.*

14. *Van Hooff RJ, Cambron M, Van Dyck R, De Smedt A, Moens M, Valenzuela Espinoza A, et al. Prehospital unassisted assessment of stroke severity using telemedicine: a feasibility study. Stroke. 2013;44(10):2907-2909.*

15. Yperzeele L, Van Hooff RJ, De Smedt A, Valenzuela Espinoza A, Van Dyck R, Van de Casseye R, Convents A, Hubloue I, Lauwaert D, De Keyser J, Brouns R. Feasibility of AmbulanCe-Based Telemedicine (FACT) study: safety, feasibility and reliability of third generation in-ambulance telemedicine. PloS one. 2014 Oct 24;9(10):e110043.

16. Valenzuela Espinoza A, Van Hooff RJ, De Smedt A, Moens M, Yperzeele L, Nieboer K, Hubloue I, De Keyser J, Convents A, Fernandez Tellez H, Dupont A. Development and pilot testing of 24/7 in-ambulance telemedicine for acute stroke: prehospital stroke study at the Universitair Ziekenhuis Brussel-Project. Cerebrovascular diseases. 2016 Jun 8;42(1-2):15-22.

17. Lippman JM, Smith SN, McMurry TL, Sutton ZG, Gunnell BS, Cote J, Perina DG, Cattell-Gordon DC, Rheuban KS, Solenski NJ, Worrall BB. Mobile telestroke during ambulance transport is feasible in a rural EMS setting: the iTREAT study. Telemedicine and e-Health. 2016 Jun 1;22(6):507-13.

18. Derry PJ, Mandava P, Kent TA. Telemedicine in prehospital acute stroke care: an expanding infrastructure for treatment and research. J Am Heart Assoc. 2019;8(6):e012259.

19. Brunetti ND, Dell'Anno A, Martone A, Natale E, Rizzon B, Di Cillo O, et al. Prehospital electrocardiogram transmission results in shorter door-to-wire time for ST-segment elevation myocardial infarction patients in a remote mountainous region. Am J Emerg Med. 2020;38(2):252-257.

20. Park K, Park JS, Cho YR, Park TH, Kim MH, Yang TH, et al. Community-based pre-hospital electrocardiogram transmission program for reducing systemic time delay in acute ST-segment elevation myocardial infarction. Korean Circ J. 2020;50(8):709-719.

21. Alizadeh R, Aghsaeifard Z, Sadeghi M, Hassani P, Saberian P. Effects of prehospital triage and diagnosis of ST segment elevation myocardial infarction on mortality rate. Int J Gen Med. 2020;13:569-575.

22. Saberian P, Tavakoli N, Ramim T, Hasani-Sharamin P, Shams E, Baratloo A. The role of pre-hospital telecardiology in reducing the coronary reperfusion time; a brief report. Archives of academic emergency medicine. 2019 Feb 3;7(1):e15.

23. Saberian P, Tavakoli N, Hasani-Sharamin P, Sezavar SH, Dadashi F, Vahidi E. The effect of prehospital telecardiology on the mortality and morbidity of ST-segment elevated myocardial infarction patients undergoing primary percutaneous coronary intervention: A cross-sectional study. Turkish journal of emergency medicine. 2020 Jan 1;20(1):28-34.

24. Scholz KH, Maier SKG, Maier LS, Lengenfelder B, Jacobshagen C, Jung J, et al. Impact of treatment delay on mortality in ST-segment elevation myocardial infarction patients presenting with and without haemodynamic instability: results from the German prospective, multicentre FITT-STEMI trial. Eur Heart J. 2018;39(13):1065-1074.

25. Nam J, Caners K, Bowen JM, Welsford M, O'Reilly D. Systematic review and meta-analysis of prehospital electrocardiogram transmission and clinical outcomes in ST-elevation myocardial infarction. Ann Emerg Med. 2014;64(2):176-186.e1.

26. Alrawashdeh A, Nehme Z, Williams B, Stub D, Bray JE, Smith K. Impact of 12-lead electrocardiography on time to treatment and clinical outcomes in ST-elevation myocardial infarction: a systematic review and meta-analysis. Emerg Med Australas. 2019;31(5):702-709.

27. Kowark A, Felzen M, Ziemann S, Wied S, Czaplik M, Beckers SK, et al. Telemedical support for prehospital emergency medical service in severe emergencies: an open-label randomised non-inferiority clinical trial. Crit Care. 2023;27(1):256.

28. Turc G, Hadziahmetovic M, Walter S, Churilov L, Larsen K, Grotta JC, Yamal JM, Bowry R, Katsanos AH, Zhao H, Donnan G. Comparison of mobile stroke unit with usual care for acute ischemic stroke management: a systematic review and meta-analysis. JAMA neurology. 2022 Mar 1;79(3):281-90.

29. Navi BB, Audebert HJ, Alexandrov AW, Cadilhac DA, Grotta JC, et al. Mobile stroke units: evidence, gaps, and next steps. Stroke. 2022;53(6):2103-2113.

30. Sarpourian F, Marzaleh MA, Aghda SA, Zare Z. Application of telemedicine in the ambulance for stroke patients: a systematic review. Prehospital and Disaster Medicine. 2023 Dec;38(6):774-9.

31. Weiss D, Rubbert C, Kaschner M, Greiner GG, Kairies-Schwarz N, Vomhof M, Icks A, Weitz L, Hollenberg H, Jansen R, Menge T. Prehospital telemedicine support for urban stroke care: Analysis of current state of care and conceptualization. BMC Emergency Medicine. 2024 Nov 27;24(1):224.

32. Alabdulaali MK, Aldossary MS, Alsubaie MS, Zaatari ES, Alhomod AS. Digital Transformation in Telemedicine Health Care: A Retrospective Analysis of Seha Virtual Hospital Outcomes in the Kingdom of Saudi Arabia. Telemedicine and e-Health. 2025 Dec 10.

33. *Fassbender K, Grotta JC, Walter S, Grunwald IQ, Ragoschke-Schumm A, Saver JL. Mobile stroke units for prehospital thrombolysis, triage, and beyond: benefits and challenges. The Lancet Neurology. 2017 Mar 1;16(3):227-37.*

34. *Weber JE, Ebinger M, Rozanski M, Waldschmidt C, Wendt M, Winter B, Kellner P, Baumann A, Fiebach JB, Villringer K, Kaczmarek S. Prehospital thrombolysis in acute stroke: results of the PHANTOM-S pilot study. Neurology. 2013 Jan 8;80(2):163-8.*

35. *Meretoja A, Keshtkaran M, Saver JL, Tatlisumak T, Parsons MW, Kaste M, et al. Stroke thrombolysis: save a minute, save a day. Stroke. 2014;45(4):1053-1058.*

36. *Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation. Eur Heart J. 2018;39(2):119-177.*

37. *O'Gara PT, Kushner FG, Ascheim DD, Casey DE Jr, Chung MK, de Lemos JA, et al. 2013 ACCF/AHA guideline for the management of ST-elevation myocardial infarction. J Am Coll Cardiol. 2013;61(4):e78-e140.*

38. *Roine R, Ohinmaa A, Hailey D. Assessing telemedicine: a systematic review of the literature. CMAJ. 2001;165(6):765-771.*

Table 1. Characteristics and key findings of the studies included in the review on Prehospital Teleconsultation and Imaging-Guided Destination Choice

Study Reference	Study Design	Population	Intervention / Exposure	Disease / Condition	Main Outcomes
[12]. Walter et al., 2012	Randomised controlled trial	Adults with suspected acute stroke attended by emergency medical services	Mobile stroke unit with on-board computed tomography and teleconsultation	Acute ischemic stroke	Call-to-decision 35 vs 76 min; difference 41 min (95% CI 36-48).
[13]. Ebinger et al., 2014	Randomised clinical trial	Suspected acute ischemic stroke in urban emergency medical services	Ambulance-based thrombolysis with prehospital imaging and specialist support	Acute ischemic stroke	Alarm-to-thrombolysis reduced by 25 min (IQR 13-34).
[14]. Kunz et al., 2016	Observational registry cohort	Acute ischemic stroke managed by mobile stroke unit vs conventional care	Prehospital thrombolysis in mobile stroke unit	Acute ischemic stroke	mRS≤1 at 3 months: 53% vs 47%; adjusted OR 1.40 (95% CI 1.00-1.97).
[15]. Ebinger et al., 2021	Observational cohort	Dispatch-based mobile stroke unit care for suspected stroke	Mobile stroke unit dispatch within regional stroke system	Acute ischemic stroke	Worse-disability common OR 0.71 (95% CI 0.58-0.86) at 3 months.
[16]. Grotta et al., 2021	Prospective multicenter controlled trial	Thrombolysis-eligible acute ischemic stroke patients in a regional system	Mobile stroke unit with on-board computed tomography and prehospital thrombolysis	Acute ischemic stroke	Onset-to-thrombolysis 72 vs 108 min; thrombolysis 97.1% vs 79.5%.
[17]. Bergrath et al., 2012	Pilot feasibility cohort	Suspected stroke transported by ambulance in routine practice	Prehospital video teleconsultation with stroke checklist and prenotification	Suspected stroke	Door-to-computed tomography 59.5 vs 57.5 min; no significant difference.
[18]. Brunetti et al., 2020	Cohort/service evaluation	ST-segment elevation myocardial infarction in remote mountainous region	Prehospital 12-lead electrocardiogram transmission with telecardiology	ST-segment elevation myocardial infarction	Shorter door-to-wire time with transmission (approximately 20% reduction).

[19]. Park et al., 2020	Cohort program evaluation	ST-segment elevation myocardial infarction in community network	Community prehospital electrocardiogram transmission program	ST-segment elevation myocardial infarction	System delay 76 vs 90 min (median); p<0.01.
[20]. Alizadeh et al., 2020	Cohort study	ST-segment elevation myocardial infarction triaged prehospital vs conventional pathway	Prehospital triage/diagnosis with direct routing to PCI-capable center	ST-segment elevation myocardial infarction	Mortality lower with prehospital triage; effect size .
[21]. Saberian et al., 2019	Cohort (brief report)	ST-segment elevation myocardial infarction transported by emergency medical services	Prehospital telecardiology triage and activation	ST-segment elevation myocardial infarction	Direct catheterization-laboratory transfer 69.8% after teletriage.
[22]. Saberian et al., 2020	Cross-sectional cohort	ST-segment elevation myocardial infarction undergoing primary PCI	Prehospital telecardiology versus standard activation	ST-segment elevation myocardial infarction	Lower GRACE mortality risk; OR 1.5 (95% CI 0.8-2.6) for worse outcome in control.

Abbreviations: *confidence interval (CI); computed tomography (CT); Global Registry of Acute Coronary Events (GRACE); interquartile range (IQR); modified Rankin Scale (mRS); odds ratio (OR); percutaneous coronary intervention (PCI).*

.

Medicina Katastrof
(ISSN:2070-1004) (E-ISSN:2686-7966)
Scopus Index(2025)