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The Role Of Paramedics In The Early Recognition And Management Of Chest Pain Syndromes

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Abstract

Background: Chest pain is a common emergency medical complaint with a wide diagnostic spectrum, ranging from benign causes to life-threatening acute coronary syndromes (ACS). Early recognition and management by paramedics in the prehospital setting are critical to reducing morbidity and mortality through rapid diagnosis and timely reperfusion.
Methods: This review synthesizes current evidence on paramedics' roles in early chest pain recognition, including diagnostic tools such as 12-lead electrocardiography, symptom-based risk scores, and novel point-of-care biomarker testing. It evaluates prehospital interventions, reperfusion strategies, and system-level factors influencing outcomes.
Results: Paramedics effectively use structured assessments and ECG interpretation to identify high-risk ACS patients, enabling early activation of catheterization labs and direct transport to PCI-capable centers. Early administration of aspirin and nitrates, coupled with emerging technologies like AI-assisted ECG interpretation and prehospital troponin testing, shorten treatment delays and improve outcomes. System disparities and training variations impact diagnostic accuracy and treatment equity. Innovative extended paramedic roles, including community-based management, are emerging.
Conclusions: Paramedics play a pivotal role in the early recognition and management of chest pain syndromes, contributing to reduced ischemic times and improved patient outcomes. Standardized training, adoption of advanced diagnostic tools, and integration into regional cardiac care systems are essential to optimize prehospital chest pain care. Future research should address gaps in paramedic-specific diagnostic accuracy, technology integration, and equity in care delivery.

Keywords Paramedics, chest pain syndromes, acute coronary syndrome, prehospital care, electrocardiogram, early recognition, reperfusion, risk stratification, emergency medical services.

Introduction

Chest pain is one of the most common reasons for seeking emergency medical care worldwide and represents a major diagnostic and organizational challenge for emergency medical services (EMS) because it encompasses a broad spectrum of conditions ranging from benign musculoskeletal pain to time-critical acute coronary syndromes (ACS), aortic dissection, pulmonary embolism, and other cardiovascular emergencies that carry high risks of mortality and long-term morbidity if not rapidly recognized and treated. In contemporary EMS cohorts, chest pain accounts for a substantial proportion of ambulance activations, and although only a minority of these patients ultimately have myocardial infarction or another immediately life-threatening diagnosis, the prehospital phase is crucial for early risk stratification, initiation of evidence-based therapies, and rapid routing to definitive reperfusion or specialist care. Paramedics now occupy a pivotal position at the interface between community and hospital by performing structured assessments, 12-lead electrocardiography (ECG), symptom-based risk scores, and in some systems point-of-care biomarker testing, thereby shifting key elements of the traditional emergency department (ED) workflow into the prehospital environment and potentially shortening total ischemic time for patients with ACS while safely identifying low-risk patients who may not require urgent conveyance (Ahmed et al., 2024).

The burden of chest pain syndromes on EMS and health systems is considerable, with large registry studies from Europe showing that chest pain constitutes one of the leading dispatch codes, representing tens of thousands of calls over multi-year periods and consuming significant ambulance, telecommunication, and ED resources. Detailed characterization of unselected prehospital chest pain cohorts indicates that most patients receive non-cardiac or low-risk cardiac diagnoses at hospital discharge, yet a sizeable subset, often around 12–16%, are found to have myocardial infarction or another high-risk underlying condition such as pulmonary embolism, aortic dissection, life-threatening arrhythmias, sepsis, or major gastrointestinal bleeding, underscoring both the heterogeneity of this population and the critical need for accurate early triage to avoid missed time-sensitive pathology while limiting unnecessary high-acuity transports. Beyond immediate mortality, chest pain syndromes, particularly ACS, impose a substantial long-term burden in terms of recurrent events, heart failure, reduced functional capacity, and health-related quality of life, meaning that even small prehospital gains in timely diagnosis and optimization of early therapy can translate into important downstream benefits for patients and health systems (Wibring et al., 2021).

Epidemiological analyses of EMS databases reveal that chest pain calls represent a consistent and high-volume proportion of overall caseloads, with one Danish EMS study reporting more than 90,000 chest pain calls among approximately 4.8 million total calls over a five-year period, and similar patterns observed in other European and North American settings. Within this broad group, only a fraction ultimately prove to have ACS or other acute life-threatening conditions, while the majority receive diagnoses such as musculoskeletal pain, nonspecific chest pain, anxiety-related syndromes, or stable coronary disease, which creates an inherent tension between the need for rapid conservative over-triage to avoid missed infarction and the imperative to deploy limited EMS and ED resources efficiently. Several studies examining prehospital predictors have identified clinical features, vital signs, and ECG findings associated with an increased likelihood of acute life-threatening conditions, enabling development of chest pain risk-stratification tools that can be operationalized by paramedics to more precisely differentiate high- and low-risk patients at the scene (Galinski et al., 2015).

Prospective and registry-based EMS studies suggest that roughly 10–15% of patients transported with chest pain are ultimately diagnosed with acute myocardial infarction, with an additional segment harboring other serious etiologies such as pulmonary embolism, aortic dissection, sepsis, or significant gastrointestinal hemorrhage, each associated with high short-term morbidity and mortality if not promptly identified. Among chest pain patients initially assessed by paramedics, those with ACS or other acute life-threatening conditions experience substantially worse outcomes than patients with low-risk diagnoses, including higher rates of in-hospital death, cardiogenic shock, heart failure, prolonged hospital stay, and subsequent readmissions, thereby highlighting the potential for targeted prehospital interventions to modify risk trajectories. Importantly, outcome differences have been linked not only to the underlying pathology but also to system factors such as prehospital delay, timely ECG acquisition, appropriate activation of cardiac catheterization laboratories, and prehospital initiation of guideline-directed pharmacotherapy, all domains in which paramedics exert direct influence (Wibring et al., 2016).

ACS, particularly ST-segment elevation myocardial infarction (STEMI), is fundamentally time-dependent because persistent coronary occlusion leads to progressive myocardial necrosis, adverse ventricular remodeling, and increased likelihood of malignant arrhythmias and death, making early restoration of coronary blood flow the cornerstone of management. Clinical and registry data consistently demonstrate that shorter total ischemic time spanning symptom onset through prehospital delay, transport, and in-hospital processes, is associated with reduced infarct size, lower rates of heart failure and cardiogenic shock, and improved short- and long-term survival, a relationship that has driven international guideline emphasis on rapid patient recognition, prompt EMS activation, and streamlined reperfusion pathways. The prehospital phase, where paramedics operate, constitutes a substantial proportion of total ischemic time because it includes the patient's decision to call for help, dispatch and response intervals, on-scene assessment, and transport; however, once contact is made, paramedics can markedly compress subsequent delays through rapid ECG-based diagnosis, prenotification of receiving hospitals, and direct transfer to catheterization-capable centers (Jollis & Jollis, 2018).

Myocardial ischemia arises when there is an imbalance between myocardial oxygen supply and demand, most commonly due to acute plaque rupture or erosion with superimposed thrombus formation in a coronary artery, leading to abrupt reduction or cessation of blood flow and deprivation of oxygen and nutrients to the downstream myocardium. Experimental and clinical data have long shown a "wavefront" phenomenon in which myocardial cell death progresses from subendocardium to subepicardium over time, such that delays in reperfusion convert potentially salvageable ischemic myocardium into irreversible infarction with consequent loss of contractile function, electrical instability, and adverse remodeling. In STEMI, full-thickness ischemia produces characteristic ECG changes and is particularly sensitive to time-to-reperfusion, whereas non-ST-elevation ACS often reflects subtotal occlusion or distal embolization with more variable ECG patterns, placing a premium on careful clinical assessment, serial ECGs, and biomarker testing to discriminate high-risk patients who require urgent invasive management from those suitable for conservative strategies (Koh et al., 2024).

Multiple large-scale observational studies have demonstrated a strong association between shorter symptom-to-reperfusion times and improved outcomes in STEMI, with door-to-balloon times under 90 minutes for primary percutaneous coronary intervention (PCI) and door-to-needle times under 30 minutes for fibrinolysis now widely endorsed as benchmarks of high-quality care. Data from national registries and contemporary cohorts indicate that incremental reductions in door-to-balloon time within these ranges correlate with lower 30-day and 1-year mortality, smaller infarct size, and decreased incidence of heart failure, though some analyses suggest diminishing returns once door-to-balloon times reach very low thresholds, emphasizing that total ischemic time, including prehospital delay, may be an even more critical determinant of outcome. From the EMS perspective, prehospital strategies such as early 12-lead ECG acquisition, pre-activation of the catheterization laboratory, bypass of non-PCI hospitals, and in some systems prehospital fibrinolysis can significantly reduce system delay and door-to-balloon or door-to-needle times, thereby aligning paramedic practice directly with core performance metrics and patient-centered outcomes (Kubica et al., 2022).

The "chain of survival" concept, originally articulated for out-of-hospital cardiac arrest, has been adapted to ACS and chest pain syndromes to emphasize the sequence of early symptom recognition, prompt EMS activation, rapid assessment and stabilization, timely diagnosis, and expeditious reperfusion or definitive treatment, with each link influencing overall survival and functional recovery. Within this framework, paramedics constitute the operational backbone of the prehospital chain because they translate layperson recognition into structured medical care, performing rapid vital sign assessment, ECG acquisition and interpretation or transmission, administration of antiplatelet and anti-ischemic therapies, analgesia, and hemodynamic support while simultaneously coordinating logistics such as destination selection and hospital prenotification. Integration of paramedic-delivered processes into regional cardiac systems of care, including standardized ACS protocols, direct-to-cath-lab pathways, and feedback-driven quality improvement, has been associated with sustained reductions in treatment delays and improvements in survival for STEMI and high-risk NSTE-ACS patients (Kubica et al., 2022).

The “golden hour” in cardiac care refers to the early time window after onset of ischemic symptoms during which prompt reperfusion yields the greatest incremental myocardial salvage, an idea supported by pathophysiological data on wavefront necrosis and by clinical studies showing steep early time-to-benefit gradients for fibrinolysis and PCI. In practice, the golden hour spans not only hospital-based processes but also the often-underappreciated prehospital interval, where delays in symptom recognition, EMS activation, or on-scene decision-making can erode potential benefit long before arrival at the catheterization laboratory, thereby positioning paramedics as key actors in preserving or squandering this critical window. By embedding rapid assessment, ECG-based triage, protocolized therapy, and direct routing to reperfusion-capable centers into paramedic practice, EMS systems strengthen the earliest links in the chain of survival and operationalize the golden hour concept into measurable process targets such as first medical contact-to-device times (Mackay et al., 2022).

Early recognition and management of chest pain syndromes in the prehospital setting are pivotal because they directly influence diagnostic accuracy, timeliness of reperfusion, prevention of life-threatening complications, and allocation of limited hospital resources. Paramedic-led interventions such as acquisition of prehospital 12-lead ECGs with rapid transmission or interpretation, application of validated chest pain risk scores, early administration of antiplatelet therapy, and destination decisions that prioritize PCI-capable centers have been associated with shorter treatment delays and improved outcomes in ACS, while structured triage also allows identification of low-risk patients who might be safely managed through alternative care pathways. Furthermore, prehospital recognition of non-cardiac but serious conditions presenting with chest pain such as pulmonary embolism, aortic dissection, or sepsis enables targeted supportive care, early notification of receiving teams, and tailored transport decisions that may reduce morbidity and mortality even when definitive diagnosis requires hospital-based imaging and laboratory testing (Wibring et al., 2016).

Despite the central role of paramedics in the contemporary management of chest pain syndromes, existing literature is heterogeneous, with substantial variability in scopes of practice, training standards, diagnostic tools, and protocols across EMS systems, which complicates synthesis of evidence and translation into unified practice recommendations. Many ACS and chest pain outcome studies report aggregated EMS data without distinguishing paramedic-specific contributions such as ECG interpretation accuracy, implementation of prehospital risk scores, use of point-of-care troponin, or adherence to analgesia and antithrombotic protocols, leading to gaps in understanding of how paramedic-level decisions and competencies affect time-to-treatment and patient outcomes. There is also growing interest in emerging technologies and expanded roles such as community paramedicine, teleconsultation with cardiologists, and advanced diagnostic aids, that have not yet been comprehensively reviewed in the context of chest pain, underscoring the need for a focused synthesis that examines paramedics’ specific contributions and opportunities for practice optimization (Sagel, Vlaar, van Roosmalen, et al., 2021).

Current evidence reveals important gaps, including limited high-quality data on the diagnostic performance of paramedic-applied chest pain risk stratification tools, variation in training and competency for ECG interpretation, and inconsistent availability and use of prehospital point-of-care troponin across systems. Studies also highlight sex- and gender-related disparities in prehospital analgesia and management for patients with suspected ACS, as well as regional differences in protocols for prehospital antiplatelet therapy, anticoagulation, and fibrinolysis, suggesting that patient outcomes may be influenced not only by system organization but also by implicit biases and local practice cultures. Furthermore, only a subset of EMS systems has fully integrated feedback loops and outcome-linked quality improvement for chest pain care, meaning that many paramedics operate with limited insight into the downstream consequences of their prehospital decisions, which may slow adoption of best practices and perpetuate unwarranted variation (Fernando et al., 2023).

Focusing specifically on paramedics rather than the broader EMS structure is justified because paramedics typically constitute the principal clinical decision-makers at the scene, directly responsible for assessment, initial diagnosis, risk stratification, therapeutic interventions, and transport decisions for patients with chest pain. While dispatchers, emergency medical technicians, and hospital teams are integral to the overall care pathway, paramedics uniquely bridge the gap between layperson recognition and hospital-based specialist care, and their autonomy and skill set including advanced life support, pharmacologic management, and ECG interpretation, mean that variation in paramedic practice can have disproportionate effects on key outcomes such as time to reperfusion and occurrence of prehospital complications. A paramedic-centered lens also facilitates more precise evaluation of training curricula, decision support tools, and scope-of-practice expansions, enabling targeted recommendations that can be operationalized within EMS agencies to directly enhance frontline care for chest pain syndromes (Snavely et al., 2022).

The primary aim of this review is to synthesize current evidence on the role of paramedics in the early recognition and prehospital management of chest pain syndromes, with particular emphasis on ACS and other life-threatening causes, and to examine how paramedic-level interventions influence time-critical processes and patient outcomes across diverse EMS settings. Specific research questions include: (1) what is the impact of paramedic-delivered diagnostic strategies such as prehospital 12-lead ECG acquisition and interpretation, risk stratification scores, and point-of-care troponin, on diagnostic accuracy and early identification of high-risk chest pain patients; (2) how do paramedic-initiated treatments and pathways, including prehospital antiplatelet therapy, analgesia, fibrinolysis, and direct transfer to PCI-capable centers, affect time to reperfusion, complication rates, and short- and long-term outcomes; and (3) what system-level, training, and technological factors facilitate or hinder optimal paramedic performance in chest pain care. By addressing these questions, the review seeks to identify evidence-based strategies, knowledge gaps, and priority areas for research and quality improvement that can guide policymakers, educators, and EMS leaders in strengthening paramedic contributions to the care of patients with chest pain syndromes (Snavely et al., 2022).

Scope of practice of paramedics

Paramedic practice in the early recognition and management of chest pain syndromes is embedded within diverse emergency medical services (EMS) systems that shape what assessments, interventions, and decisions are possible before hospital arrival, with direct implications for time to reperfusion and patient outcomes in acute coronary syndromes (ACS) and ST-elevation myocardial infarction (STEMI). Internationally, paramedicine has evolved from a transport-focused occupation to a regulated health profession delivering complex out-of-hospital care, but this evolution has occurred unevenly across countries, resulting in wide variation in professional titles, registration, and roles in chest pain pathways. In many Anglo-American–style systems (for example, the United Kingdom, Ireland, Australia, New Zealand, parts of North America, and South Africa), paramedics are primary providers of prehospital emergency care for suspected ACS, responsible for rapid risk assessment, 12-lead ECG acquisition, symptom control, and activation of reperfusion pathways, whereas Franco-German models rely more heavily on physician-staffed mobile intensive care units that bring advanced decision-making and therapies to the scene. These system contexts determine whether paramedics function mainly as protocol-driven technicians or as autonomous clinicians integrated into regional STEMI networks, with consequent differences in their capacity to shorten ischemic time and to contribute to diagnostic decision-making in chest pain syndromes (Batt et al., 2024).

Across jurisdictions, the scope of practice of paramedics in relation to chest pain ranges from basic monitoring and prompt transport to sophisticated assessment, diagnostic interpretation, and initiation of time-critical therapies such as antiplatelet agents and anticoagulants. In many high-income settings, advanced life support (ALS) paramedics are authorised to obtain and interpret 12-lead ECGs, recognise STEMI criteria, administer aspirin, nitrates, and opioids, initiate oxygen when indicated, treat arrhythmias, and, in some systems, begin antithrombotic regimens at first medical contact in line with guideline-directed care. By contrast, basic life support (BLS) providers may be limited to symptom recognition, vital sign monitoring, basic analgesia, and rapid transport, relying on ALS intercepts or hospital-based teams for definitive management, which can introduce delays in reperfusion and limit early risk stratification. Even within a single country, differential scopes for technician-level, paramedic, and extended-practice or practitioner roles lead to heterogeneity in which provider type first sees chest pain patients, which in turn affects the timing and quality of prehospital ACS care (Heardman, 2014).

International analyses highlight striking variability in paramedic education, clinical decision-making authority, and professional governance, which together shape how effectively early chest pain recognition and management can be delivered. Some countries have transitioned to university-based degree programs with strong emphasis on pathophysiology, ECG interpretation, pharmacology, and evidence-based practice, producing clinicians who are better equipped to differentiate cardiac from non-cardiac chest pain and to recognise atypical presentations. In other contexts, shorter vocational training and limited exposure to cardiology or research methods restrict paramedics' confidence and autonomy, leading to greater reliance on rigid algorithms or hospital-based decisions, which may reduce flexibility in complex or ambiguous chest pain scenarios. Decision-making authority also varies: in some systems, paramedics can make independent decisions about direct transport to catheterisation-capable centres or bypass of closer hospitals once STEMI is suspected, while in others, such decisions require online medical direction or are reserved for physicians, influencing door-to-balloon times and regional equity in access to reperfusion (Feerick et al., 2025).

Clinical governance frameworks, including protocols, standing orders, and medical oversight, are central in standardising prehospital chest pain care and enabling paramedics to act rapidly without waiting for real-time physician authorisation. Protocols derived from cardiology and resuscitation guidelines typically specify indications and contraindications for aspirin, nitrates, and opioid analgesia; criteria for ECG acquisition and repeat recordings; thresholds for STEMI activation; and destination policies for direct transport to percutaneous coronary intervention (PCI) centres, thus operationalising evidence-based practice in the field. Standing orders granted under delegated medical authority allow paramedics to initiate these interventions when ACS is suspected, while structured medical oversight, audit, and feedback support continuous quality improvement, identify deviations, and refine pathways in response to performance data such as first medical contact–to-device times and false activation rates. However, governance can also constrain practice when protocols are overly restrictive or not updated to reflect evolving evidence, potentially limiting prehospital antithrombotic strategies or teleconsultation, especially in resource-limited environments (Reddy et al., 2025).

Integration of paramedics into regional STEMI and broader ACS systems of care is a key determinant of how effectively early recognition translates into timely reperfusion and improved outcomes. Well-functioning systems typically empower paramedics to obtain prehospital 12-lead ECGs, interpret or transmit them for expert review, pre-activate catheterisation laboratories, and bypass non-PCI facilities when STEMI criteria are met, thereby compressing the EMS-to-balloon interval. Structured algorithms such as prehospital activation protocols define communication pathways, inclusion and exclusion criteria, and decision rules for direct-to-catheterisation-laboratory transport, and implementation of such models has been associated with reductions in emergency department dwell times, lower rates of inappropriate activations, and improved adherence to guideline time targets. In some networks, paramedics also contribute to risk stratification of non-ST-elevation ACS through validated scores and early biomarker strategies, although use of point-of-care cardiac troponin in the field remains inconsistent and heavily influenced by local governance and resource availability (Kontos et al., 2020).

The composition of EMS crews and models of deployment further condition how chest pain syndromes are assessed and managed before hospital arrival. Traditional two-person ALS crews, often comprising paramedics supported by emergency medical technicians, provide a balance between rapid scene times and sufficient manpower for concurrent tasks such as ECG acquisition, intravenous access, medication administration, and continuous monitoring; however, in some regions, single-responder paramedics operate alone, which can extend on-scene times or limit complex interventions in unstable patients. Systems that pair paramedics with emergency nurses or physicians, particularly in ALS units or specialised response teams, can enhance pharmacologic options and procedural capabilities, including management of high-risk arrhythmias or cardiogenic shock, but may be less scalable for routine chest pain due to cost and staffing constraints. Evidence comparing ALS and BLS outcomes in medical emergencies suggests that highly protocolised ALS care does not automatically translate into survival benefits and may even be associated with higher mortality if scene times are prolonged or interventions are not carefully targeted, underscoring the importance of model design and training in chest pain pathways (Sanghavi et al., 2015).

Alternative and extended models of care, such as community paramedicine and mobile integrated healthcare, are increasingly relevant to chest pain syndromes, particularly for low-risk or recurrent presentations. Community paramedics, working in collaboration with primary care and cardiology services, can provide scheduled or unscheduled home visits for patients with known coronary artery disease or heart failure, perform focused assessments, reinforce medication adherence and lifestyle modifications, and identify early symptom deterioration that might otherwise go unrecognised until an emergency event. Some programs allow specially trained paramedics to use structured risk tools, teleconsultation, and point-of-care investigations to safely refer selected low-risk chest pain patients to rapid access clinics or primary care follow-up instead of default transport to crowded emergency departments, potentially reducing unnecessary admissions while maintaining safety. These models rely on robust governance, shared electronic records, and interdisciplinary collaboration but highlight the expanding role of paramedics beyond emergency response into longitudinal cardiovascular risk management and secondary prevention, which may indirectly affect incidence and severity of future ACS events(Feerick et al., 2025).

Early recognition of chest pain syndromes by paramedics

Early recognition of chest pain syndromes by paramedics is critical in the chain of survival and optimal patient outcomes. Paramedics often serve as the first point of medical contact for patients experiencing chest pain, which may indicate life-threatening conditions such as acute coronary syndrome (ACS). Studies show that paramedics can accurately identify chest pain cases warranting urgent intervention by using clinical skills combined with diagnostic tools. Sensitivity and specificity for the prehospital diagnosis of myocardial infarction by advanced paramedics have been reported as approximately 78% and 82%, respectively, reflecting their essential role in early recognition and triage. The challenge lies not only in identifying typical presentations but also in recognizing elusive or atypical cases, which demands thorough assessment skills and clinical decision-making (Ulrich Hansen et al., 2022).

Initial assessment and scene management begin with ensuring scene safety followed by a rapid but focused triage using the primary survey (ABCDE - Airway, Breathing, Circulation, Disability, Exposure). Paramedics must quickly evaluate airway patency, adequate breathing, and circulation status while maintaining scene control and patient safety. Rapid identification of time-critical chest pain involves prioritizing patients with symptoms indicating possible myocardial infarction or unstable angina. This may include recognizing patient distress, diaphoresis, pallor, or altered consciousness to activate emergency interventions early. The primary survey also guides immediate resuscitative measures if shock or respiratory failure is suspected. Effective scene management influences downstream clinical decision-making and patient outcomes by ensuring appropriate urgency and resource allocation (Ulrich Hansen et al., 2022).

History-taking in the prehospital setting focuses on a structured but concise chest pain history, including onset time, pain character (pressure, tightness, stabbing), radiation (arms, jaw, back), and associated symptoms such as diaphoresis, nausea, or dyspnea. Paramedics utilize this information to form a differential diagnosis and risk stratification. However, history-taking is limited by environmental factors like noise, chaos, and patient distress, which can obscure critical details. Moreover, the subjective nature of pain and communication barriers may reduce accuracy. Despite these limitations, systematic chest pain history remains a cornerstone of prehospital assessment, helping prioritize patients for expedited care (Wibring et al., 2022).

Physical examination by paramedics includes vital sign measurement (heart rate, blood pressure, respiratory rate, oxygen saturation) and targeted cardiovascular and respiratory examinations. This examination aims to detect signs of hemodynamic instability such as shock (hypotension, tachycardia), heart failure (pulmonary crackles, jugular venous distension), or respiratory compromise (tachypnea, hypoxia). Identification of these signs facilitates urgent interventions and guides transport decisions. While the prehospital physical exam cannot replace comprehensive hospital diagnostics, it is valuable for immediate risk assessment and ongoing patient monitoring during transport (Wibring et al., 2022).

Clinical decision tools adapted for prehospital use, such as the HEART, EDACS, and other risk scores, aid paramedics in objective risk stratification of chest pain patients. These tools combine symptoms, vital signs, ECG findings, and sometimes biomarker results to classify patients into risk categories, guiding treatment and destination decisions. The use of such scoring systems improves diagnostic accuracy and standardizes care, though limitations exist due to the incomplete data in the prehospital environment and variable paramedic training. Nonetheless, implementation of decision aids is feasible and enhances paramedic confidence and patient safety (Sagel, Vlaar, Roosmalen, et al., 2021).

Recognition of atypical and under-recognized chest pain presentations is an ongoing challenge for paramedics. Women, older adults, diabetic patients, and those facing cultural or communication barriers may present with non-classic symptoms such as fatigue, indigestion, or atypical pain locations. Paramedic awareness of sex and gender differences and the influence of comorbid conditions is crucial, as these populations are at risk of under-triage and delayed treatment. Training programs increasingly highlight these disparities and advocate for a high index of suspicion to improve equitable and timely care (Sagel, Vlaar, Roosmalen, et al., 2021).

Prehospital Diagnostics in Chest Pain

Prehospital diagnostics in chest pain syndromes represent a critical frontline intervention by paramedics, enabling rapid risk stratification and timely activation of specialized care pathways for conditions such as ST-elevation myocardial infarction (STEMI) and non-ST-elevation acute coronary syndromes (NSTE-ACS). Paramedics employ structured assessment tools like the modified HEART score combined with point-of-care testing to differentiate low-risk patients suitable for alternative care from those requiring urgent hospital transport, thereby optimizing resource allocation and reducing unnecessary emergency department overcrowding. Studies demonstrate that prehospital evaluation using questionnaires and initial electrocardiograms (ECGs) achieves high accuracy in identifying STEMI, with paramedics showing excellent agreement with emergency physician diagnoses across organ systems involved in chest pain etiologies. Furthermore, population-wide prospective analyses reveal that most prehospital chest pain patients suffer low-risk conditions without prognostic need for acute hospitalization, while a minority harbor high-risk pathologies like acute myocardial infarction or pulmonary embolism that demand prompt specialist intervention. Integration of these diagnostics into emergency medical services (EMS) protocols enhances patient safety through personalized care models that balance conveyance decisions with evidence-based risk prediction (Wong et al., 2025).

Acquisition of 12-lead ECGs by paramedics in the prehospital setting has become a cornerstone of chest pain management, facilitating early detection of ischemic changes and expediting reperfusion therapies through direct cath lab activation. Paramedics demonstrate proficiency in obtaining and interpreting these ECGs, with systematic reviews confirming their ability to independently identify STEMI with pooled sensitivity and specificity exceeding 95%, particularly when supported by additional training and interpretive protocols. Comparative studies across EMS systems highlight that paramedic ECG interpretation aligns closely with cardiologist assessments, enabling safe standalone decision-making for STEMI recognition while minimizing false activations. Enhanced education and tools further elevate accuracy, as evidenced by sensitivities ranging from 75% to 99% and specificities up to 96% in trained cohorts, underscoring the feasibility of out-of-hospital ECGs as a pivotal diagnostic modality. This capability not only shortens door-to-balloon times but also supports broader ischemic pattern detection beyond classic STEMI criteria (Tanaka et al., 2022).

Paramedic accuracy in interpreting prehospital 12-lead ECGs for STEMI reaches high levels, with meta-analyses reporting pooled sensitivities of 95.5% and specificities of 95.8%, affirming reliability in real-world EMS applications despite variability in training and equipment. For other ischemic changes, such as ST-depression or bundle branch blocks, paramedics achieve strong consensus with physician interpretations, though challenges persist in distinguishing STEMI mimics, necessitating protocol-driven approaches to mitigate over- or under-diagnosis. Prospective observational data from diverse systems indicate that 80% of paramedics correctly identify STEMI, with positive predictive values around 83% and negative predictive values up to 96%, supporting independent activation of PCI pathways. Factors like mandatory training and computer-assisted interpretation further boost performance, reducing diagnostic dilemmas that could delay cath lab mobilization or overburden facilities. Overall, these accuracies position paramedics as effective diagnosticians, with outcomes favoring early STEMI identification over risks of misinterpreting subtle ischemic patterns (Tanguay et al., 2019).

Telemedicine integration via remote ECG transmission markedly enhances prehospital chest pain diagnostics, associating with 47% mortality reductions in STEMI cohorts through faster physician oversight and systems-of-care optimization. Transmission of digital 12-lead ECGs to interventional cardiologists shortens first medical contact-to-device and door-to-device times, as meta-analyses of observational studies confirm significant improvements in reperfusion metrics. Sensitivity for chest pain diagnosis via telecardiology reaches 97.4% with 89.5% specificity, enabling real-time consultations that refine paramedic decisions in non-PCI capable regions. Programs incorporating videoconference and ECG upload features extend these benefits to walk-in patients without EMS prehospital ECGs, broadening access to expert interpretation. Such networks prove cost-effective and scalable, advocating for universal adoption in STEMI protocols to amplify paramedic capabilities with remote specialist input (Moxham et al., 2024).

Serial ECGs during prehospital and transport phases capture dynamic ischemic evolutions missed by initial tracings, proving more sensitive for acute coronary syndromes (ACS) detection with up to 68.1% sensitivity for myocardial infarction versus 55.4% for single ECGs. Repeat acquisitions every 20 minutes or during symptom recurrence reveal evolving ST-elevation, new injury patterns, or de Winter configurations, enhancing specificity to 99.4% for ACS while identifying additional injury in 16.2% of infarction cases. In chest pain patients with initially normal ECGs, serial monitoring predicts 30-day outcomes better, guiding anti-ischemic therapies and reperfusion evaluations proactively. These dynamic assessments are particularly vital for recurrent pain episodes, where temporally striking changes differentiate pericarditis mimics from true ischemia, informing conservative versus invasive strategies en route (Elmahy et al., 2013).

During transport, repeat ECGs enable ongoing surveillance of chest pain trajectories, detecting progression from subtle ST changes to overt STEMI, which supports intravel adjustments like fibrinolysis initiation. Protocols mandating serial ECGs post-initial acquisition minimize transport delays while maximizing diagnostic yield, as studies show heightened injury detection without prolonging scene times significantly. This practice proves indispensable for hypotensive or tachycardic patients, where dynamic elevations prompt urgent echo corroboration or analgesia escalation. Evidence underscores that transport-phase repeats outperform static initial ECGs in prognostic accuracy, fostering seamless handoffs to receiving centers (Elmahy et al., 2013).

Emerging point-of-care high-sensitivity troponin I/T assays in prehospital settings accelerate NSTEMI diagnosis, with rapid results informing conveyance decisions and reducing ED burdens. Multicenter trials validate their feasibility, showing minimal transport delays and improved discharge rates for low-risk cohorts via serial sampling. Integration with risk scores like HEART enhances diagnostic cornerstones, projecting earlier treatment initiation for confirmed ACS (Lökholm et al., 2025).

Diagnostic yield from prehospital troponin proves high, with studies reporting viable risk categorization that avoids admissions for non-ACS cases and streamlines high-risk pathways. Impacts include shorter ED stays and cost efficiencies, though prospective safety trials remain essential to confirm low adverse event rates in discharged patients. Evidence supports broader EMS adoption, particularly with 5th-generation assays for unselected chest pain populations (Dawson et al., 2023).

Routine monitoring via pulse oximetry tracks oxygenation trends, while capnography assesses ventilation-perfusion matching in chest pain, aiding differential diagnosis of respiratory contributors like pulmonary embolism. Blood pressure serials detect hemodynamic instability, complementing ECG/biomarker data for holistic prehospital assessment. Capnography's real-time waveforms provide seventh vital sign status, alerting to hypoventilation before desaturation (Al-Beltagi et al., 2024).

Prehospital diagnostics face constraints from austere environments, including motion artifacts degrading ECG quality and limiting serial acquisitions. Equipment portability challenges biomarker stability, while time pressures prioritize transport over comprehensive testing, potentially reducing yield. These factors underscore needs for ruggedized tools and streamlined protocols to sustain accuracy under duress (Alrumayh et al., 2022).

Prehospital Management of Chest Pain Syndromes

Prehospital management of chest pain syndromes by paramedics focuses on rapid assessment, stabilization, and initiation of evidence-based interventions to minimize myocardial damage and improve outcomes in suspected acute coronary syndrome (ACS), while also addressing potential non-cardiac etiologies. This approach emphasizes a systematic protocol including 12-lead ECG acquisition, vital signs monitoring, and transport decisions based on local capabilities, with general supportive measures forming the foundation to optimize patient physiology prior to hospital arrival. Paramedics prioritize airway, breathing, and circulation while mitigating risks like arrhythmias or hemodynamic instability, adapting strategies to scope of practice variations across regions(Ahmed et al., 2024).

General supportive management in prehospital chest pain care encompasses oxygen therapy tailored to hypoxia, patient positioning for comfort and ventilation, psychological reassurance to reduce anxiety, and pain control to alleviate suffering without obscuring diagnostic clues. Oxygen administration targets saturations of 94-98% in normoxic patients to avoid vasoconstriction and infarct expansion, with high-flow oxygen discouraged based on trials showing increased myocardial injury; titration via nasal cannula or mask follows pulse oximetry guidance, reserving high concentrations for SpO_2 below 90% or respiratory distress. Positioning favors semi-upright or sitting if tolerated to reduce preload and dyspnea, while psychological support involves calm communication and family involvement; pain control principles employ multimodal analgesia starting with non-opioids, escalating cautiously to prevent respiratory depression, all integrated with continuous ECG monitoring and rapid transport (Carhart & Salzman, 2014).

Pharmacological treatment protocols for prehospital chest pain prioritize antiplatelet therapy with aspirin loading doses of 162-325 mg chewed orally for all suspected ACS without contraindications, yielding mortality reductions through platelet inhibition and thrombus stabilization when administered early by paramedics. Nitrates, typically sublingual nitroglycerin 0.3-0.4 mg repeated up to three doses if systolic blood pressure exceeds 100 mmHg, relieve ischemia by venodilation but require caution in right ventricular infarction, inferior STEMI patterns, or hypotension, with hemodynamic monitoring essential to avert profound bradycardia or collapse. Analgesia incorporates opioids like morphine or fentanyl titrated for severe pain unresponsive to nitrates, though alternatives such as paracetamol or ketorolac suit milder cases to minimize assessment interference; anticoagulants like heparin fall within expanded scopes, alongside beta-blockers in select stable patients, all underscoring protocol adherence to enhance reperfusion timelines(Nakayama et al., 2022).

Advanced cardiac care extends to prehospital thrombolysis for STEMI when percutaneous coronary intervention delays exceed 120 minutes, with paramedics applying strict criteria including symptom onset under 12 hours, ST-elevation on ECG, no absolute contraindications like recent stroke, achieving reperfusion times under 90 minutes and mortality benefits comparable to in-hospital therapy despite minor bleeding risks. Protocols demand consultant oversight, serial ECGs, and rescue PCI transfer, demonstrating reduced total ischemic time in rural settings. Management of ACS-related arrhythmias involves synchronized cardioversion for unstable tachycardias or defibrillation per ACLS, while cardiac arrest mandates high-quality CPR, epinephrine, and amiodarone, with dual dispatch systems optimizing outcomes through field termination of resuscitation judiciously (Faddy et al., 2025).

Paramedic strategies for non-ACS chest pain like suspected pulmonary embolism (PE), aortic dissection, or tension pneumothorax emphasize high-flow oxygen for hypoxia, fluid resuscitation for shock, and decompressive interventions where trained, such as needle thoracostomy for tension physiology evidenced by tracheal deviation and absent breath sounds. Aortic dissection prompts blood pressure control with cautious beta-blockers avoiding vasodilators alone, while PE management supports perfusion pending thrombolysis in extremis; limitations in definitive prehospital diagnosis via ECG or ultrasound necessitate broad differentials, prioritizing supportive care like analgesia, antiemetics, and rapid transport to tertiary centers over risky field therapies. Emphasis remains on serial assessments and "load-and-go" for instability, bridging to hospital imaging and specialist intervention (Axelsson et al., 2015).

Paramedic Role in Systems of Care and Reperfusion Strategies

Paramedics serve as critical frontline providers in ST-elevation myocardial infarction (STEMI) systems of care, facilitating rapid reperfusion through prehospital electrocardiogram (ECG) acquisition, STEMI identification, and coordination with receiving centers to minimize total ischemic time and improve survival rates. Their integration into reperfusion strategies emphasizes primary percutaneous coronary intervention (PCI) as the preferred approach when achievable within guideline timelines, with paramedics enabling direct transport protocols that bypass non-PCI facilities to optimize door-to-balloon (DTB) times, which are strongly linked to reduced mortality and major adverse cardiac events. Evidence highlights that paramedic-led prehospital notifications increase PCI center preparedness, reducing system delays, while regional networks leverage paramedic data for quality improvement and protocol adherence, addressing disparities in urban versus rural settings where transport logistics pose unique challenges (Alrawashdeh et al., 2021).

Paramedic-facilitated direct-to-PCI-center triage protocols allow for immediate bypass of non-PCI facilities, significantly shortening DTB times by avoiding secondary transfers that can add 30-60 minutes or more to reperfusion delays, with studies demonstrating median DTB reductions from 83 minutes via emergency departments to 37 minutes with direct cath lab access. Prehospital activation of catheterization labs by paramedics, often supported by 12-lead ECG transmission and telemetry consultation, streamlines workflows, though criteria such as ST-elevation thresholds must balance sensitivity and specificity to limit false positives (typically 4-12%) and false negatives that could delay care. These pathways not only cut treatment delays but also enhance outcomes, including lower 30-day mortality, by ensuring first medical contact-to-device times meet targets like under 90-120 minutes, particularly when paramedic education programs boost direct transfer rates from 52% to 85% over time (Mahadevan et al., 2022).

Activation criteria for prehospital cath lab alerts generally include new ST-elevation ≥1-2 mm in two contiguous leads, coupled with chest pain syndromes suggestive of acute coronary syndrome (ACS), with paramedic training and physician oversight reducing inappropriate activations from 7% to 3% while maintaining high true-positive yields. False-positive rates hover around 4-16% depending on automated versus physician-reviewed ECGs, with human interpretation errors accounting for most discrepancies, yet acceptable thresholds under 10-20% support net benefits in timely reperfusion outweighing resource utilization costs. False negatives, often from subtle ECG changes or atypical presentations, underscore the need for ongoing paramedic competency assessments, as low rates preserve patient outcomes without excessive delays from over-cautious protocols (Boivin-Proulx et al., 2020).

Direct triage and prehospital activation profoundly impact treatment delays, achieving first medical contact-to-balloon times under 90 minutes in over 75% of cases with optimized paramedic protocols, directly correlating with 20-30% relative mortality reductions per 30-minute DTB decrement. Outcomes improve markedly, evidenced by decreased in-hospital mortality (6% in optimized cohorts) and fewer reinfarctions, as paramedic interventions like aspirin administration and rapid transport integrate seamlessly into PCI pathways. Long-term benefits extend to reduced readmissions for heart failure or recurrent ACS, affirming paramedics' pivotal role in bridging prehospital and hospital phases for superior patient survival and quality of life(Alrawashdeh et al., 2021).

Paramedics require advanced ECG interpretation, thrombolytic administration skills (where authorized), and protocol adherence for safe reperfusion integration, bolstered by education yielding sustained DTB improvements and false-positive reductions. Safety hinges on low complication rates from fibrinolytics (<5% major bleeds in trained hands) and balanced activation criteria minimizing unnecessary cath lab use while averting misses. Competencies encompass real-time physician oversight, aspirin/antiplatelet protocols, and rural adaptations like helicopter coordination, ensuring paramedics enhance systems without compromising patient safety (Godfrey & Borger, 2022).

Challenges and barriers in prehospital chest pain care

Challenges and barriers in prehospital chest pain care encompass multifactorial system-level impediments that impact timely and effective care delivery. System-level barriers include resource constraints, especially pronounced in rural or remote settings where longer transport times to definitive care centers significantly delay treatment initiation. Limited availability of advanced diagnostic equipment such as electrocardiogram (ECG) transmission tools and point-of-care testing manifests as variation in capability among emergency medical services (EMS), impacting early risk stratification and clinical decision-making. This disparity often results in emergency departments (ED) being overcrowded with chest pain patients, many of whom may be at low risk yet require urgent triage to prevent adverse outcomes. The lack of infrastructure for rapid diagnostic confirmation challenges the balance between over-triage and under-triage in prehospital contexts, exacerbating healthcare resource allocation issues in acute coronary syndromes (ACS) management(Wibring et al., 2021).

Clinically, paramedics face significant diagnostic challenges due to the non-specific nature of chest pain symptoms and the complexity introduced by patient comorbidities and polypharmacy. Distinguishing cardiac chest pain from non-cardiac causes within limited on-scene and transport time is difficult, as symptoms often overlap with gastrointestinal, pulmonary, or musculoskeletal conditions. The urgent context and incomplete patient history further complicate accurate diagnosis. Standard diagnostic tools available in hospital settings are often not accessible prehospital, requiring paramedics to rely on clinical judgment, limited ECG interpretation, and basic physiological assessment, which may lack sensitivity or specificity for ACS. This clinical uncertainty affects timely identification of high-risk cases needing direct transport to specialized cardiac facilities and may delay reperfusion strategies for conditions like STEMI (Wibring et al., 2021).

Human factors critically influence paramedic performance in chest pain recognition and management. High levels of stress, fatigue, cognitive load, and decision fatigue during emergency responses impair clinical judgement and increase the risk of diagnostic errors or suboptimal treatment decisions. Communication barriers compound these difficulties, as paramedics may face challenges interacting effectively with patients, their families, or other healthcare providers due to environmental noise, emotional distress, or linguistic and cultural differences. Furthermore, occupational safety concerns and environmental risks at call sites may distract paramedics, reducing situational awareness and focus on clinical tasks. These human factors require systemic support, including adequate training, teamwork coordination, and organizational policies promoting wellbeing for emergency responders (Poranen et al., 2025).

Equity and bias present persistent challenges in prehospital chest pain care, affecting diagnostic and therapeutic equity for diverse populations. Sex and gender disparities are evident in rates of ECG acquisition and timely treatment, with women often less likely to receive ECGs or interventions due to biases linked to atypical symptom presentation or provider hesitancy. Socioeconomic status, racial and ethnic minority status, and language barriers also contribute to unequal care, with evidence showing lower receipt of analgesia and diagnostic procedures among certain racial and ethnic groups. These inequities not only compromise patient outcomes but undermine trust in EMS systems. Addressing these disparities demands targeted quality improvement initiatives, cultural competency training, and policies to ensure equitable care across all demographic groups (Asghar et al., 2016).

Emerging innovations and future directions

Emerging innovations in the role of paramedics for early recognition and management of chest pain syndromes are greatly influenced by advancements in technology and expanding clinical roles. One of the most promising technological developments is artificial intelligence (AI)-assisted ECG interpretation. AI models, using convolutional neural networks and long short-term memory networks, can provide rapid and highly accurate detection of ST-elevation myocardial infarction (STEMI) from prehospital 12-lead ECGs. This technology significantly shortens the response time to paramedics in the field compared to conventional physician interpretation, enabling faster triage and timely reperfusion therapy. AI-assisted ECG interpretation has reached cardiologist-level diagnostic performance and has been validated both in preclinical testing and real-world emergency medical settings, thus expediting the crucial decision-making process in prehospital care for chest pain patients (Chen et al., 2022).

Decision-support tools embedded directly into monitors or electronic patient care record (ePCR) systems represent another technological front. These tools can enhance paramedics' clinical judgment by integrating real-time patient data and guideline-based algorithms to support risk stratification and management decisions. The incorporation of AI and decision support within prehospital monitoring systems streamlines workflow, reduces diagnostic uncertainty, and promotes adherence to clinical protocols, thereby improving patient outcomes. Such innovations are facilitating broader adoption of advanced diagnostic modalities in the prehospital setting, enabling paramedics to perform more comprehensive assessments on scene (Demandt et al., 2025).

Expanding diagnostic capabilities include the wider adoption of prehospital troponin testing and multi-marker cardiac panels. Point-of-care troponin assays are increasingly feasible for use by paramedics, allowing for early risk stratification of patients with acute chest pain. Studies have demonstrated that prehospital troponin testing combined with paramedic clinical assessment can safely reduce unnecessary hospital admissions and emergency department length of stay, while maintaining equivalent cardiovascular outcomes. This approach also offers significant health system cost savings, supporting its broader implementation. The use of high-sensitivity point-of-care troponin assays in the prehospital environment is an evolving field that promises to refine chest pain pathways and expedite management decisions for acute coronary syndromes(Dawson et al., 2023).

Research priorities to maximize these advances include conducting high-quality clinical trials examining the impact of prehospital interventions like AI-assisted ECG interpretation and point-of-care testing on patient-centered outcomes such as time to reperfusion, diagnostic accuracy, and morbidity. Additionally, implementation science research is critical to understanding how to effectively translate evolving guidelines and innovations into routine prehospital practice. This includes identifying barriers and facilitators to guideline adherence among paramedics, optimizing training, and evaluating scalable models for integrating new technologies. Bridging these gaps will ensure that evidence-based care for chest pain syndromes is reliably delivered at the earliest stages of emergency medical response (Ebben et al., 2018).

Conclusion

Paramedics represent a critical frontline in the management of chest pain syndromes. Their ability to perform rapid assessments, interpret ECGs, administer life-saving interventions, and activate reperfusion pathways significantly reduces delays to definitive care in acute coronary syndromes. Variability in training, diagnostic capability, and system integration influences care quality and outcomes, highlighting the need for ongoing education, protocol standardization, and technological support. Expanding paramedic roles and integrating emerging diagnostics hold promise for further improving prehospital chest pain management and patient survival.

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