



# Perspective/Commentary: The Transformation of STEMI Care with Thrombolysis in Paramedicine

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## Abstract

The integration of thrombolysis into paramedicine practice has brought about a significant paradigm shift in the treatment and prognosis of patients with STEMI (ST-Elevation Myocardial Infarction). This innovative approach has led to a notable increase in patient survival rates, demonstrating its effectiveness. A crucial aspect of this transformative change is the noteworthy reduction in “door-to-needle” time, a critical benchmark in STEMI management. As we delve deeper into examining this shift, it becomes increasingly evident that its impact extends beyond the immediate and convenient on-scene medical intervention. Instead, it fundamentally alters the trajectory of patient outcomes, highlighting the evolving role of paramedicine within the realm of medical care.

**Keywords** Myocardial infarction · Thrombolysis · Paramedicine · Telehealth · Outcomes

## 1 Introduction

Cardiovascular emergencies remain a significant global health concern, calling for innovative strategies to enhance survival rates and mitigate the risks inherent to these time-sensitive conditions [1]. Around fifty years ago, renowned medical expert Eugene Braunwald, proposed a revolutionary idea: time is muscle [2]. This concept suggested that myocardial infarctions were not static events but dynamic processes, with the clinical outcome largely influenced by the size of the infarction [3].

Braunwald and his team's investigation of this theory led to a key understanding: the extent and severity of heart damage due to arterial blockage can be drastically altered, not just by previous treatments, but also by timely intervention—even up to three hours following the blockage [3]. This understanding led to two primary conclusions from the resultant clinical trials: First, re-establishing arterial flow improves survival rates, and second, for maximum effectiveness, artery reopening should be performed within a shorter timeframe than Braunwald initially suggested [4–7].

Today, the European Society of Cardiology recommends a ‘call-to-needle’ time of less than 30 min for prehospital thrombolysis (PHT), if primary percutaneous coronary intervention (PCI) cannot be performed within the optimal timeframe [8, 9]. Time from ST-Elevation Myocardial Infarction (STEMI) diagnosis to wire crossing is recommended to be <60 min for patients presenting at a primary PCI hospital, whereas it should be <90 min for patients diagnosed either in a non-PCI hospital or in the out-of-hospital setting. For patients treated by fibrinolysis, the recommended time between STEMI diagnosis and initiation of fibrinolysis is <10 min [10].

The timings associated with thrombolytic therapy shape critical clinical decisions. The survival benefit associated with primary PCI for STEMI could diminish if the time from hospital arrival to balloon inflation extends by over an hour compared to the time from hospital arrival to the commencement of fibrinolytic therapy [4]. The criticality of this “golden hour” is monumental. It underscores the irrefutable importance of time and that the fleeting “golden hour” often determines life and death scenarios for these patients [11, 12]. Traditionally, thrombolysis was a treatment confined to hospital settings, bound by time and location limitations. Yet, the rise of paramedicine has drastically altered this narrative [13], equipping paramedics as frontline responders with the capacity to administer thrombolytic agents directly at the emergency scene.

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This shift from hospital-centric care to paramedicine intervention marks a transformative change in emergency medicine. This commentary explores the integral role of thrombolysis in paramedicine and its significant influence on the management of cardiovascular emergencies.

## 2 Historical Evolution of PHT

The historical evolution of thrombolysis in paramedicine provides a compelling narrative, revealing a story of determination and innovation in the realm of emergency medical care. The journey commences with a traditional model of care for STEMI patients, grounded within the hospital environment. However, an increasing need for effective field interventions soon became evident.

Initial scepticism within the cardiovascular emergency medicine community was steadily replaced by curiosity as questions regarding feasibility, safety, and effectiveness began to surface [14, 15]. The 1990s marked the significant inclusion of prehospital lysis into paramedic clinical practice guidelines, following the recommendations of the National Heart Attack Alert Program [16]. This program concluded that prehospital thrombolysis reduces mortality in a particular subset of patients in need of long out-of-hospital transport times to an emergency department [17].

Morrison's 2000 meta-analysis [18] incorporated six studies from this period, including Castaigne et al.'s [19] placebo-based RCT which tested the feasibility of using PHT. This study demonstrated the safety and feasibility of PHT, and while its efficacy was yet to be tested, further studies had already begun [20–23]. However, the variance in study characteristics proved challenging for data analysis, including differing skill levels among administering health officers and types of drugs given to patients. Morrison et al. concluded that a clinically important and statistically significant decrease in all-cause hospital mortality occurred when patients with AMI received prehospital versus in-hospital thrombolysis [18].

Ground-breaking trials such as Steg et al.'s 2003 CAPTIM study [8] highlighted the benefits of prehospital thrombolysis in specific patient demographics. It underscored the efficacy of differing reperfusion strategies during the acute phase of myocardial infarction, given the presence of a robust pre-hospital organisation. A subsequent 2009 follow-up study further corroborated the long-term mortality benefits of patients managed with PHT [9]. Such studies instigated a metamorphosis in patient care, leading to the idea of trialling of differing reperfusion strategies beyond the confines of hospital walls.

Further studies such as Bøtker et al. [24] investigation began to challenge the conventional hospital-bound care model by examining the condition-specific short- and

long-term mortality of EMS patients [24]. Their findings, and similar studies such as that by Bonnefoy et al. [9] and Björklund et al. [25], suggested not only the feasibility of administering thrombolytic in field conditions but also the potential for improved patient outcomes.

This shift in perspective, however, brought about its challenges. The implementation of thrombolysis in paramedicine necessitated extensive training, the establishment of stringent clinical protocols, careful patient selection, and the development of supporting infrastructure [26–28]. Collaboration with hospitals and other medical professionals was fundamental to overcoming these hurdles.

## 3 Impact on STEMI Patient Outcomes

The integration of thrombolysis in paramedicine marks a pivotal shift in the care and outcomes of patients experiencing STEMI. As we examine this shift, the impact goes beyond the mere advantage of on-scene intervention; it fundamentally changes patient outcomes. This transformation is largely attributed to the significant reduction in 'door-to-needle' time, a vital factor in STEMI care [12, 29]. With thrombolysis now part of paramedic practice, geographical barriers and hospital-based interventions no longer restrict care. Trained for rapid and precise decision making, paramedics can initiate thrombolytic therapy at the scene or in transit to the hospital [28]. This immediate action significantly cuts down door-to-needle time, preserving essential cardiac muscle and improving patients' prognosis.

Research findings reveal comparable results between thrombolytics and primary percutaneous coronary intervention (PCI), particularly for patients who might face delays in accessing PCI [30]. This evidence-based shift has led to a wider acceptance of paramedics administering thrombolytics in the prehospital setting. Such evidence also verifies the feasibility and effectiveness of prehospital thrombolysis, demonstrating paramedics' abilities to correctly identify STEMI cases and initiate life-saving procedures [31, 32].

Studies, such as PRAGUE-2, STOPAMI-1 and -2, MITRA, MIR, and CAPTIM trials [20–23], have shown that pre-hospital thrombolysis is particularly useful for patients with short duration of infarct symptoms. In cases where patients face delays in reaching the hospital, for example due to remote locations or significant travel times to a PCI capable hospital, prehospital thrombolytics have improved patient outcomes. The expedited initiation of thrombolytic treatment increases the likelihood of coronary artery reperfusion and myocardial salvage, reducing severe cardiac damage and enhancing prognosis.

Pre-hospital reperfusion therapy also contributes to 'facilitated' PCI, a strategy that combines immediate medical reperfusion, such as thrombolytic therapy, with subsequent

PCI [30]. This approach aims to maximize the benefits of both pre-hospital reperfusion therapy and PCI. Facilitated PCI initiates early reperfusion with thrombolytic therapy in the pre-hospital setting, rapidly restoring blood flow to the affected coronary artery. Upon hospital arrival, the patient undergoes PCI to further optimize coronary reperfusion and address any residual stenosis or thrombus.

Research trials have demonstrated that pre-hospital thrombolysis, as part of urgent or immediate PCI, is particularly beneficial for patients with short duration of infarct symptoms [20–23]. This approach has exhibited similar effectiveness to primary PCI on mortality and infarct size in these specific patient populations. Consequently, urgent or immediate PCI may be particularly advantageous for STEMI patients who present within the first few hours after symptom onset.

The ultimate beneficiaries of this transformation are the patients. The significant reduction in door-to-needle times, increased survival rates, and a more patient-focused approach to care underscores the profound influence of thrombolysis in paramedicine on STEMI patient outcomes. This paradigm shift sets a new standard in managing cardiovascular emergencies, shaping the trajectory of lives saved and futures preserved.

## 4 Future Prospects

While the integration of thrombolysis in paramedicine has revolutionized STEMI care, the journey is far from over. The future holds a wealth of possibilities that promise to further enhance the landscape of cardiovascular emergency medicine.

*Advancements in Thrombolytic Agents:* As we venture into the future, one area ripe for development is the refinement and innovation of thrombolytic agents [33]. Researchers and pharmaceutical companies are continuously exploring the design of more effective and targeted thrombolytics [33]. These advanced agents may not only expedite coronary artery reperfusion but also minimize the risk of bleeding complications. The evolution of thrombolytic agents stands as a beacon of hope, offering potential refinements in the safety and efficacy of STEMI care.

*Telemedicine Support:* The advent of telemedicine has the potential to reshape the practice of paramedicine in STEMI care. Telemedicine support systems could provide real-time consultation with remote cardiologists, allowing paramedics to make more informed decisions and ensuring that patients receive the most up-to-date care. These systems, if facilitated by high-speed data networks, can offer expert guidance, interpretation of diagnostic tests, and immediate feedback on treatment plans. The integration of telemedicine support holds promise in mitigating the challenges of remote

or underserved areas and has been trialled with some limited successes already [34–37].

*Scope Expansion for Paramedics:* The horizon of paramedicine's role in STEMI care is expanding. Beyond the administration of thrombolytic agents, paramedics are increasingly being required to diagnose and manage a broader range of cardiovascular emergencies [38–40]. This scope expansion empowers paramedics to address conditions beyond STEMI, such as acute heart failure, arrhythmias, and hypertensive crises [41]. The development of comprehensive protocols and guidelines ensures the safe and effective application of paramedicine in an ever-widening array of cardiovascular emergencies. Advancements in data capture through standardized reporting for PHT will be essential in addressing the ongoing needs and identifying future research areas in paramedicine [42].

*Integration of Artificial Intelligence (AI) and Data Analytics:* The integration of AI and data analytics in paramedicine offers another exciting dimension to the future of STEMI care. AI can assist paramedics in rapid diagnosis and treatment decisions, making use of vast data sets and predictive algorithms [43]. Machine learning and AI-driven analytics can help identify at-risk populations and refine treatment protocols [44, 45]. These technologies offer the potential to enhance the precision and timeliness of care delivery.

## 5 Conclusion

In the dynamic field of cardiovascular emergency medicine, the integration of thrombolysis in paramedicine has become a powerful symbol of innovation and adaptability. It has transformed the way we respond to STEMI, shifting our focus from hospital-based care to immediate, on-scene interventions. This paradigm shift was met with initial scepticism, but relentless commitment and evidence-based practice have solidified its crucial role in emergency care.

Today, thrombolysis in paramedicine is not just a matter of convenience—it's a critical lifeline for STEMI patients. Empowered paramedics, making swift and judicious decisions on the scene, can initiate thrombolytic therapy that substantially reduces door-to-needle time, preserving cardiac muscle and enhancing patient prognosis.

Moreover, the advent of thrombolysis in paramedicine has significantly improved survival rates. It has created a patient-centred care approach, where every second counts and every decision is informed—redefining the trajectory of cardiovascular emergencies.

As we look ahead, the future of STEMI care in paramedicine is brimming with potential. From advancements in thrombolytic agents to the integration of telemedicine support, and from the expansion of paramedic roles to the incorporation of artificial intelligence in decision-making,

the landscape of cardiovascular emergency medicine is on the cusp of another revolution.

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## Declarations

**Conflict of Interest** Sonja Jane Maria declares that there are no competing interests associated with the research, authorship, or publication of this article.

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