The digital revolution in chest pain triage

A solution to real-world challenges

March 2026

Contents

Executive summary

Chest pain is a common and clinically complex presentation in the emergency department (ED). While high-sensitivity cardiac troponins (hs-cTn) and the European Society of Cardiology (ESC) rapid rule-out/rule-in protocols for Acute Coronary Syndrome (ACS) have improved diagnosis, their consistent application in busy clinical settings remains challenging. The recent ESC 2025 congress highlighted the explosive growth of digital Clinical Decision Support (CDS) tools, including artificial intelligence (AI) in cardiology, and its potential to address these very issues.

Here, we review the clinical workflow for ACS, where CDS tools, like digital algorithms, can support healthcare professionals (HCPs) in their clinical decision-making in chest pain clinical presentations. Here, we examine the obstacles to implementing ESC evidence-based guidelines for the management of ACS and introduce the CE-marked **Chest Pain Triage algorithm**, which is part of the **navify®** Algorithm Suite, designed to help HCPs enhance diagnostic accuracy, streamline workflows, and standardise guideline-adherent care.

Chest pain in the emergency department (ED) is common and complex to manage

Chest pain is the leading symptom prompting consideration of ACS. It accounts for a significant portion of all ED encounters, yet less than 10% of these cases are ultimately diagnosed as ACS.[1-3] The clinical heterogeneity of chest pain necessitates rapid and accurate differentiation between life-threatening conditions, such as myocardial infarction (MI), and other causes to ensure appropriate patient care while preventing unnecessary admissions and diagnostic procedures.[4-6]

ACS is an acute event that is often a complication of Coronary Artery Disease (CAD), an underlying condition of atherosclerosis that can be asymptomatic and usually chronic. ACS is a medical emergency caused by a sudden reduction in blood flow to the heart, leading to a spectrum of conditions from Unstable Angina (UA), an incomplete blockage that may not cause heart muscle damage, to a complete or persistent blockage causing damage to the heart muscle in non-ST elevation myocardial infarction (NSTEMI), due to partial blockage, and ST-elevation MI (STEMI), due to complete blockage; distinguished by the patterns on the electrocardiogram (ECG). The injury to the heart muscle releases troponin into the bloodstream. However, sometimes the injury is so recent at the ED presentation that there has not been enough time for the troponin levels to rise, and, similarly, troponin elevation may be less obvious over time; hence, serial measurements and the delta changes are helpful for the accurate and timely diagnosis of myocardial infarction (MI).

The primary task for HCP is to quickly categorise patients to guide care. This is a critical balancing act for HCPs, given the wide range of differential diagnoses, including MI and other life-threatening conditions such as pulmonary embolism and aortic dissection. The goal is to safely and efficiently identify high-risk patients who require immediate intervention, while also confidently ruling out MI in low-risk patients. Failure to do so can lead to not only delayed diagnosis and treatment of MI, but also to an overuse of diagnostic resources, prolonged patient wait times, and increased burdens on specialist services such as cardiology and imaging.[7]

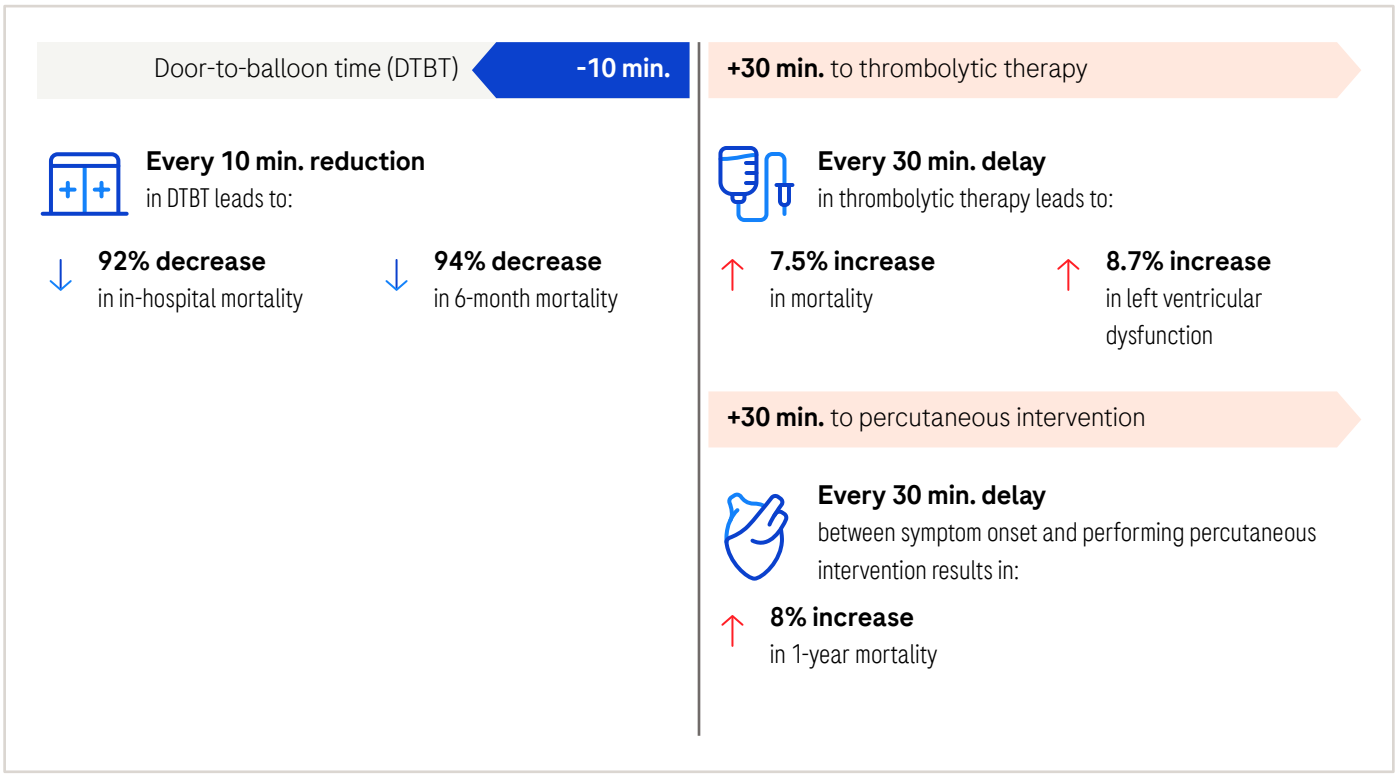

Figure 1. Correct and timely identification of chest pain causes can help reduce mortality.[8]

High-sensitivity cardiac troponin (hs-cTn) and the European Society of Cardiology (ESC) guidelines allow rapid triage

The introduction of hs-cTn assays revolutionised the early detection of suspected ACS, offering superior sensitivity and a high negative predictive value,[9] allowing the development of rapid triage algorithms by the ESC guidelines, including the highly recommended 0/1-hour and 0/2-hour diagnostic algorithm,[10-13] which rely on the probability of MI with increasing hs-cTn values.

These protocols, used in conjunction with clinical and ECG findings, provide a strategy for the rule-out of MI, rule-in, or further observation of patients presenting with chest pain. For example, using assay-specific cut-offs for the Roche Elecsys® Troponin T hs assay,[14] the 0/1-hour algorithm allows for the following categorisation:[10]

- **Rule-out:** hs-cTn below specific thresholds (<5 ng/L at ESC 0 hour or <12 ng/L for ESC 0/1-hour with a 1-hour delta <3 ng/L) indicates a very low likelihood of MI.
- **Rule-in:** hs-cTn above a threshold (>52 ng/L) or a substantial 1-hour increase (>5 ng/L) points toward a high likelihood of MI.
- **Observe:** Patients not meeting these criteria require further assessment, such as additional blood draws or diagnostic procedures (e.g. echocardiography or non-invasive coronary imaging).

Studies have demonstrated the safety and efficacy of these algorithms, with a negative predictive value (NPV) for MI exceeding 99% in large validation cohorts.[10-13] These rapid algorithms are a cornerstone of modern ACS management and are now a Class I recommendation in the ESC guidelines[10] and are designed to accelerate time to diagnosis and safe discharge, while maintaining high diagnostic accuracy.[11]

Improves patient flow in ED[15–18]

75–84%
Of patients triaged using rule-in or rule-out

62–72%
of patients had AMI ruled out

Feasible[15,16]

94%
High algorithm adherence

45 min.
Reduction in time between initial and first follow-up sample

Safe for rule-out patients[15–18]

0.2%
30-day MACE

0.1–0.5%
30-day mortality

Shorter triage time[15–17]

1–2.25 hr.
Reduction in time spent in ED

9–13%
Increase in ED discharge rates

Limits overuse of resources[15–17]

3.5%
Reduction in functional cardiac testing

No difference
In coronary angiography

Figure 2. Benefits of rapid rule-in and rule-out protocols in modern ACS management.

Patients presenting with chest pain and suspected ACS require timely diagnosis and intervention. As a first step, a 12-lead ECG is recommended to differentiate STEMI from NSTEMI. In addition, hs-cTn biomarkers Patients presenting with chest pain and suspected ACS require timely diagnosis and intervention. As a first step, a 12-lead ECG is recommended to differentiate STEMI from NSTEMI. In addition, hs-cTn biomarkers are recommended for diagnosing and risk-stratifying patients with suspected ACS and are required in all patients with suspected NSTEMI-ACS.[11] A clinical presentation compatible with myocardial ischemia – including symptoms of ischemia, new ECG changes, imaging evidence, new regional wall motion abnormality, new loss of viable myocardium, intracoronary thrombus–alongside an elevation of hs-cTn above the 99th percentile, with a typical rise and/or fall, fulfils the fourth universal definition of acute MI.[19]

The two acute MI presentations, which involve heart muscle injury and troponin release, are: STEMI, characterised by a sudden plaque rupture, which causes a complete blockage of the coronary artery, requiring immediate revascularisation; and NSTEMI, a more subtle injury requiring serial troponin measurements to detect a significant rise (delta) over time. The most difficult diagnosis is UA, which is also categorised as ACS but does not show the troponin pattern of injury. Patients with UA present with chest pain, but a definitive diagnosis requires downstream cardiac testing (e.g., stress test or Coronary Computed Tomography Angiography, CCTA) to prove occlusive CAD.

Although the ESC guidelines provide a standardised triage strategy for ACS,[10] for HCPs, the main challenge is managing the patient who does not meet the MI criteria and ensuring these are not under- or overtreated. Similarly, the decision to admit patients for further overnight testing for potential UA is significant in crowded hospitals. The goal is to avoid keeping a patient unnecessarily while also preventing the potentially fatal evolution into sudden cardiac death.

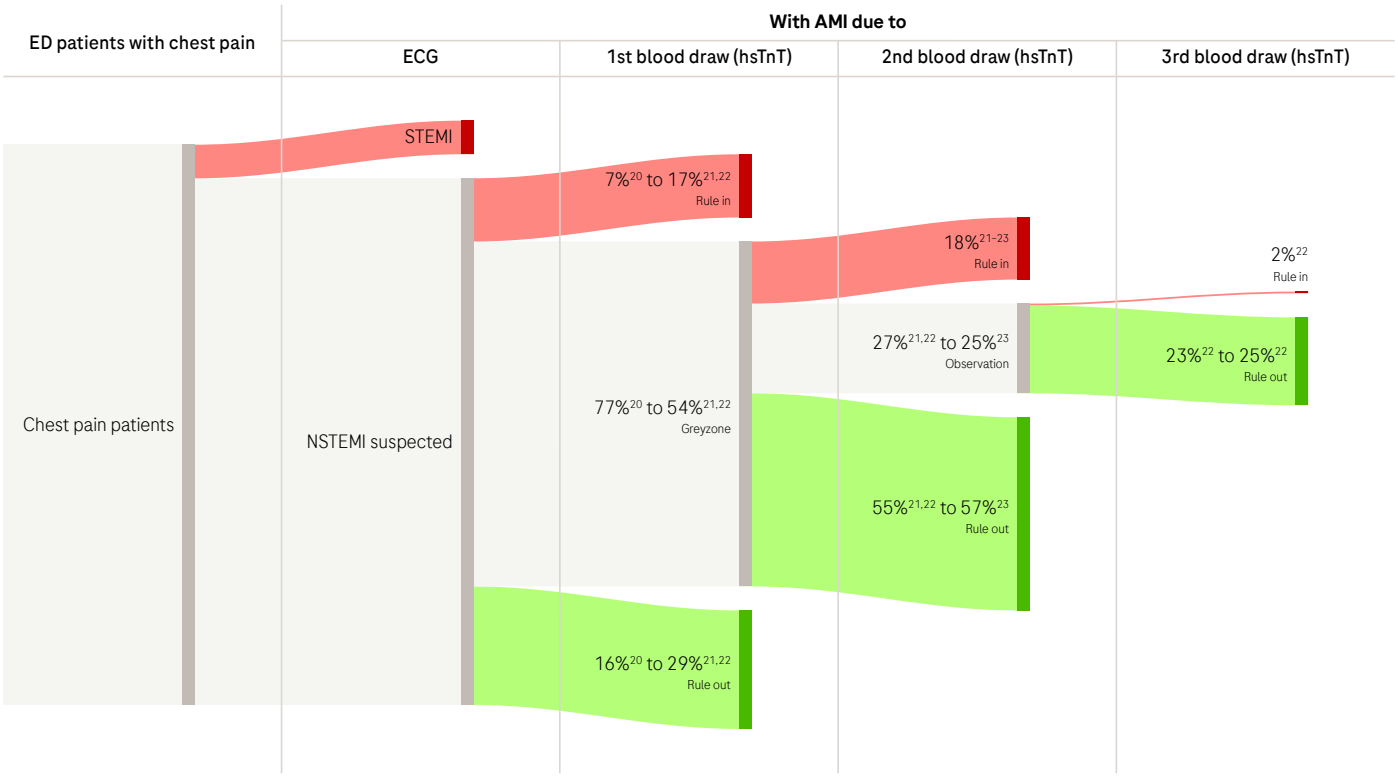

Figure 3. Example of the clinical decision pathway for chest pain.

The challenge: the gap between clinical guidelines and clinical practice

The successful implementation of rapid triage protocols in real-world clinical settings, such as the ED, presents significant and quantifiable challenges,[20] such as:

- **Overcrowding and patient safety:** hospital presentations for chest pain are increasing while bed capacity is decreasing. As a result, many EDs operate continuously under moderate or severe pressure, which is directly linked to patient outcomes. Every hour of delay in the ED increases mortality, and a length of stay exceeding six hours can almost double the risk of death. Therefore, accelerating the triage process into a rapid Rule-out of MI or Rule-in decision can improve patient safety and throughput. However, as per the ESC guidelines, Rule-out applies to MI and not other differential diagnoses like pulmonary embolism, aortic dissection, or unstable angina.
- **Test turnaround time:** successful adherence to the ESC 0/1-hour algorithm requires a strict 60-minute turnaround time for troponin results. However, real-world data confirms that this precise timing is difficult to achieve consistently.[7] This lack of precision is critical, as the truly elapsed time between blood draws, and not just the protocol name, determines the correct interpretation of serial troponin values. Imprecise timing can lead to misclassification (e.g., classifying a patient as Rule-out when they should be in the Observe zone), which undermines diagnostic safety and influences mortality rates.
- **Protocol adherence:** assay-specific interpretation and the choice between the 0/1- and 0/2-hour protocols can be challenging for HCPs. Confusion results in significant protocol violations, such as a second troponin test in low-risk groups, which is unnecessary, or missed serial testing in intermediate-risk groups (up to 30% of cases). These unnecessary or absent tests delay management, increase resource consumption, and further demonstrate the critical need for the **Chest Pain Triage algorithm** to enforce protocol adherence and simplify complex, time-dependent decisions.

The solution: digital clinical decision support (CDS) tools

The ESC 2025 congress highlighted a massive increase in digital solutions and AI-related cardiology research, with over 6,854 results in a recent PubMed search, and acknowledged that AI tools are being developed to address the same real-world challenges faced by HCPs.[26] **Chest Pain Triage** – a **navify®** Algorithm Suite algorithm – empowers HCPs by providing real-time, evidence-based recommendations for chest pain management. This CDS tool provides semi-quantitative recommendations to aid in the diagnosis and risk stratification of adult patients with NSTEMI using a single or serial cardiac troponin measurement Roche Elecsys® cTnT-hs assay in conjunction with information about the chest pain onset, providing a triage recommendation based on the validated ESC 0/1-hour, 0/2-hour, and 0/3-hour accelerated diagnostic algorithms.[27]

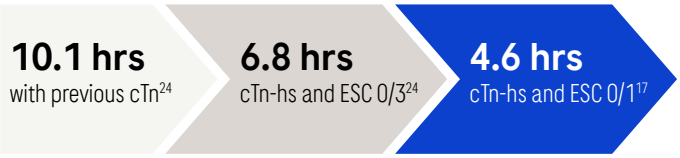

Figure 4. Tangible impact of ESC rapid protocols in NSTEMI

Key features and functionality

This **Chest Pain Triage algorithm** integrates seamlessly with a hospital's electronic medical record (EMR) or laboratory system. It leverages real-time data, including patient demographics, chest pain onset time, and hs-cTn levels, to automatically apply the appropriate ESC algorithm (0/1-hour, 0/2-hour, or 0/3-hour).[11,13] It presents a clear recommendation to Rule out MI, Rule in MI, or Observe, reducing the cognitive load and standardising the decision-making process. For example, if hs-cTn values are <5 ng/L or <12 ng/L with <3 ng/L change in one hour, the **Chest Pain Triage algorithm** recommends ruling out NSTEMI. If hs-cTn values are >52 ng/L or >5 ng/L change in one hour, the algorithm recommends ruling in NSTEMI. This semi-automated process ensures that all relevant data points are considered.

This **Chest Pain Triage algorithm** takes the five key characteristics of an effective CDS[28] into account: delivering the (i) right information, (ii) to the right person, (iii) in the right format, (iv) through the right channel, and (v) at the right time in the workflow. By embedding the algorithm directly into the EMR, it ensures this timely delivery, helping to reduce the current average length of stay for suspected MI patients.

Impact and benefits

- Enhanced guideline adherence: the **Chest Pain Triage algorithm** ensures consistent application of the latest ESC guidelines, reducing clinical variability and improving the quality of care. By providing real-time, evidence-based recommendations, the algorithm supports rapid, informed decisions.
- Improved efficiency and length of stay: by providing a clear, semi-automated pathway, the **Chest Pain Triage algorithm** can accelerate the diagnostic process. It can enable replication of the results of the stepped-wedge cluster randomised controlled trial by Anand et al. in a broader range of hospitals. Anand et al. showed that an early rule-out strategy based on hs-cTn testing led to a significant reduction in ED length of stay by an average of 3.3 hours and a 59% decrease in hospital admissions compared to standard care.[24] These findings are consistent with a meta-analysis by Chiang et al.,[13] which confirmed the superior performance of the ESC 0/1-hour and 0/2-hour algorithms in accelerating the time to diagnosis and safe discharge.
- Resource optimisation: the **Chest Pain Triage algorithm** instils confidence in HCPs to rely on troponin values and symptoms, which can lead to a reduction in unnecessary additional diagnostic tests, alleviating burdens on specialist services.[29]
- Empowering clinicians: the **Chest Pain Triage algorithm** provides reliable guidance for junior HCPs, ensuring high-quality, standardised care even when senior resources may be limited. The demographic challenges and staff shortages[30] highlight the urgent need for tools like a **Chest Pain Triage algorithm** to standardise care and empower less-experienced HCPs to make evidence-based decisions.

Use of algorithms could improve decision-making in a number of settings

Low-income areas with limited resources[31]

Out-of-hours settings[32]

Where there is a lack of expertise[33]

Healthcare professionals

Base their decision-making on previous experience and personal beliefs.[34]
This can lead to inconsistencies and uncertainty.[34]

By 2035, there will be a ~12.9 million deficit of skilled HCPs globally.[35]
HCP time needs to be better utilized to counteract these deficits.[35]

42% of physicians report feeling burnt out.[35]
High workload and stress level can lead to errors in diagnosis and treatment decisions.[36]

~25% of total healthcare expenditure is wasted.[37]
Resources such as HCP time, clinical.

Patients

75% expect more personalized treatments.[38]
There is a shift in expectations from the patient's perspective.[38]

Figure 5. Impact of digital algorithms integrated into clinical hospital workflows.

Conclusion

The management of chest pain in the ED demands a precise and systematic approach. While high-sensitivity troponin and ESC guidelines provide the scientific foundation for this, real-world application faces significant hurdles. The **Chest Pain Triage algorithm** addresses these challenges by translating complex guidelines into a user-friendly, semi-automated tool. By facilitating rapid, accurate, and consistent clinical decisions, the **Chest Pain Triage algorithm** cannot only enhance individual patient care and outcomes but also significantly improve operational efficiency in acute care settings. In conclusion, embracing standardised diagnostic tools like the **Chest Pain Triage algorithm** can significantly improve patient outcomes and operational efficiency.

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