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Comparison of new point-of-care troponin assay with high sensitivity troponin in diagnosing myocardial infarction

Sally Aldous [a,*], A. Mark Richards [b,c,d], Peter M. George [e], Louise Cullen [f], William A. Parsonage [f], Dylan Flaws [g], Christopher M. Florkowski [e], Richard W. Troughton [b,c], Jack W. O'Sullivan [f], Christopher M. Reid [h], Laura Bannister [b], Martin Than [b]

[a] Department of Cardiology, Christchurch Hospital, Riccarton Avenue, Christchurch, New Zealand
[b] Christchurch Hospital, Christchurch, New Zealand
[c] University of Otago, Christchurch, New Zealand
[d] National University Heart Centre, Singapore
[e] Canterbury Health Laboratories, Christchurch, New Zealand
[f] Royal Brisbane and Women's Hospital, Brisbane, Australia
[g] University of Technology, Brisbane, Australia
[h] Monash University, Melbourne, Australia

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ABSTRACT

Objectives: The aim of this study is to compare a new improved point of care cardiac troponin assay (new POC-cTnI) with 1. its predecessor (old POC-cTnI) and 2. a high sensitivity assay (hs-cTnI) for the diagnosis of acute myocardial infarction (AMI) and for major adverse cardiac events (MACE) by 30 days.
Methods: This is a single centre observational study, set in Christchurch Hospital, New Zealand. Patients presenting to the emergency department with non-traumatic chest pain underwent blood sampling at 0 h and 2 h post presentation for analysis with the 3 cTnI assays for the outcome of AMI and for analysis using an accelerated diagnostic protocol (ADP-normal 2 h troponins, normal electrocardiograms and Thrombolysis In Myocardial Infarction (TIMI) score of 0 or ≤1) for 30 day MACE.
Results: Of 962 patients, 220 (22.9%) had AMI. Old POC-cTnI was least sensitive at 70.0% (65.4–73.9%) by 2 h ($p < 0.001$). New POC-cTnI, sensitivity 93.6% (89.9–96.2%) had similar sensitivity to hs-cTnI, sensitivity 95.0% (91.5–97.3%) ($p = 0.508$). There were 231 (24.0%) patients with 30 day MACE. When used as part of the ADP, all assays had 100% (98.0–100%) sensitivity using TIMI = 0. Sensitivities of new POC-cTnI ADP, 98.3% (95.4–99.4%), old POC-cTnI, 96.5% (93.2–98.4%) and hs-cTnI, 98.7% (96.0–99.7%) were similar ($p = 0.063$–0.375) using TIMI ≤ 1.
Conclusions: A new POC-cTnI has improved sensitivity for AMI and MACE compared with its predecessor and comparable sensitivity to a high sensitivity assay. Now that sensitivities of the POC assay are improved, the new assay may be a useful alternative to central laboratory assays when rapid turn-around times are not possible.

1. Introduction

Risk stratification tools for the evaluation of patients presenting with chest pain suspicious of acute coronary syndrome (ACS)/acute myocardial infarction (AMI) have been around for decades. Such tools have previously required patients to remain in hospital for lengthy periods whilst undergoing investigation. However, given that most patients presenting in this way ultimately do not have ACS, the concept of the accelerated diagnostic protocol (ADP) has been developed. Accelerated diagnostic protocols involve using a more rapid investigation pathway for a sub-group of patients with chest pain identified as being at low risk of an ACS [1].

The multinational ASPECT (Asia Pacific Evaluation of Chest pain Trial) [2] study evaluated an ADP comprising early measurement (at presentation and 2 h later) of a point of care (POC) biomarker panel (cardiac troponin [cTn] I/myoglobin/creatine kinase) and electrocardiograms in conjunction with the Thrombolysis In Myocardial Infarction (TIMI) score. Those with an ADP score of 0 (9.8%) were identified as being at very low-risk for 30 day major adverse cardiac events (MACE) (0.9%) and suitable for expedited discharge. Subsequent research including the ADAPT (2-hour Accelerated Diagnostic protocol

Abbreviations: ADAPT, 2-hour Accelerated Diagnostic protocol to Assess Patients with chest pain symptoms using contemporary Troponins; ADP, accelerated diagnostic protocol; AMI, acute myocardial infarction; ASPECT, Asia Pacific Evaluation of Chest Pain Trial; ED, Emergency Department; (hs)-cTn, (high sensitivity) cardiac troponin; MACE, major adverse cardiac events; POC, point of care; TIMI, Thrombolysis In Myocardial Infarction.

* Corresponding author. Tel.: +64 33640640; fax: +64 33641415.
E-mail address: sally.aldous@cdhb.health.nz (S. Aldous).

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to Assess Patients with chest pain symptoms using contemporary Troponins) trial [3] has shown that more patients can be identified as low risk with no loss of clinical sensitivity for the occurrence of MACE/ACS when cTn (laboratory or POC) is the only biomarker contingent of the ADP (without myoglobin and creatine kinase) [3,4].

Analytical sensitivity (limit of detection) of an assay is defined as the ability of the assay to measure the minimum detectable concentration of an analyte which can be reliably distinguished from the limit of blank (the highest *apparent* analyte concentration expected to be found when replicates of a blank sample containing no analyte are tested) and at which detection is feasible [5]. In order to maintain optimal clinical sensitivity (the chance of testing positive [elevated cTn] amongst those with the condition [AMI]), the analytical sensitivity of an assay must be below the decision cut-point. In the case of cTn, the decision cut-point is recommended at the 99th percentile of a normal population [6]. However, precision, or repeatability, of assay test results, is also important and is expressed using the inter and intra-assay coefficients of variation. Guidelines recommend a coefficient of variation equal or lower than 10% at the 99th percentile [6].

The POC cTnI used in ASPECT has low analytical sensitivity and the recommended precision is not achieved whereas the laboratory cTnIs used in ADAPT have superior analytical sensitivity and achieve near guideline recommended precision. High sensitivity cardiac troponins (hs-cTn) fulfil all recommended criteria.

Further analysis of ADAPT/ASPECT showed that although the POC-cTnI assay performed inferiorly to sensitive and hs-cTn laboratory assays for the diagnosis of AMI, performance of all troponins were comparable when used as part of the ADP with a TIMI score cut-point of 0 [3,4]. However, additional analysis showed that use of an hs-cTnI allowed the ADP to be modified to include a broader low-risk group by including patients with a TIMI score of ≤1 (0 and 1 rather than just 0), classified as low risk (41.5%) whilst maintaining safety against adverse events (30 day MACE rate 0.8%) [7].

The aim of this pre-specified analysis of the data from the New Zealand arm of ASPECT/ADAPT was to compare a new POC cTn assay, that claims to have improved analytical sensitivity, 1. with the POC assay used in the ASPECT and 2. with a central laboratory hs-cTnI assay (the assay currently used in clinical practice at our institution). This analysis assessed both individual performances of assays in the diagnosis of AMI and also for MACE by 30 days when used as part of the ADP.

2. Materials and methods

2.1. Study design

The study design has previously been reported in detail [3]. In brief, patients presenting to the ED between 0530 and 2000 from November 2007 until April 2010 were recruited by research nursing staff. Those with symptoms suggestive of cardiac ischaemia (acute chest, epigastric, neck, jaw or arm pain or discomfort or pressure without an apparent non-cardiac source) were included. Patients were excluded if they were <18 years, unable to provide informed consent, unwilling to participate or would not be available for follow-up. Hospital clinical protocols required laboratory cTnI levels to be measured at presentation (0 h) and again at least 6 h later. Additional sample was taken at 2 h post presentation for study laboratory cTnI measurement, at 0 h and 2 h for immediate analysis on a POC device and freezing for later analysis using other cTn assays. Electrocardiograms were recorded at presentation and ≥6 h later, during episodes of symptoms and if requested by medical staff. Data for the TIMI score were collected by research nurses. The decision to perform stress testing, coronary angiography and other management plans was at the discretion of the attending clinician with knowledge of the clinically utilized cTnI results but without the knowledge of all other cTn assays under investigation or ADP results as a whole.

Patients were followed for 30 days by telephone contact, review of patient notes and search of the National Health Index database (identifies national hospital attendances/deaths using a unique alphanumeric identifier). The research protocol was approved by the Upper South A Regional Ethics Committee of the New Zealand Ministry of Health. All participants gave informed consent.

2.2. Troponin assays

The 99th percentile of a normal population, analytical sensitivity (limit of detection), 10% coefficient of variation and decision cut-point for each assay is shown in Table 1.

The reference test was Architect Troponin I, Abbott Diagnostics, Chicago, Illinois. Blood samples for the hospital clinical pathway were obtained at presentation and 6–12 h after presentation and were sent in tubes coated with lithium heparin.

Fresh whole blood samples in ethylenediaminetetraacetic acid tubes were taken at 0 h and 2 h post presentation and immediately analysed on the Triage CardioProfilER (Alere, San Diego, California) for cTnI (old POC-cTnI) then centrifuged. The plasma was stored frozen at −80 °C for later analysis in a blinded fashion in batches for a new POC cTnI (new POC-cTnI, Alere Cardio3, San Diego, California). The new POC-cTnI has not published its limit of detection but has improved limit of blank, as judged by the 95th percentile of twenty replicates per day each of a whole and plasma blank sample each tested for 5 days on three lots of test devices. The 99th percentile was determined using specimens obtained from 989 apparently healthy individuals (cTnI results ranged from <10 ng/L to 65 ng/L). Precision was tested for a high (600 ng/L) and low (60 ng/L) control plasma with 80 replicates for each control, over 40 separate test runs, over 20 days of. Total precision for the high control was 11.0% and of 16.7% for the low control.

Further frozen plasma samples were later analysed in a blinded fashion in batches for a high sensitivity cTnI (hs-cTnI, Architect Troponin I, Abbott Diagnostics, Chicago, Illinois).

2.3. Electrocardiograms

Ischaemic electrocardiogram changes were defined by ST depression of ≥0.5 mm or T-wave inversion of ≥1 mm in ≥two contiguous leads, not known to be old.

2.4. Adjudication

Patient data were recorded according to the American College of Cardiology's key data elements and definitions for measuring the clinical management and outcomes of patients with ACS [8], standardized guidelines for reporting data for patients with ACS [9] and presented as per Comprehensive Standardised Data Definitions for ACS Research in ED Australasia [10]. Diagnoses on admission and at follow-up were independently adjudicated by a Cardiologist and a Cardiology Research Clinician, blinded to the results of the test assays and ADP results. A second Cardiologist was involved in cases of discrepancy.

2.5. Outcome measures

The primary outcome measure was a comparison of the diagnostic performance of the new POC-cTnI with 1. the old POC-cTnI and 2. Hs-cTnI in isolation when measured at 0 h and 2 h after presentation for the diagnosis of AMI. The diagnostic criteria for AMI (as per Universal Definition) were a detection of a rise and/or fall of cTn with at least one value above the 99th percentile in the setting of symptoms of ischaemia, with or without new or presumed new significant ST-segment/T wave changes/new left bundle branch block/development of pathological Q waves or imaging evidence of new loss of viable myocardium or new regional wall motion abnormality [6].

The secondary outcome measure was a comparison of the ADP where the cTn contigent included 0 h and 2 h new POC-cTnI with 1. the ADP using old POC-cTnI and 2. the ADP using hs-cTnI in combination with the TIMI score (both cut-points of 0 and ≤1) and electrocardiogram results for the outcome of a MACE (where MACE was defined as AMI, cardiac death, cardiogenic shock, emergency revascularization, ventricular arrhythmia or high degree heart block requiring treatment) by 30 days post presentation.

2.6. Statistical analysis

Continuous variables are presented as medians/interquartile ranges, and categorical variables as numbers/percentages. We calculated the sensitivity, specificity, positive predictive value, negative predictive value and accuracy of each of the cTn assays for the diagnosis of AMI at 0 h and also by 2 h (i.e. incorporating both 0 h and 2 h results). We then calculated the same parameters for an ADP incorporating values from each of the cTn assays using both cut-points for the TIMI score for the outcome of MACE at 30 days. Sensitivities and specificities were compared using the McNemar test. All statistics were completed using SPSS version 20.

3. Results

There were 1184 patients recruited in the New Zealand arm of the ASPECT/ADAPT study. There were 962 patients with complete results for each of the troponin assays at both 0 h and 2 h. Patient characteristics are shown in Table 2.

There were 220 patients (22.9%) diagnosed with AMI (196 non ST elevation AMI and 24 ST elevation AMI). At both time points all assays were more sensitive ($p < 0.001$ for all pair-wise comparisons) than the old POC-cTnI test which failed to identify 93 patients with AMI at 0 h and 66 patients by 2 h. Both other assays were as sensitive as each other ($p = 0.302$ at 0 h and 0.508 by 2 h). The hs-cTnI failed to identify 22 and new POC-cTnI 27 patients with AMI when measured at 0 h (Table 3) and hs-cTnI failed to identify 11 and new POC-cTnI 14 patients with AMI using both 0 h and 2 h measurements (Table 4). New POC-

Table 1
Assay specifications.

Assay	Manufacturer	99th percentile (ng/L)	Analytical sensitivity (limit of detection) (ng/L)	10% coefficient of variation (ng/L)	Decision cut-point (ng/L)
Reference cTnI	Abbott	28	10	32	30
Old POC-cTnI	Alere	<50	50	Not stated	50
New POC-cTnI	Alere	20	10 (limit of blank)	Not stated	20
Hs-cTnI	Abbott	26.2	1.1–1.9	4.7	26.2

POC—point of care; (hs)-cTnI—(high sensitivity)-cardiac troponin I.

cTnI was less specific than both other assays by 2 h post presentation ($p < 0.001$–0.009). hs-cTnI was trending to be less specific than old POC-cTnI ($p = 0.053$) (Table 4).

All patients were followed to 30 days. There were 231 patients (24.0%) with at least one MACE by this time (7 who died, 228 with AMI, 25 requiring emergency revascularization, 3 with ventricular arrhythmias requiring intervention, 1 with cardiogenic shock and none with cardiac arrest or high degree heart block requiring intervention. Of the 11 patients who did not have the MACE event of AMI on presentation, the MACE was made up of 2 deaths, 8 AMI post presentation but within 30 days and 1 ventricular arrhythmia requiring intervention). All assays identified similar numbers as low risk (test negatives) when using a TIMI score cut-point of 0 ($n = 135$–144, 14.0–15.0%, $p = 0.289$–1.00) with 100% sensitivity for MACE (Table 5).

More patients were identified as low risk by hs-cTnI ($n = 287$, 29.8%) and old POC-cTnI ($n = 288$, 29.9%) compared with new POC-cTnI ($n = 277$, 28.8%) ($p < 0.001$) when using a TIMI score cut-point of ≤1, but were no less specific than each other ($p = 0.454$) (Table 6). Sensitivities for 30 day MACE did not differ significantly ($p = 0.063$–0.375), failing to identify 3 (hs-cTnI), 4 (new POC-cTnI) and 8 (old POC-cTnI) patients with MACE by 30 days (Table 6).

Table 2
Patient characteristics.

Characteristic ($n = 962$)	Number (%)
Age (median/interquartile range)	66 (56–76)
Male	568 (59)
Ethnicity	762 (79.2)
New Zealand European	91 (9.5)
Other European	5 (0.5)
Maori/Pacific Islander	6 (0.6)
Asian	1 (0.1)
African	64 (6.7)
Unknown	
Prior ischemic heart disease	474 (49.3)
Prior myocardial infarction	279 (29.0)
Prior revascularization	272 (28.3)
Diabetes	153 (15.9)
Hypertension	583 (60.6)
Dyslipidaemia	539 (56.0)
Smoking	141 (14.7)
Current	437 (45.4)
Ex	
Family history ischemic heart disease	578 (60.1)
Prior stroke	123 (12.8)
Peripheral vascular disease	46 (4.8)
Creatinine (median/interquartile range, μmol/L)	88 (77–101)
Ischaemic electrocardiogram changes	261 (27.1)
TIMI score	174 (18.1)
0	218 (22.7)
1	231 (24.0)
2	210 (21.8)
3	89 (9.3)
4	34 (3.5)
5	6 (0.6)
6	0
7	
Elevated cTn at 2 h	193 (20.1)
Old POC cTnI	279 (29.0)
New POC cTnI	265 (27.5)
Hs-cTnI	

TIMI—Thrombolysis In Myocardial Infarction, POC—point of care, and (hs)-cTnI—(high sensitivity) cardiac troponin I.

4. Discussion

This study has shown that that a new POC-cTnI assay with claimed improved analytical sensitivity has improved clinical sensitivity for the diagnosis of AMI compared with the older POC assay. It has statistically comparable clinical sensitivity (numerically slightly inferior) to a high sensitivity assay, which to the knowledge of the authors is the first paper to carry out such a comparison. It should be noted than none of the assays used in isolation were sensitive enough to rule out AMI by 2 h post presentation. The new POC-cTnI is less specific than the older assay as might be expected given the lower cut-point used but is also less specific than hs-cTnI at the tested time points. This has implications for those patients who ultimately have false positive results.

The new POC-cTnI also has similar clinical sensitivity when used as part of an ADP with ECG results and TIMI scores for 30 day MACE. It does have slightly diminished specificity for 30 day MACE which would mean that fewer patients are suitable for out-patient care.

With the significant differences in analytical characteristics of troponin assays, each assay requires individual assessment. Previously there have been concerns that POC cTn assays lack the analytical sensitivity of laboratory assays, have higher levels of imprecision, lack of concordance with laboratory assays, and variability between assays that results in an overall lower clinical sensitivity for AMI [11–16]. This means that older POC assays carried the disadvantage that a higher proportion of patients with AMI were not detected, either overall or in the early period after onset of symptoms. [10,14,15] This could affect clinical outcomes if additional samples were not sent to the core laboratory. Limited data compare newer more sensitive POC assays with laboratory assays. Precision of the new POC-cTnI still falls short of that recommended by international guidelines for a cTn assay [6].

Point of care assays represent a useful option in clinical settings where because of local circumstances (e.g. an off-site central laboratory) there is a long turnaround time to receiving results. The POC devices in this study for cTnI assays have an analyser run time of 15–20 min, has been designed for bedside use (useful in the ED or ward base and possibly rural settings), can use whole blood (or plasma) and results are available directly from the analyser. The laboratory cTn assays all have an analyser run time of 18 min. However, all laboratory based assays require time for specimen transfer, preparation such as centrifugation and labelling, and the reporting of results. Previous studies have shown laboratory result turn-around times of 65–128 min and POC turnaround times of 15–26.5 min [17–21]. Recommendations for turnaround times by the American College of Cardiology/American Heart Association and National Academy for Clinical Biochemistry for core laboratories suggest a maximum of 60 min and recommend that if this is not achievable, POC devices should be used [11,13,17]. Shorter turnaround times can potentially accelerate clinical decision making and patient discharge (in those with negative results) which may reduce ED and hospital overcrowding and have economical benefits; and possibly

Table 3
Diagnostic accuracy of cardiac troponins for myocardial infarction on presentation.

% (95% C.I.)	Sensitivity	Specificity	PPV	NPV	Accuracy
Old POC cTnI	57.7 (53.5–61.1)	96.8 (95.5–97.8)	84.1 (78.0–89.0)	88.5 (87.4–89.4)	87.8 (85.9–89.4)
New POC cTnI	87.7 (83.6–91.1)	93.1 (91.9–94.1)	79.1 (75.3–82.1)	96.2 (95.0–97.3)	91.9 (90.0–93.4)
Hs-cTnI	90.0 (86.1–93.1)	93.9 (92.8–94.8)	81.5 (77.9–84.3)	96.9 (95.7–97.9)	93.0 (91.2–94.4)

PPV—positive predictive value, NPV—negative predictive value, POC—point of care, and (hs)-cTnI—(high sensitivity) cardiac troponin I.

acceleration of treatment pathways (in those with positive results) which may improve outcomes, although a not insignificant false positive rate should alert physicians to employ clinical judgment in these patients.

In New Zealand the national Shorter Stays in ED Health Target aims for disposition of 95% of ED patients at ≤6 h and similar policies are under implementation internationally. Turnaround times from blood sampling to results can therefore be highly important both to meet policy targets and for efficient patient disposition and initiation of definitive treatment [11]. Previous studies have had varying results regarding the effect of POC devices on length of stay with some showing improvement and some not [11,17,20–23]. However, some authors ascribe the inconsistent improvement in lengths of stay, occurring in some centres but not others, to how POC results are incorporated into the assessment pathways. No improvement is seen in centres where no change other than assay type was made to these processes [24].

Although there appears to be a shorter time to treatment in those with AMI when POC assays are used, a previous systematic review did not show improvement in outcomes although were also not inferior [25]. It should be noted that many of the studies included in the review used older less sensitive assays.

The POC assays are more expensive than laboratory assays [26,27]. Although it would be hoped that other clinical benefits would offset these increased costs there have been no randomized studies looking at this as a primary outcome. However, the RATPAC group showed in their study that POC testing was not cost effective with higher overall costs in the POC cohort [26]. Conversely, a study by Apple et al. [27] showed overall costs per patient were lower. Whether this remains the case for POC assays with improved analytical sensitivity and in centres with specific chest pain pathways incorporating POC assays, remains to be seen.

5. Limitations

This is single centre observational data. The new POC-cTnI was analysed in batches by specialist technicians rather than by individual clinical staff, as would usually occur in a clinical situation, which may overestimate performance. The new POC-cTnI was also analysed from frozen plasma rather than fresh whole blood which would be the intention if this assay was used clinically. The hs-cTnI has gender specific cut-points for the 99th percentile which were not used in this analysis as the original adjudication was based on a single cut point using a less sensitive assay. Therefore the impact of gender specific cut points cannot be assessed in this cohort. This observational study did not test whether a POC assay could actually reduce turn-around times, or admissions, or improve outcomes; further studies would be required to test such a hypothesis. This study is a comparison between 3 different cTn products; the clinical significance of the results is therefore limited to these specific assays and cannot be generalized to other cTn assays.

6. Conclusion

A new POC-cTnI assay performs superiorly to an older generation assay in terms of sensitivity for the diagnosis of AMI or MACE. Sensitivities are comparable statistically to that of a hs-cTnI assay. In situations where turn-around times impact significantly on patient care (such as hospital/ED over-crowding and remote areas with poor access to laboratories), improved clinical sensitivities of the new POC-cTnI suggest that such a product is a now a viable alternative to laboratory based assays.

Conflicts of interests

Drs. Than, Cullen, Parsonage, George, Dylan Flaws and Prof. Richards have accepted travel, accommodation, consulting fees, or honoraria from Abbott. Drs. Cullen and Parsonage have had research support from Roche. All other authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Contributors

Authors Sally J Aldous, A. Mark Richards, Louise Cullen, Dylan Flaws and Martin Than made substantial contributions to the conception or design of the work; authors Sally J Aldous, Peter M George, Louise Cullen, William A. Parsonage, Dylan Flaws, Christopher M Florkowski, Richard W Troughton, Jack W O'Sullivan, Christopher M Reid, Laura Bannister, and Martin Than made substantial contributions to the acquisition, analysis, or interpretation of data for the work; author Sally Aldous drafted the work and all authors contributed to revising it critically for important intellectual content; and to the final approval of the version to be published; and agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Author Martin Than is the guarantor.

Table 4
Diagnostic accuracy of cardiac troponins for myocardial infarction 2 h after presentation.

% (95% C.I.)	Sensitivity	Specificity	PPV	NPV	Accuracy
Old POC cTnI	70.0 (65.4–73.9)	94.7 (93.4–95.9)	79.8 (74.6–84.3)	91.4 (90.1–92.5)	89.1 (87.0–90.9)
New POC cTnI	93.6 (89.9–96.2)	90.2 (89.0–90.9)	73.8 (70.9–75.9)	98.0 (96.7–98.8)	91.0 (89.2–92.1)
Hs-cTnI	95.0 (91.5–97.3)	92.5 (91.4–93.1)	78.9 (76.0–80.7)	98.4 (97.3–99.1)	93.0 (91.5–94.1)

PPV—positive predictive value, NPV—negative predictive value, POC—point of care, and (hs)-cTnI—(high sensitivity) cardiac troponin I.

Table 5
Diagnostic accuracy for the ADP utilizing each 2 hour cardiac troponin, electrocardiograms and a TIMI score cut-point of 0.

% (95% C.I.)	Sensitivity	Specificity	PPV	NPV	Accuracy
Old POC cTnI	100 (98.0–100)	19.7 (19.1–19.7)	28.2 (27.7–28.2)	100 (96.8–100)	39.0 (38.0–39.0)
New POC cTnI	100 (98.0–100)	19.0 (18.4–19.0)	28.1 (27.5–28.1)	100 (96.7–100)	38.5 (37.5–38.5)
Hs-cTnI	100 (98.0–100)	19.7 (19.1–19.7)	28.2 (27.7–28.2)	100 (96.8–100)	39.0 (38.0–39.0)

ADP—accelerated diagnostic protocol, TIMI—Thrombolysis In Myocardial Infarction, PPV—positive predictive value, NPV—negative predictive value, POC—point of care, and (hs)-cTnI—(high sensitivity) cardiac troponin I.

Table 6
Diagnostic accuracy for the ADP utilizing each 2 hour cardiac troponin, electrocardiograms and a TIMI score cut-point of 1.

% (95% C.I.)	Sensitivity	Specificity	PPV	NPV	Accuracy
Old POC cTnI	96.5 (93.2–98.4)	38.3 (37.3–38.9)	33.1 (31.9–33.7)	97.2 (94.6–98.7)	52.3 (50.7–53.2)
New POC cTnI	98.3 (95.4)99.4	37.3 (36.5–37.7)	33.1 (32.2–33.5)	98.6 (96.2–99.5)	52.0 (50.6–52.5)
Hs-cTnI	98.7 (96.0–99.7)	38.9 (38.0–(39.2)	33.8 (32.9–34.1)	99.0 (96.8–99.7)	53.2 (51.9–53.7)

ADP—accelerated diagnostic protocol, TIMI—Thrombolysis In Myocardial Infarction, PPV—positive predictive value, NPV—negative predictive value, POC—point of care, and (hs)-cTnI—(high sensitivity) cardiac troponin I.

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Appendix A. Supplementary data

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