Comparison of six decision aid rules for diagnosis of acute myocardial infarction in elderly patients presenting to the emergency department with acute chest pain

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Background

1. **Rapid diagnosis** of acute coronary syndrome without ST segment elevations **is problematic**

2. **Older patients** often have atypical symptoms, non-specific repolarisation changes on electrocardiogram and elevated levels of cardiac troponins from multiple cardiac and non-cardiac conditions

3. **Decision aid rules** could make the diagnostic process quicker and more effective

4. However **using** these decision aids **is not common** in our region

5. and there is **little evidence** about their use **in** the population of **elderly**

Objectives

1. to **describe characteristics and cardiac outcomes** in the elderly with acute chest pain presented to the emergency department

2. to **compare the performance of decision aid rules** for diagnosis of acute myocardial infarction (AMI) in the population of elderly

Methods

- analysis of elderly patients presenting to the emergency department of our hospital with acute chest pain <u>during one year</u> (january-december 2016)

- **<u>inclusion criteria:</u>** age > 70 years, chest pain as a dominant symptom, twelve lead electrocardiogram (ECG) recorded, and at least one blood sample for high sensitive troponin T (hs-TnT) analyzed

- **<u>exclusion criteria:</u>** apparent ST-segment elevations on ECG (these were recommended for acute coronary angiography) and those unable to follow up

- **<u>outcomes:</u>** MACE (= composite of acute myocardial infarction, myocardial revascularization and all-cause death) in 30 days after the index presentation

Results: baseline characteristics

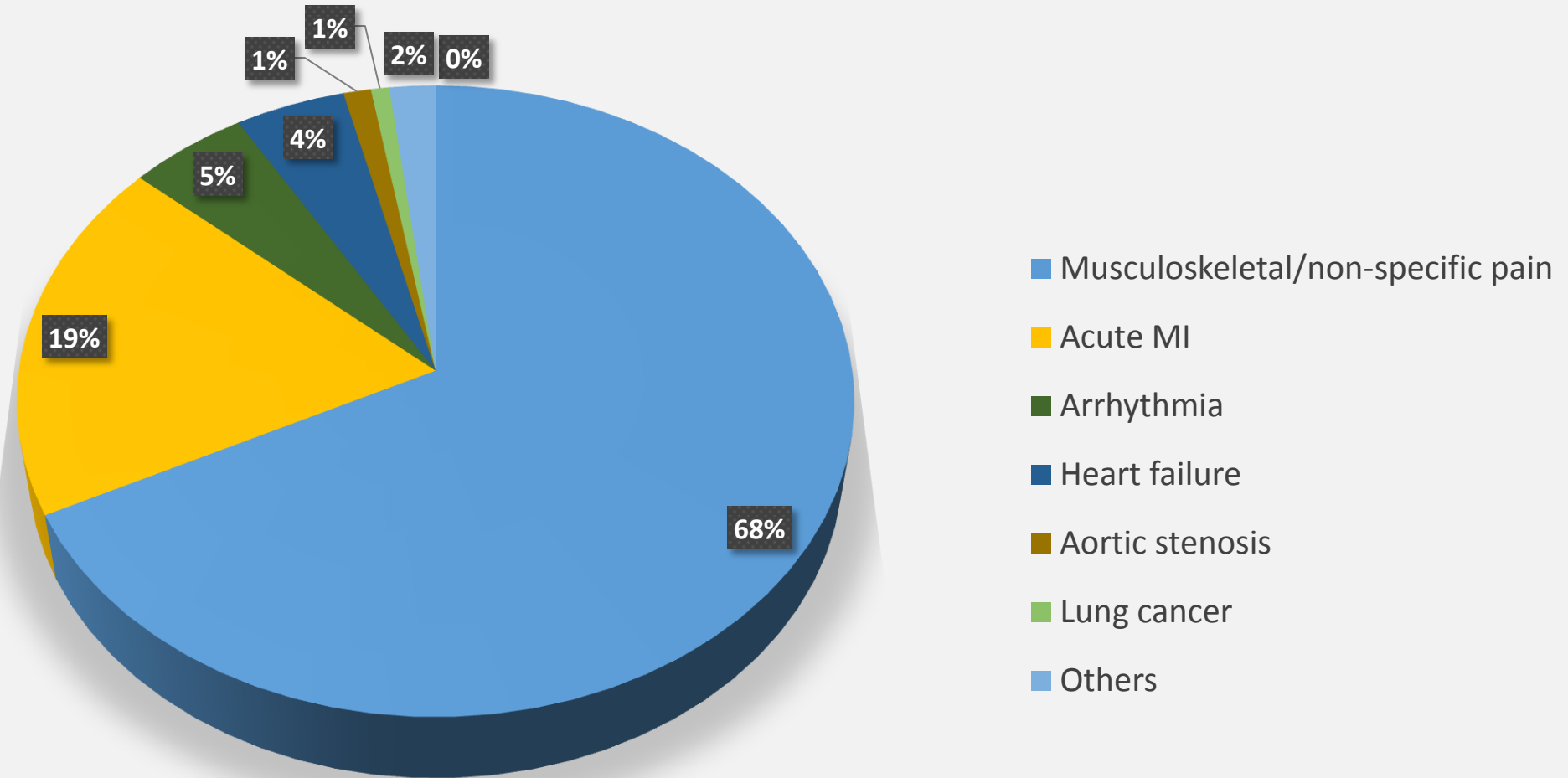| Total patients, n	250
Age, median (IQR)	78 (73-84)
Men, n (%)	126 (50.4)
Past medical history	
Coronary artery disease, n (%)	106 (42.4)
Peripheral artery disease, n (%)	23 (9.2)
TIA/ stroke, n (%)	25 (10.0)
Dyslipidaemia, n (%)	146 (58.4)
Hypertension, n (%)	209 (83.6)
Diabetes mellitus, n (%)	73 (29.2)
Current smoking, n (%)	73 (29.2)
Others	
Hospital admissions, n (%)	99 (39.6)
Coronary angiography performed, n (%)	39 (15.6)

Chest pain characteristics	
Typical angina, n (%)	97 (38.8)
Propagation to arm, n (%)	40 (16.0)
Relief after nitrates, n (%)	62 (24.8)
Nausea/ vomiting, n (%)	24 (9.6)
Sweating observed, n (%)	23 (9.2)
Pain produced by palpation, n (%)	49 (19.6)
Pain worsened with inspiration, n (%)	26 (10.4)
ECG and biochemical findings	
No new ischemic ECG changes, n (%)	183 (73.2)
hs-TnT at arrival ng/L, median (IQR)	16 (10-25)
creatinine µmol/L, median (IQR)	93 (80-112)
CKD-EPI eGFR ml/min/1.73m^2, median (IQR)	59.4 (46.2-70.2)

Results: outcomes in 30 days
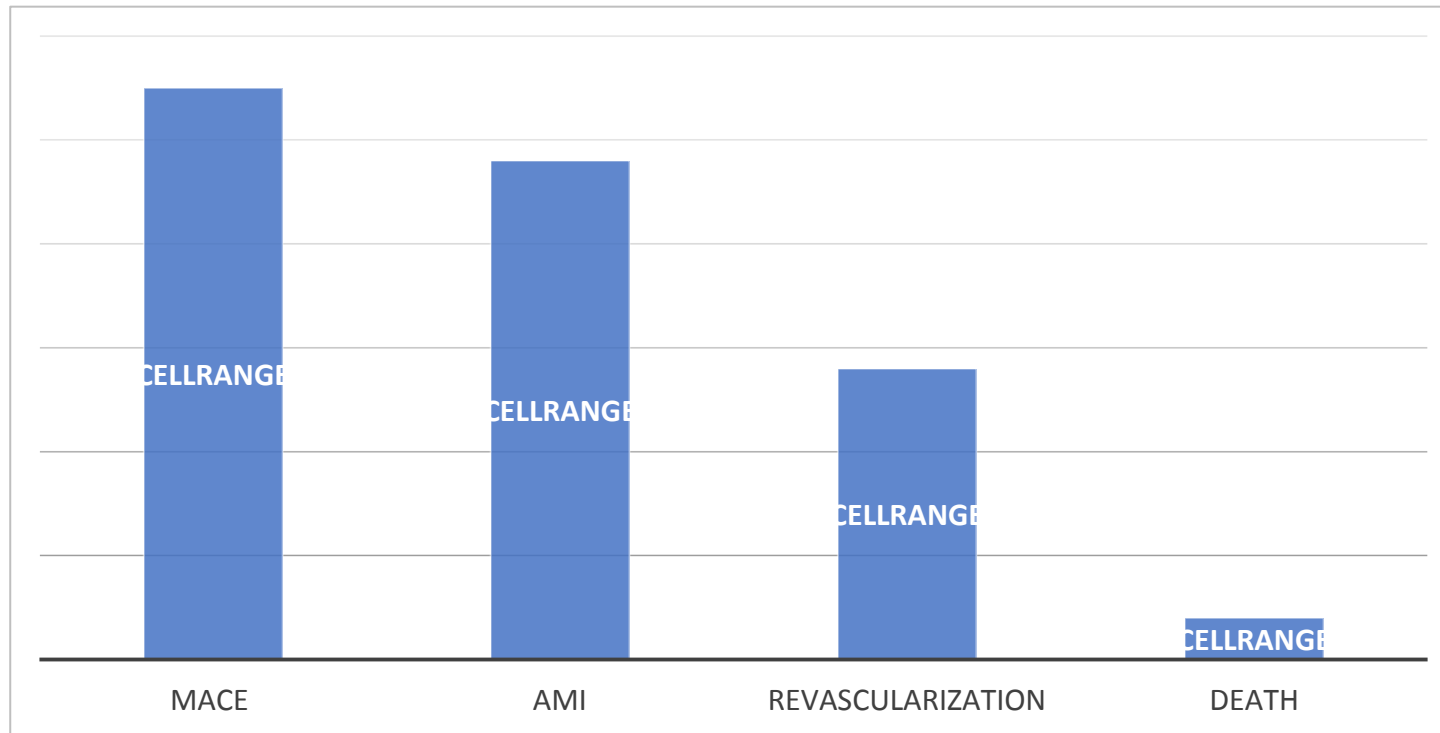
- 28 patients underwent myocardial revascularization: (coronary artery bypass graft surgery in 4 patients, percutaneous revascularization in 24 patients)

- 46 patients had AMI at the time of presentation to the ED, 2 had dg. AMI during follow-up

Spectrum of diagnosis at ED

Legend:
- Musculoskeletal/non-specific pain
- Acute MI
- Arrhythmia
- Heart failure
- Aortic stenosis
- Lung cancer
- Others

68%, 19%, 5%, 4%, 1%, 1%, 2%, 0%

Comparison between patients with and without AMI

	With AMI	Without AMI	p-value
Total, n	48	202	
Age, median (IQR)	81 (73-85.8)	77 (73-83)	0.101
Male sex, n (%)	35 (72.9)	89 (44.1)	**< 0.001**
CAD, n (%)	22 (45.8)	84 (41.6)	0.592
PAD, n (%)	8 (16.7)	15 (7.4)	**0.046**
Stroke, n (%)	5 (10.4)	20 (9.9)	0.915
Dyslipidemia, n (%)	23 (47.9)	123 (60.9)	0.101
Hypertension, n (%)	40 (83.3)	169 (83.7)	0.956
Diabetes mellitus, n (%)	19 (39.6)	54 (26.7)	0.078
Current smoker, n (%)	21 (43.8)	52 (25.7)	**0.014**
Typical angina, n (%)	39 (81.3)	58 (28.7)	**< 0.001**
Propagation do arm, n (%)	8 (16.7)	32 (15.8)	0.889
Relief after nitrates, n (%)	24 (50.0)	38 (18.8)	**< 0.001**
Nausea/ vomiting, (%)	9 (18.8)	15 (7.4)	**0.017**
Sweating observed, n (%)	6 (12.5)	17 (8.4)	0.379
Pain produced by palpation, n (%)	2 (4.2)	47 (23.3)	**0.003**
Pain worsened with inspiration, n (%)	1 (2.1)	25 (12.4)	**0.036**
ECG without ischemia, n (%)	23 (47.9)	160 (79.2)	**< 0.001**
hs-TnT at time 0 ng/L, median (IQR)	26.5 (16.3-61.8)	14 (10-22)	**< 0.001**
hs-TnT at time 1 ng/L, median (IQR)	59 (27-120)	20 (14-30)	**< 0.001**
Creatinine µmol/L, median (IQR)	92,5 (81-106.3)	93 (78-114)	0.961
Hospital admissions, n (%)	46 (95.8)	53 (26.2)	< 0.001
ICA performed, n (%)	27 (56.3)	12 (5.9)	< 0.001

* Mann-Whitney U test for continuous data, Pearson's Chi-square test for independence for categorical data

Risk factors for MACE

Risk factor	OR (95% CI)
Age	1.04 (0.99, 1.09)
Male sex	**3.15** (1.65, 6.02)
Coronary artery disease	1.17 (0.64, 2.14)
Peripheral artery disease	**2.53** (1.03, 6.21)
Stroke	1.13 (0.43, 2.99)
Dyslipidemia	0.56 (0.31, 1.02)
Arterial hypertension	1.00 (0.45, 2.25)
Diabetes mellitus	1.53 (0.81, 2.88)
Current smoker	**2.31** (1.24, 4.30)
Typical angina	**9.36** (4.59, 19.08)
Propagation of pain to arm	0.87 (0.37, 2.01)
Relief after nitrates	**3.96** (2.09, 7.52)
Nausea/ vomiting	**2.87** (1.20, 6.89)
Sweating observed	1.28 (0.48, 3.43)
Pain produced by palpation	0.12 (0.03, 0.51)
Pain worsened with inspiration	0.13 (0.02, 0.95)
ECG without ischemia	0.22 (0.11, 0.41)
hs-TnT at time 0	1.02 (1.01, 1.03)
Creatinine	1.00 (0.99, 1.00)
eGFR (CKD-EPI)	**2.40** (0.83, 6.91)
ICA performed	20.63 (9.02, 47.21)
Hospital admission	29.80 (11.24, 78.96)

* logistic regression, univariate analysis

Decision aid rules used in this study

- **T-MACS** (Troponin-only Manchester Acute Coronary Syndrom Score Decision Aid Rule)

- **HEART** score

- **EDACS** (Emergency Department Assessment of Chest Pain Score)

- **GRACE score** (Global Registry of Acute Coronary Events)

- **TIMI** (Thrombolysis in Myocardial Infarction) risk score for UA/NSTEMI

- **ADAPT** (Accelerated Diagnostic Protocol to Assess Patients With Chest Pain Symptoms)

- **Solo Troponin T (TnT) strategy** (decision made only by single hs-TnT value, cut-off value at the 99th percentile upper reference limit for used assay (14ng/L for men and women) for determination)

Protocol	T-MACS	HEART	EDACS	TIMI	GRACE	ADAPT
Variables	ECG ischemia	History	Age	Age ≥ 65	Age	Abnormal troponin at 0 or 2 hours
	Crescendo angina	ECG	Sex	≥ 3 risk factors for CAD	Heart Rate	Ischemic changes on ECG
	Pain radiating to shoulder	Age	Known CAD or ≥ 3 risk factors for CAD	Know CAD	Systolic Blood Pressure	Age ≥ 65
	Pain associated with vomiting	Risk factors	Diaphoresis	ASA use	Creatinine	≥ 3 risk factors for CAD
	Sweating observed	Initial Troponin	Pain radiating to arm, shoulder, neck, or jaw	Severe angina	Cardiac Arrest at Admission	Know CAD
	Hypotension		Pain worsened with inspiration	ECG ischemic changes	ST-segment deviation	ASA use
	Initial Troponin		Pain reproduced by palpation	Positive cardiac marker	Abnormal cardiac enzymes	Severe angina
					Killip class	
Risk stratification	Very low risk (0-1%)	Low risk (score 0-3)	Low risk (score <16)	Low risk (score 0-1)	Low risk (< 109 pts)	Low risk (normal TnT, normal ECG and TIMI 0)
	Low risk (2-4%)	Moderate risk (score 4-6)	Not-low risk (score ≥ 16)	Moderate risk (score 2-5)	Medium risk (109-140 pts)	Intermediate (normal TnT, normal ECG, and TIMI 1)
	Moderate risk (5-94%)	High risk (score >6)		High risk (score 6-7)	High risk (> 140 pts)	High (abnormal TnT or abnormal ECG, any TIMI)
	High risk (>94%)					
Value of age on total score	none*	age ≥ 65: 2 pts **(20%)**	70 years: 12 pts **(31%)**	age ≥ 65: 1 pt **(14%)**	70-79 years: 73 pts **(21%)**	age ≥ 65 counts for TIMI score ≥ 1
			71-75 years: 14 pts **(36%)**			
			76-80 years: 16 pts **(42%)**			
			81-85 years: 18 pts **(47%)**		> 79 years: 91 pts **(26%)**	
			≥ 86 years: 20 pts **(52%)**			
Maximum possible score	100%	10 points	38 points	7 points	340 points	NA

Troponin-only Manchester Acute Coronary Syndromes (T-MACS) Decision Aid ☆

Rules out acute coronary syndrome.

EKG ischemia As determined by treating clinician	No 0	**Yes +1**
Worsening or crescendo angina	**No 0**	Yes +1
Pain radiating to right arm or shoulder	**No 0**	Yes +1
Pain associated with vomiting	**No 0**	Yes +1
Sweating observed As observed by treating clinician	**No 0**	Yes +1
Hypotension sBP <100 mmHg on arrival to ED	**No 0**	Yes +1
hs-cTnT concentration on arrival	23	ng/L ⇆

Moderate risk

Serial troponin in general ward, consider stress testing and/or CT coronary angiography.

27 %

Risk of ACS or MACE in 30 days

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TIMI Risk Score for UA/NSTEMI ☆

Estimates mortality for patients with unstable angina and non-ST elevation MI.

Age ≥65	No 0	**Yes +1**
≥3 CAD risk factors Hypertension, hypercholesterolemia, diabetes, family history of CAD, or current smoker	No 0	**Yes +1**
Known CAD (stenosis ≥50%)	**No 0**	Yes +1
ASA use in past 7 days	**No 0**	Yes +1
Severe angina (≥2 episodes in 24 hrs)	**No 0**	Yes +1
EKG ST changes ≥0.5mm	**No 0**	Yes +1
Positive cardiac marker	No 0	**Yes +1**

3 points

13% risk at 14 days of: all-cause mortality, new or recurrent MI, or severe recurrent ischemia requiring urgent revascularization.

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Risk stratification in study population

T-MACS	total, n	%	AMI, n	%
Very Low	11	4.4	0	0.0
Low	95	38.0	3	3.2
Moderate	130	52.0	36	27.7
High	14	5.6	9	64.3
HEART	total, n	%	AMI, n	%
Low	35	14.0	0	0.0
Moderate	148	59.2	15	10.1
High	67	26.8	33	49.3
EDACS	total, n	%	AMI, n	%
Low risk	54	21.6	1	1.9
Not-low risk	196	78.4	47	24.0

TIMI	total, n	%	AMI, n	%
Low	49	19.6	3	6.1
Moderate	183	73.2	37	20.2
High	18	7.2	8	44.4
GRACE	total, n	%	AMI, n	%
Low	99	39.6	9	9.1
Moderate	94	37.6	19	20.2
High	57	22.8	20	35.1
ADAPT	total, n	%	AMI, n	%
Low	0	0.0	0	0.0
Intermediate	96	38.4	3	3.1
High	154	61.6	45	29.2
Solo TnT strategy	total, n	%	AMI, n	%
TnT < 15ng/L	113	45.2	9	8.0
TnT ≥ 15ng/L	137	54.8	39	28.5

Proportion of AMI patients in high risk groups
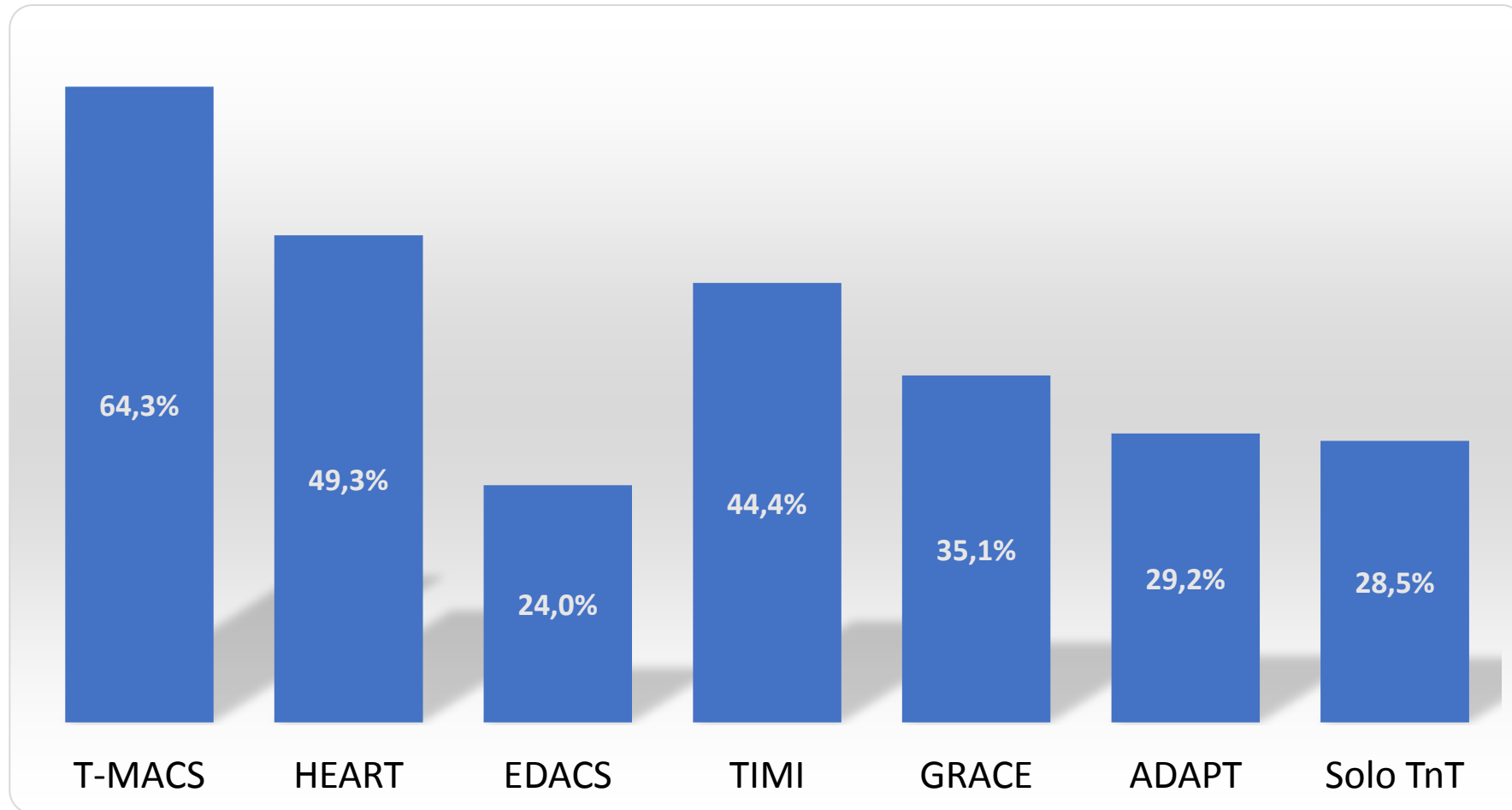
Performance of decision aids for *rule-in AMI*

Rule-In	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV, % (95% CI)	NPV, % (95% CI)	Accuracy, %	LR +	LR -	OR (95% CI)
T-MACS	18.8 (7.7-29.8)	97.5 (95.4-99.7)	64.3 (39.2-89.4)	83.5 (78.7-88.2)	82.4	7.6	0.8	9.1 (2.9-28.6)
HEART	68.8 (55.6-81.9)	83.2 (78.0-88.3)	49.3 (37.3-61.2)	91.8 (87.8-95.8)	80.4	4.1	0.4	10.9 (5.3-22.2)
TIMI	16.7 (6.1-27.2)	95.0 (92.1-98.0)	44.4 (21.5-67.4)	82.8 (77.9-87.6)	80.0	3.4	0.9	3.8 (1.4-10.3)
GRACE	41.7 (27.7-55.6)	81.7 (76.4-87.0)	35.1 (22.7-47.5)	85.5 (80.5-90.5)	74.0	2.3	0.7	3.2 (1.6-6.3)
ADAPT	93.8 (86.9-100.0)	46.0 (39.2-52.9)	29.2 (22.0-36.4)	96.9 (93.4-100.0)	55.2	1.7	0.1	12.8 (3.9-42.5)

Performance of decision aids for *rule-out AMI*

Rule-Out	Sensitivity, % (95% CI)	Specificity, % (95% CI)	PPV, % (95% CI)	NPV, % (95% CI)	Accuracy, %	LR +	LR -	OR (95% CI)
T-MACS	100.0 (100-100)	5.4 (2.3-8.6)	20.1 (15.0-25.2)	100.0 (100-100)	23.6	1.1	0.0	NA
HEART	100.0 (100-100)	17.3 (12.1-22.6)	22.3 (16.8-27.9)	100.0 (100-100)	33.2	1.2	0.0	NA
EDACS	97.9 (93.9-100.0)	26.2 (20.2-32.3)	24.0 (18.0-30.0)	98.1 (94.6-100.0)	40.0	1.3	0.1	16.7 (2.3-124.2)
TIMI	93.8 (86.9-100.0)	22.8 (17.0-28.6)	22.4 (16.6-28.2)	93.9 (87.2-100.0)	36.4	1.2	0.3	4.4 (1.3-14.9)
GRACE	81.3 (70.2-92.3)	44.6 (37.7-51.4)	25.8 (18.9-32.8)	90.9 (85.3-96.6)	51.6	1.5	0.4	3.5 (1.6-7.6)
ADAPT	100.0 (100-100)	0.0	19.2 (14.3-24.1)	NA	19.2	1.0	NA	NA
Solo TnT	81.3 (70.2-92.3)	51.5 (44.6-58.4)	28.5 (20.9-36.0)	92.0 (87.0-97.0)	57.2	1.7	0.4	4.6 (2.1-10.0)

ROC ANALYSIS
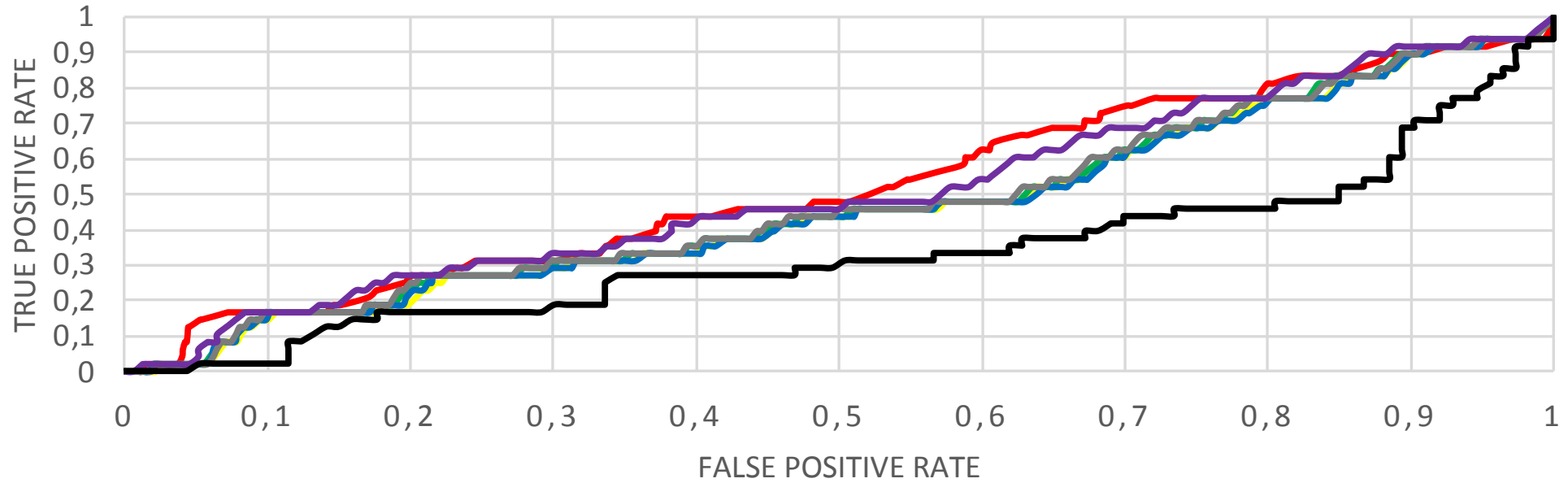
T-MACS: AUC=0.52 (95% CI 0.44-0.60)   HEART: AUC=0.46 (95% CI 0.38-0.55)

EDACS: AUC=0.47 (95% CI 0.39-0.55)   TIMI: AUC=0.46 (95% CI 0.38-0.55)

GRACE: AUC=0.47 (95% CI 0.39-0.56)   ADAPT: AUC=0.51 (95% CI 0.41-0.60)

TnT: AUC=0.33 (95% CI 0.23-0.42)

Discussion

- As far as we know, there are **not enough studies** that evaluated the use of decision aids in the selected population of the elderly and compared these protocols in-between.

- To our knowledge, this study is **unique because of the mean age** of participants included and the **number of decision protocols used.**

- We hope that the publication of these results **could lead to a change of practice** and hopefully even **better care** in this field.

Conclusions

1. Risk stratification of elderly patients with suspected ACS based on **decision aid rules is effective and safe**

2. **T-MACS** decision aid had **the best performance** for rule-in and rule-out AMI in this study

3. Decision making based just on troponin value is insufficient (solo TnT strategy had **worst performance** in this study)