International Journal of Cardiology xxx (2020) xxx

Contents lists available at ScienceDirect

International Journal of Cardiology

journal homepage: www.elsevier.com/locate/ijcard

Type 1 myocardial infarction rapid screening scale for emergency triage in patients with non-traumatic chest pain: A study of 1928 cases with coronary angiography

Jian-ning Ma [a,1], Xiao Wu [b,c,1], Li-juan Shen [d], Shan-you Hu [c,e], Min Liu [f], Qing Chang [f], Qin Xu [a,c,**], Fei Wang [b,*]

[a] Department of Nursing, Jiading District Central Hospital Affiliated Shanghai University of Medicine & Health Sciences, Shanghai, China
[b] Emergency Department, Jiading District Central Hospital Affiliated Shanghai University of Medicine & Health Sciences, Shanghai, China
[c] Chest pain center, Jiading District Central Hospital Affiliated Shanghai University of Medicine & Health Sciences, Shanghai, China
[d] Clinical Trials Unit, Jiading District Central Hospital Affiliated Shanghai University of Medicine & Health Sciences, Shanghai, China
[e] Department of Critical Care Medicine, Jiading District Central Hospital Affiliated Shanghai University of Medicine & Health Sciences, Shanghai, China
[f] Clinical Research Center, Jiading District Central Hospital Affiliated Shanghai University of Medicine & Health Sciences, Shanghai, China

ARTICLE INFO

Article history:
Received 16 December 2019
Received in revised form 11 July 2020
Accepted 7 August 2020
Available online xxxx

Keywords:
Type 1 myocardial infarction
Modified early warning score
Pre-examination triage
Risk factors
Acute coronary syndrome

ABSTRACT

Introduction: The effectiveness of treatment and prognosis of patients with type 1 myocardial infarction are highly correlated with time of diagnosis. This study aimed to develop a type 1 MI rapid screening scale (T1MIrs scale) suitable for emergency pre-diagnosis.
Methods: A total of 1928 patients who underwent coronary angiography were enrolled. Multivariate regression analysis was used to identify the independent risk factors of type 1 MI. And the T1MIrs scale was developed and evaluated according to the multivariate regression result.
Results: The incidence of type 1 MI was 23.3% in the population with suspected acute coronary syndrome. After 5 adjusting for relevant factors, MEWS score (OR = 1.809, 95%CI 1.623–2.016, $P < .001$), typical symptoms (OR = 9.826, 95%CI 7.379–13.084, $P < .001$), male (OR = 2.184, 95%CI 1.602–2.979, $P < .001$), age (OR = 1.021, 95%CI 1.009–1.033, $P = .001$), history of diabetes (OR = 2.174, 95%CI 1.594–2.963, $P < .001$) and current smoker (OR = 2.498, 95%CI 1.550–4.026, $P < .001$) were the independent risk factors for type 1 MI. The T1MIrs scale is established based on risk factors, with a range of 0–8 points. The incidence of type 1 MI is ascending with the scale (0.3% vs. 3.7% vs. 14.3% vs. 34.9% vs. 57% vs. 76.4% vs. 84.2% vs. 87.5% vs. 100%, P for trend <0.001).
Conclusions: Type 1 MI is common in patients with suspected acute coronary syndrome in emergency department. The T1MIrs scale could act as a rapid pre-examination triage of suspected population in emergency department, which is meaningful to screen out type 1 MI patients as soon as possible.

1. Background

Type 1 myocardial infarction (Type 1 MI) [1] refers to unstable plaque ulceration and rupture on the basis of coronary atherosclerosis, secondary acute thrombosis, leading to spontaneous myocardial infarction, which is one of the most common critical illnesses in emergency department. The prognosis of MI is highly time dependent, when the coronary artery is completely occluded, only a small portion of the affected myocardium will be necrotic in the first 20–30 min; The necrotic area will escalate to about 30% after 40 min, ~50% after 3 h, ~70% after 6 h and ~ 80% after 24 h. This dependency makes the effectiveness of treatment and the in-hospital mortality rate of Type 1 MI patients increase significantly with the onset time (<90 min, 3% vs. >150 min, 7.4%) [2]. The AHA/ACC treatment guidelines for Type 1 MI clearly indicate that the time from hospital visit to the first balloon-expansion (Door-to-Balloon, DTB) should be within 90 min [3], but in actual clinical practice, in-hospital delay is still prevalent. As demonstrated in the study of Dr. Park J, different diagnostic algorithms and initial work up tests should hold the balance for DTB [4], indicating that a quickly screening method for high-risk Type 1 MI patients could help to shorten the DTB time in emergency department. The Chinese government has vigorously promoted the construction of primary chest pain center with great attention since November

Abbreviations: Type 1 MI, Type 1 myocardial infarction; T1MIrs scale, Type 1 myocardial infarction rapid screening scale; DTB, Door-to-Balloon; MEWS, The modified early warning score; SRI, Simple Risk Index; OR, Odds ratio; CI, confidence interval; SD, standard deviation; IQR, Interquartile range; ACS, acute coronary syndrome.

* Correspondence to: F. Wang, Emergency Department, No.1, Chengbei Rd, Jiading District, Shanghai, China.
** Correspondence to: Q. Xu, Department of Nursing, No.1, Chengbei Rd, Jiading District, Shanghai, China.
E-mail addresses: 92xuxiao@sina.com (Q. Xu), chazwf@163.com (F. Wang).
[1]Co-authors: Jian-ning Ma and Xiao Wu contributed equally to this work.

https://doi.org/10.1016/j.ijcard.2020.08.008

2015 [5], aiming at reducing the impact of Type 1 MI patients due to the prolonged DTB time as well as screening out the high-risk Type 1 MI patients as early as possible. During the construction process, several potential problems emerged from the emergency pre-examination triage: 1. the emergency pre-examination triage is a non-cardiovascular professional, and most of physicians decide whether to enter the procedure of chest pain by acquiring medical history and appraising chest pain performance, which could result in delayed or missed diagnosis, misdiagnosis or overtreatment. 2, up to date troponin level is still the most essential standard for the diagnosis of myocardial infarction, while on one hand the measurement process takes at least 15 min [6]; on the other hand, troponin begins to rise in about 3 to 4 h after MI onset, which implies it is not suitable as a basis for rapid diagnosis in emergency department. 3, shorten DTB time could possibly lead to increased stress and professional requirement of the emergency pre-examination triage. Therefore, it is particularly important to establish a rapid screening scale based on the symptoms of patients with chest pain and suitable for emergency pre-examination triage.

The modified early warning score (MEWS) has been widely used in clinical practice for rapid screening of emergency pre-examination triage, especially screening for critically ill patients in emergency department [7], [Supplementary Tables]. Patients with Type 1 MI are often accompanied by a variety of potentially fatal symptoms like hypotension, bradycardia or tachycardia. These symptoms scored relatively higher in MEWS, indicating that patients with Type 1 MI might have higher MEWS score. In a study of 2014 [8], MEWS owned a good prediction ability for acute cardiac complications with area under curve = 0.672. Simple Risk Index (SRI), with clinical significance in quick and efficient risk evaluation for suspected STEMI patients, is also used in clinical practice [9]. According to this research, SRI could be calculated by (heart rate × [age/10]^2)/systolic blood pressure. This score had a strong prediction capacity with C-index = 0.78. However, SRI was established for prehospital emergency environment or paramedics. Based on the scores and syndrome features of MI patients, we attempted to establish a Type 1 MI rapid screening scale for patients with non-traumatic chest pain and suspected acute coronary syndrome in order to provide a basis for reducing the chance of missed diagnosis, misdiagnosis or over-treatment due to subjective human factors.

2. Methods

2.1. Study population

Patients in the emergency department of chest pain center of Jiading District Central Hospital affiliated to Shanghai University of Medicine and Health Science from January 2015 to December 2016 were consecutively enrolled. Inclusion criteria: patients with suspected acute coronary syndrome [10]; Exclusion criteria: patients with traumatic chest pain, patients with stable angina pectoris, patients with type 3 myocardial infarction, patients with unexplained sudden death, pulmonary embolism, aortic dissection, and contraindications for angiography. The study was approved by the hospital ethics committee, and all patients or their legal attorney in the study were informed before enrollment.

2.2. Data

General clinical data (gender and age), comorbidities (hypertension and diabetes), lifestyle history (smoking and alcohol consumption), and the symptoms (typical symptoms or atypical symptoms) of the patient at the time of the visit was collected, MEWS score is calculated from the real-time vital signs monitoring value, the patient's prognosis and diagnosis was followed up to death or discharge from the hospital. The patients were divided into two groups according to whether ultimately diagnosed as Type 1 MI. The general clinical data of the two groups were analyzed. Multivariate logistic regression was used to identify the independent risk factors for Type 1 MI, and the Type 1 MI screening score scale was introduced based on the results of the regression analysis.

2.3. Diagnostic criteria

1. Diagnostic criteria for myocardial infarction: refer to the "The Fourth Global Definition of Myocardial Infarction" of the European Society of Cardiology (ESC) 2018 [11]. Specifically: the detection of myocardial biomarkers (cTn) increased, exceeding the 99th percentile of the upper reference limit at least once and observed at least one of the following clinical evidences of acute myocardial ischemia: (1) acute myocardial ischemia; (2) meaningful or suspected new-onset ST-T changes or new left bundle branch block; (3) pathological Q wave in ECG; (4) imaging evidence suggesting new viable myocardium loss or new local wall motion abnormalities; (5) by angiography or autopsy confirmed coronary thrombosis.
2. Diagnostic criteria for hypertension [12]: If the systolic blood pressure level is ≥140 mmHg for three consecutive days, and/or the diastolic blood pressure is ≥90 mmHg, it is diagnosed as hypertension.
3. Diagnostic criteria for diabetes [13]: The following three conditions can be used to determine the presence of diabetes: random blood glucose greater than or equal to 11.1 mmol/L with a history of diabetes; fasting blood glucose greater than or equal to 7 mmo1/L; 2 h blood glucose level of Oral Glucose Tolerance Test was greater than or equal to 11.1 mmol/L.
4. The typical symptoms of myocardial infarction criteria [14]: rapid onset, long duration of pain, located in the substernal or precordial area, radiating pain to the left neck, left arm, crushed pain often accompanied by sudden death.

2.4. Statistical method

Statistical analysis was performed using IBM SPSS 19.0 software. Continuous variable data with normal distribution was expressed as mean ± standard deviation (Mean ± SD), and was analyzed by *t*-test; the indicator that does not conform to the normal distribution was presented as median (first quartile distance ~ third Interquartile range), ie M (Q1 ~ Q3), and was analyzed using a nonparametric test (M-W test). Categorical variable data was expressed as rate, and X^2 test was used for comparison. Multivariate logistic regression analysis was used to identify independent risk factors for myocardial infarction. Receiver operator curve (ROC) test was used to determine the predictive value of T1MIrs scale, MEWS score and SRI score for Type 1 MI. The myocardial infarction screening scale was established with relevant risk factors, and the scores and myocardial infarction were analyzed. The differences were statistically significant at $P < .05$.

3. Resust

3.1. Population and baseline characteristics

A total of 4220 patients were continuously enrolled in the emergency chest pain center, including 513 patients with traumatic chest pain, 858 patients with stable angina pectoris, 217 patients with treatment abandoning, and 47 patients with type 3 myocardial infarction. There were 31 patients with unexplained sudden death, 25 patients with pulmonary embolism, 22 patients with aortic dissection and 16 patients with unknown diagnosis. The remaining 2491 patients were diagnosed with acute coronary syndrome and underwent coronary angiography, in which 369 patients who refused to conduct coronary angiography and 194 patients with contrast contraindications (101 patients with severe heart failure, angiography, 12 patients with allergic reactions, 23 patients with severe coagulopathy and 58 patients with severe hepatorenal dysfunction) were excluded. After exclusion a total of 1928 patients were

Please cite this article as: J. Ma, X. Wu, L. Shen, et al., Type 1 myocardial infarction rapid screening scale for emergency triage in patients with non-traumat..., International Journal of Cardiology, https://doi.org/10.1016/j.ijcard.2020.08.008

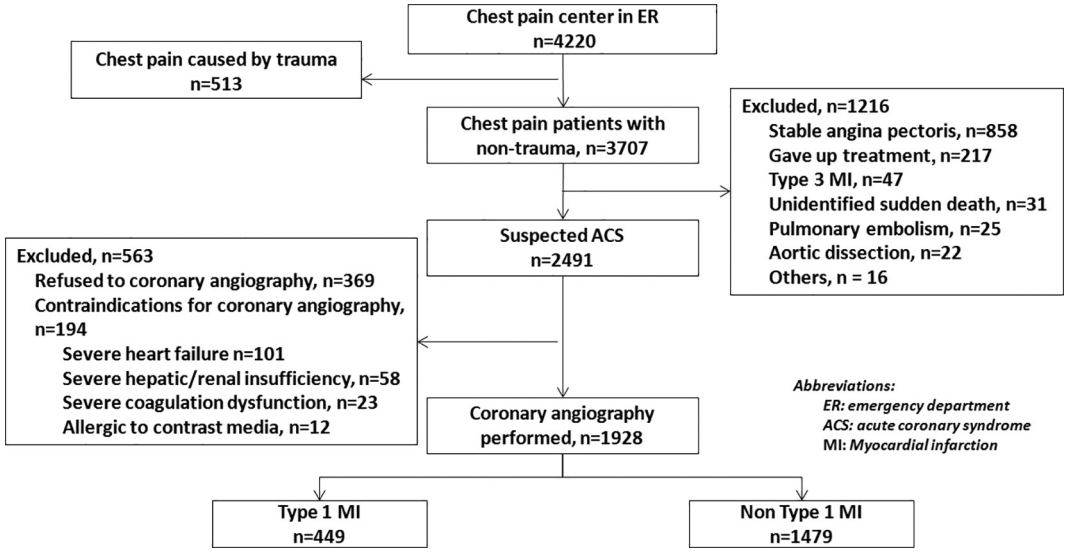

Fig. 1. Flow diagram of patients.

included in the analysis (Fig. 1), including 1122 males (58.2%) and 806 females (41.8%), the average age was (64.27 ± 12.11) years old, and 449 patients were diagnosed with Type 1 MI. The incidence of Type 1 MI was 10.6% (449/4220) in the overall population, 23.3% (449/1928) in the suspected acute coronary syndrome, and the in hospital mortality was 1.1% (22/1928).

3.2. Comparison between Type 1 MI and non-Type 1 MI patients

Compared with non-Type 1 MI patients, the MEWS score (3 (2–3) vs. 1 (1–2), $P < .001$) and SRI score (26.0(18.1–35.7) vs. 21.8 (16.5–28.2), $P < .001$) of Type 1 MI patients, with typical symptom rate (65.7% vs. 11.5%, $P < .001$), combined high Blood pressure rate (70.2% vs. 64.0%, $P = .017$), combined diabetes rate (33.4% vs. 16.8%, $P < .001$), current smoker rate (16.3% vs. 5.5%, $P < .001$), current drink rate (4.9%) vs. 2.3%, $P = .004$), case fatality rate (3.8% vs. 0.3%, $P < .001$) and male ratio (76.4% vs. 52.7%, $P < .001$) were significantly elevated, as shown in Table 1. Meanwhile, the similar results were reached within non-STEMI patients in the subgroup analysis (Supplementary tables).

Table 1
Comparison of clinical data and scores between the two groups.

	All $N = 1928$	T1MI $N = 449$	Non-T1MI $N = 1479$	*p*-value for T1MI vs. non T1MI
Male [n(%)]	1122(58.2)	343(76.4)	779(52.7)	<0.001
Age (Mean ± SD, years)	64.27 ± 12.11	65.19 ± 13.92	63.99 ± 11.49	0.097
Current smoker [n(%)]	154(8.0)	73(16.3)	81(5.5)	<0.001
Current drinker [n(%)]	56(2.9)	22(4.9)	34(2.3)	0.004
Complications [n(%)]				
Hypertension	1262(65.5)	315(70.2)	947(64.0)	0.017
Diabetes	398(20.6)	150(33.4)	248(16.8)	<0.001
Atrial fibrillation	201(10.4)	49(10.9)	152(10.3)	0.699
Hyperlipidemia	155(8.0)	31(6.9)	124(8.4)	0.312
Typical symptoms [n(%)]	465(24.1)	295(65.7)	170(11.5)	<0.001
Early warning score [M (Q1 ~ Q3),score]				
MEWS score	1(1–3)	3(2–3)	1(1–2)	<0.001
SRI score	22.6 (16.8–29.9)	26.0 (18.1–35.7)	21.8 (16.5–28.2)	<0.001
Death [n(%)]	22(1.1)	17(3.8)	5(0.3)	<0.001

3.3. Regression analysis

Multivariate logistic regression analysis found that MEWS score (OR = 1.809, 95% CI 1.623–2.016, $P < .001$), typical symptoms (OR = 9.826, 95% CI 7.379–13.084, $P < .001$), male (OR = 2.184, 95% CI 1.602–2.979, $P < .001$), age (OR = 1.021, 95% CI 1.009–1.033, $P = .001$), history of diabetes (OR = 2.174, 95% CI 1.594–2.963, $P < .001$) and current smoker (OR = 2.498, 95% CI 1.550–4.026, $p < .001$) were independent risk factors for Type 1 MI (Table 2, Model 1). Meanwhile, SRI score (OR = 1.084, 95% CI 1.064–1.105, $P < .001$), typical symptoms (OR = 15.360, 95% CI 11.555–20.419, $P < .001$), male (OR = 2.315, 95% CI 1.702–3.148,

Table 2
Multivariate logistic regression analysis for independent factors.

Factor	OR	95% CI	P-value
Model 1C-index = 0.649			
Male	2.184	1.602–2.979	<0.001
Age	1.021	1.009–1.033	0.001
Diabetes	2.174	1.594–2.963	<0.001
Current smoker	2.498	1.550–4.026	<0.001
Current drinker	0.997	0.474–2.097	0.993
MEWS score	1.809	1.623–2.016	<0.001
Typical symptoms	9.826	7.379–13.084	<0.001
Hypertension	1.294	0.955–1.755	0.097
Model 2C-index = 0.563			
Male	2.315	1.702–3.148	<0.001
Age	0.968	0.951–0.985	0.001
Diabetes	2.219	1.634–3.013	<0.001
Current smoker	2.495	1.543–4.033	<0.001
Current drinker	0.961	0.460–2.009	0.916
SRI score	1.084	1.064–1.105	<0.001
Typical symptoms	15.360	11.555–20.419	<0.001
Hypertension	1.522	1.126–2.058	0.006
Model 3C-index = 0.581			
Male	2.212	1.623–3.016	<0.001
Age (< 73 years)	0.446	0.326–0.609	<0.001
Diabetes	2.299	1.682–3.142	<0.001
Current smoker	2.561	1.564–4.191	<0.001
Current drinker	1.119	0.522–2.399	0.773
Typical symptoms	7.281	5.409–9.800	<0.001
MEWS score (points)			
≥5	12.072	6.574–22.168	<0.001
2–5	6.197	4.413–8.703	<0.001
<2	Ref.		
Hypertension	1.308	0.965–1.774	0.083

Table 3
Rapid screening scale for type 1 myocardial infarction.

Factor	Score
Male	
yes	1
no	0
Diabetes	
yes	1
no	0
Current smoker	
yes	1
no	0
Typical symptoms	
yes	2
no	0
Age	
≥73 years	1
<73 years	0
MEWS score	
≥5 point	2
≥2 point	1
≥1 point	0
Total	0–8 points

$P < .001$), age (OR = 0.968, 95% CI 0.951–0.985, P = .001), history of diabetes (OR = 2.219, 95% CI 1.634–3.013, $P < .001$) and current smoker (OR = 2.495, 95% CI 1.543–4.033, p < .001) were independent risk factors for Type 1 MI (Table 2, Model 2). When the Type 1 MI was diagnosed with age as the independent variable, the optimal cut-off value was 73 years old. Further multivariate regression analysis found that after adjusting for typical symptoms, gender, age, diabetes history, and current smoker, the risk of developing Type 1 MI was significantly increased for patients with MEWS ≥5 points relative to MEWS <2 points (OR = 12.072, 95% CI 6.574–22.168, $P < .001$) and 2 to 5 points (OR = 6.197, 95% CI 4.413–8.703, P < .001) (Table 2, Model 3).

3.4. The predictive value of the scores

The T1MIrs scale (Area Under Curve (AUC) 0.869, 95%CI 0.852–0.886, P < .001) showed significantly better pre-screening efficacy for Type 1 MI in suspected ACS patients than MEWS score (AUC 0.800, 95%CI 0.777–0.823, P < .001) and SRI score (AUC 0.605, 95%CI 0.573–0.637, P < .001), even the other two also had potential value (Supplementary Fig. 1).

3.5. Establishment of T1MIrs scale

T1MIrs scale was established according to the independent risk factors in the regression analysis, specifically MEWS score (≥5, 2 points; 2–5, 1 point; <2,0 points), typical symptoms (yes, 2 points; no, 0 points), male (yes, 1 point; no, 0 points), age (≥74, 1 point; <73,0 points), diabetes (yes, 1 point; no, 0 points), current smoker (Yes), 1 point; no, 0 points), the total score range is 0–8 points (Table 3).

3.6. Validation of the T1MIrs scale

According to the T1MIrs Scale, the incidence of Type 1 MI increased with the increase of the score (0.3% vs. 3.7% vs. 14.3% vs. 34.9% vs. 57.0% vs. 76.4% vs. 84.2% vs. 87.5%) Vs.100%, P for trend<0.001) (Supplementary Fig. 2).

4. Discussion

In this study, patients with suspected acute coronary syndrome in emergency department has a high incidence of Type 1 MI. According to our study, as an emergency pre-examination triage, the Type 1 MI Rapid Screening Scale successfully made it both effective and accurate to screen out Type 1 MI within suspected patients.

Early, rapid, and complete coronary vascular recanalization in Type 1 MI patients is key to improving prognosis. Establishing a regional collaborative treatment network and standardizing chest pain centers are effective means to shorten the time from DTB to recanalization procedure. The international standard of DTB is limited to 90 min, but the compliance rate worldwide is only 70% [15]. Studies have shown that emergency departmental staff cannot identify high-risk patients quickly and effectively due to the limitation of professional knowledge, especially asymptomatic Type 1 MI patients, which hinders patients from being referred to specialist treatment in time, and was identified as an independent risk factor for hospital delay [16]. Therefore, accurate and rapid identification of the Type 1 MI in the emergency triage is crucial for reducing DTB. However, currently there is no objective scale for this purpose. Although MEWS score and SRI score have been widely used in clinical practice because of its simplicity, effectiveness and operability, the lack of specificity in identifying Type 1 MI makes the scores not suitable for this job alone. At the same time, the diagnosis of Type 1 MI is based on patients with relevant risk factors. Based on the above situation, for emergency chest pain patients, we tried to establish a rapid screening scale combining the scores with risk factors related to myocardial infarction, which can be applied to the rapid pre-examination of Type 1 MI in emergency department.

In this study the population of Type 1 MI accounted for nearly a quarter of whole population with suspected acute coronary syndrome (ACS) in emergency department, which was similar to previous studies [1], it also suggested that attention should be paid to reduce DTB time by timely screening the potential Type 1 MI patients in this population group. Significantly predominant in the Type 1 MI subgroup, the risk factors such as male, aging, diabetes and current smoker were ultimately proved to be independent risk factors by our analysis, which was consistent with previous studies [17–19], and they could be considered as cornerstones of the risk assessment scale. On the other hand, the MEWS score and SRI score were significantly increased in the Type 1 MI population. After adjusting for other factors, we observed that the two scores are independent risk factors for Type 1 MI, which indicates that the scores have certain potential value for rapid screening of Type 1 MI in patients with acute chest pain. However, the MEWS score showed significantly better pre-screening efficacy for Type 1 MI in suspected ACS patients than SRI, even SRI score also had potential value.

Based the background above we assigned these independent factors and the MEWS score according to their correlation to Type 1 MI to introduce a T1MIrs scale with a score range of 0–8. Statistical analysis showed that the incidence of Type 1 MI increased with the T1MIrs scale, and the incidence of Type 1 MI reach 100% when Type 1 MIrs scale is 8 (highest), indicating the potential clinical application value of T1MIrs scale in rapidly screening Type 1 MI population in patients with acute chest pain. Furthermore, the T1MIrs scale showed significantly better pre-screening efficacy for Type 1 MI in suspected ACS patients. In addition, the simplicity of the T1MIrs scale makes it accessible for different levels of professional knowledge background of the emergency triage; Taking advantage of fast result obtainment, the T1MIrs scale is recommendable to the emergency department for emergency suspected ACS, especially for primary hospitals (non-tertiary medical center whose facilities and specialists were not as adequate or impeccable as tertiary medical center).

This study has certain limitations. First, this is a single-center study. Although the sample size is relatively large, patients sources was mainly concentrated in the local and surrounding cities, which may be regional, a multi-centered study should be conducted for further confirmation; secondly, 10% of patients refused to undergo angiography and therefore were excluded, the potential Type 1 MI patients may have a certain impact on the results. Besides, as a retrospective non-randomized study, the relatively group comparison was not good enough, which lowered the strength of our work. Finally, the current smoker rate and current

Please cite this article as: J. Ma, X. Wu, L. Shen, et al., Type 1 myocardial infarction rapid screening scale for emergency triage in patients with non-traumat..., International Journal of Cardiology, https://doi.org/10.1016/j.ijcard.2020.08.008

drink rate in this study are lower than the average level in Shanghai, which may be related to the strict control of tobacco in Shanghai, the strengthening of public science knowledge and the living habits of local elderly [20].

5. Conclusion

Type 1 MI is common in patients with suspected acute coronary syndrome in emergency department. The T1MIrs scale based on independent clinical risk factors could act as a rapid pre-examination triage of suspected population in emergency department, which is meaningful to screen out Type 1 MI patients as soon as possible.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ijcard.2020.08.008.

Ethics approval and consent to participate

The study protocol was approved by the Ethics Review Board of Jiading District Central Hospital (JDKW-2018-W22), an affiliated teaching hospital of Shanghai University of Medicine & Health Sciences. And informed consent was not required of the participants because of the nature of the study.

Authors' contributions

MJN and WX: carried out the studies, participated in collecting data, and drafted the manuscript. SLJ, HSY, CQ and XQ: participated in collecting data and helped to draft the manuscript. LM: performed the statistical analysis. WF and XQ: design, review and editing the manuscript. All authors read and approved the final manuscript.

Funding

This study was funded by Shanghai Municipal Jiading District New Key Subject Program (2017-ZD-03), Shanghai Municipal Jiading District Science and Technology Commission Foundation (JDKW-2018-W22) and Shanghai Municipal Jiading District Health Commission Foundation (2019-KY-09). The funding sources had no role in the design of the study; in the collection, analysis, and interpretation of data; or in the writing of the manuscript.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Consent for publication

Not applicable.

Declaration of Competing Interest

The authors declare that they have no competing interests.

Acknowledgements

Not applicable.

References

[1] Y. Sandoval, S.W. Smith, A. Sexter, S.E. Thordsen, C.A. Bruen, M.D. Carlson, et al., Type 1 and 2 myocardial infarction and myocardial injury: clinical transition to high-sensitivity cardiac troponin I, Am. J. Med. 130 (12) (2017) 1431–1439.
[2] J. Wu, C.P. Gale, M. Hall, T.B. Dondo, E. Metcalfe, G. Oliver, et al., Editor's Choice - Impact of initial hospital diagnosis on mortality for acute myocardial infarction: A national cohort study, Eur. Heart J. Acute Cardiovasc. Care 7 (2) (2018) 139–148.
[3] B. Nguyen, M. Fennessy, F. Leya, W. Nowak, M. Ryan, S. Freeberg, et al., Comparison of primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction during and prior to availability of an in-house STEMI system: early experience and intermediate outcomes of the HARRT program for achieving routine D2B times <60 minutes, Catheter. Cardiovasc. Interv. 86 (2) (2015) 186–196.
[4] J. Park, K.H. Choi, J.M. Lee, H.K. Kim, D. Hwang, T.M. Rhee, et al., Prognostic implications of door-to-balloon time and onset-to-door time on mortality in patients with ST -segment-elevation myocardial infarction treated with primary percutaneous coronary intervention, J. Am. Heart Assoc. 8 (9) (2019).
[5] R.F. Hamburger, J.A. Spertus, D.E. Winchester, Utility of the diamond-forrester classification in stratifying acute chest pain in an academic chest pain center, Crit. Pathw. Cardiol. 15 (2) (2016) 56–59.
[6] M. Möckel, U. Landmesser, Challenges in using high-sensitive troponin reporting in clinical practice-the important role of appropriate use in the context of clinical evaluation, Int. J. Cardiol. 245 (2017) 61–62.
[7] D. Tirotta, M. Gambacorta, M. La Regina, T. Attardo, A. Lo Gullo, F. Panzone, et al., Evaluation of the threshold value for the modified early warning score (MEWS) in medical septic patients: a secondary analysis of an Italian multicentric prospective cohort (SNOOPII study), QJM 110 (6) (2017) 369–373.
[8] N. Liu, Z.X. Koh, E.C. Chua, et al., Risk scoring for prediction of acute cardiac complications from imbalanced clinical data, IEEE J. Biomed. Health Inform. 18 (6) (2014) 1894–1902.
[9] D.A. Morrow, E.M. Antman, R.P. Giugliano, R. Cairns, A. Charlesworth, S.A. Murphy, et al., A simple risk index for rapid initial triage of patients with ST-elevation myocardial infarction: an InTIME II substudy, Lancet 358 (9293) (2001) 1571–1575.
[10] A.R. Chapman, T. Fujisawa, K.K. Lee, J.P. Andrews, A. Anand, D. Sandeman, et al., Novel high-sensitivity cardiac troponin I assay in patients with suspected acute coronary syndrome, Heart 105 (8) (2019) 616–622.
[11] K. Thygesen, J.S. Alpert, A.S. Jaffe, B.R. Chaitman, J.J. Bax, D.A. Morrow, et al., Fourth universal definition of myocardial infarction (2018), Glob. Heart 13 (4) (2018) 305–338.
[12] Writing Group of 2018 Chinese Guidelines for the Management of Hypertension, 2018 Chinese guidelines for the management of hypertension, Chin. J. Cardiovasc. Med. 24 (1) (2019) 24–56 (article in Chinese).
[13] World Health Organization, Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycemia: Report of a WHO/IDF Consultation, 2006 [M], WHO Document Production Services, Geneva, 2006.
[14] I. Kirchberger, U. Amann, M. Heier, B. Kuch, C. Thilo, A. Peters, et al., Presenting symptoms, pre-hospital delay time and 28-day case fatality in patients with peripheral arterial disease and acute myocardial infarction from the MONICA/KORA myocardial infarction registry, Eur. J. Prev. Cardiol. 24 (3) (2017) 265–273.
[15] J.G. Jollis, H.R. Al-Khalidi, M.L. Roettig, P.B. Berger, C.C. Corbett, Doerfler, et al., Impact of regionalization of ST-segment-elevation myocardial infarction care on treatment times and outcomes for emergency medical services-transported patients presenting to hospitals with percutaneous coronary intervention: mission: lifeline accelerator-2, Circulation 137 (4) (2018) 376–387.
[16] B. Karkabi, R. Jaffe, D.A. Halon, A. Merdler, N. Khader, R. Rubinshtein, et al., An intervention to reduce the time interval between hospital entry and emergency coronary angiography in patients with ST-elevation myocardial infarction, Isr. Med. Assoc. J. 19 (9) (2017) 547–552.
[17] R. Wang, B. Mei, X. Liao, X. Lu, L. Yan, M. Lin, et al., Determination of risk factors affecting the in-hospital prognosis of patients with acute ST segment elevation myocardial infarction after percutaneous coronary intervention, BMC Cardiovasc. Disord. 17 (1) (2017) 243.
[18] S.T. Vernon, S. Coffey, R. Bhindi, S.Y. Soo Hoo, G.I. Nelson, M.R. Ward, et al., Increasing proportion of ST elevation myocardial infarction patients with coronary atherosclerosis poorly explained by standard modifiable risk factors, Eur. J. Prev. Cardiol. 24 (17) (2017) 1824–1830.
[19] I. Škrlec, J. Milić, I. Cilenšek, D. Petrovič, J. Wagner, B. Peterlin, Circadian clock genes and myocardial infarction in patients with type 2 diabetes mellitus, Gene 701 (2019) 98–103.
[20] X. Zhang, R. Xia, S. Wang, W. Xue, J. Yang, S. Sun, et al., Relative contributions of different lifestyle factors to health-related quality of life in the elderly, Int. J. Environ. Res. Public Health (2018) 15(2).

Please cite this article as: J. Ma, X. Wu, L. Shen, et al., Type 1 myocardial infarction rapid screening scale for emergency triage in patients with non-traumat..., International Journal of Cardiology, https://doi.org/10.1016/j.ijcard.2020.08.008