Comparison of different risk stratification rules to predict short-term adverse outcomes after syncope in older Chinese adults

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Research Article

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Abstract

Background: Older adults with syncope are commonly treated in the emergency department. Clinical decision rules have been developed to assess syncope patients, but there have been no application or comparative studies in older Chinese cohorts until now. This study aimed to compare the values of five existing rules in predicting the short-term adverse outcomes of older patients.

Methods: From September 2018 to February 2021, older Chinese patients (≥60 yr) with syncope admitted to our hospital were investigated and evaluated by the Risk Stratification of Syncope in the Emergency Department (ROSE) rule, the San Francisco Syncope Rule (SFSR), the FAINT rule, the Canadian Syncope Risk Score (CSRS) and the Boston Syncope Criteria (BSC). After a one-month follow-up, the sensitivity, specificity, accuracy, positive predictive values (PPV), negative predictive values (NPV), positive likelihood ratios (PLR), and negative likelihood ratios (NLR) of each aforementioned rule were calculated and compared.

Results: A total of 171 patients, with a mean age of 75.65±8.26 years and 48.54% male, were analysed in the study. Fifty-eight patients were reported to have experienced short-term adverse incidents during the month. The neurally mediated syncope group showed a significant sex-specific difference in adverse incidences but the cardiac syncope group did not. There were some factors associated with significant differences in adverse incidences, such as a history of hypertension, congestive heart failure, and chronic obstructive pulmonary disorder, as well as the levels of SpO2, B-type natriuretic peptide (BNP) and troponin T (TnT), while the levels of haemoglobin and creatinine suggested potential significance. In order of the ROSE, SFSR, FAINT, CSRS and BSC rules in the analysis, the sensitivities were 81.03%, 77.59%, 93.10%, 74.14% and 94.83%, the specificities were 86.73%, 84.96%, 38.94%, 60.18% and 56.64%, the NPVs were 89.91%, 88.07%, 91.67%, 81.93% and 95.52%, and the NLRs were 0.22, 0.26, 0.18, 0.43 and 0.09, respectively.

Conclusions: This study revealed that the five mentioned rules for syncope risk stratification, with their own characteristics, all showed crucial significance for screening older adults. Therefore, physicians in the emergency department should flexibly understand and judge older patients' potential risks according to the actual clinical situations.

Background

Syncope is a symptom of cerebral hypoperfusion and is defined as a short, sudden, self-termination episode of transient loss of consciousness (T-LOC) with a brief period of unresponsiveness and a failure to maintain postural tone, ultimately resulting in spontaneous recovery that requires no resuscitation measures. Symptoms have different aetiologies and are a common clinical problem affecting millions of patients worldwide [1]. Although the incidence rate of syncope varies in different areas of the world, it accounts for approximately 1-5% of all emergency department (ED) visits and has shown an increasing trend in recent years [2–3]. Approximately 30-40% of syncope patients were admitted to the hospital for further diagnosis and treatment. For patients over 60 years old, the proportion of hospitalized syncope patients was as high as 50%. At the same time, body reactions and complications after syncope are even worse for elderly patients than for younger patients, which makes clinical evaluation challenging for physicians [4–6].

Early risk stratification during the initial evaluation is crucial to guide clinical decisions and prevent short-term adverse events. The management of syncope patients is a difficult dilemma since its pathophysiological processes and causative factors vary and are complex. Some patients appear well when they arrive at the hospital, and there are no witnesses to the event, while some will require emergency hospitalization for the treatment of potentially life-threatening causes [7–8]. In this regard, clinical decision rules (CDRs) can be helpful for clinicians. Several clinical models used in emergency departments are designed to assist physicians in making decisions at the bedside and performing risk stratification of patients, such as the Risk Stratification of Syncope in the Emergency Department (ROSE) rule, the San Francisco Syncope Rule (SFSR), the FAINT rule, the Canadian Syncope Risk Score (CSRS) rule and the Boston Syncope Criteria (BSC) rule. Considering that these rules were derived in a few centres and some models are newly developed, there are limited external validations and even different findings from some clinical studies [9–16]. Therefore, the present study aimed to explore and compare the values of the ROSE, SFSR, FAINT, CSRS and BSC rules in recognizing syncope patients at risk for short-term adverse events. To the best of our knowledge, there are no similar studies on older Chinese syncope patients regarding the application of these five CDRs in a one-month follow-up investigation.

Methods

Study design and setting

This was a single-centre retrospective observational cohort study performed in the ED of a training and research general hospital. All patients were observed at their first consultation in our hospital's ED between September 2018 and February 2021. There were no fixed decision tools for syncope management. The one-month follow-up study was designed to evaluate the predictive values of the ROSE, SFSR, FAINT, CSRS and BSC rules in recognizing adverse events. As the study was retrospective and observational, no identifiable patient data were collected,

and the involved data were stored on a dedicated secure computer. The study protocol was approved by the Ethics Committee of Beijing Tiantan Hospital, Capital Medical University. During the course of the study, the researchers adhered to the principles of the Declaration of Helsinki.

Study population and data collection

Patients aged 60 years or older presenting to the ED with syncope (defined as T-LOC with or without prodromal symptoms characterized by a short duration and spontaneous full recovery) were eligible for the study. The exclusion criteria used to determine the target population were as follows: 1. Patients aged below 60 years; 2. Patients with confirmed nonsyncope syndromes (such as seizure, vertigo, coma, shock, sustained unconsciousness, head injury preceding the loss of consciousness, and stroke); 3. Patients with comorbidities with a low survival rate or a new serious diagnosis identified in the ED (such as advanced malignant neoplasm, dyscrasia, circulatory failure, respiratory failure, aortic dissection, pulmonary embolism, myocardial infarction, subarachnoid haemorrhage, major traumatic injury, and haemorrhage requiring blood transfusion); and 4. Patients with a history of drug or alcohol abuse. The final decision of the patients who were enrolled was made after the patient evaluation forms were completed, and the form contained dozens of variables derived from existing syncope rules. The attending physicians, including an emergency medicine specialist, a cardiologist, and a neurologist, evaluated patients independently to assess subjective variables requiring interpretation. All the patients were treated in the usual manner by a physician blinded to the aims of the study.

A total of 230 older patients who were referred to the ED with complaints of syncope were screened, and 50 patients were excluded from this analysis due to a new serious diagnosis in the ED or a lack of sufficient data to calculate CDR scores, so 180 patients were enrolled. Since 9 patients were lost to follow-up, 171 patients were eligible for the study, as shown in Figure 1.

Clinical and laboratory data were extracted for analysis and stored in a predesigned database. We used the dedicated database to calculate the scores together according to the ROSE, SFSR, FAINT, CSRS, and BSC rules to reduce personal interpretation bias. The ROSE rule considers patients positive and high risk, if any of the following are present: a B-type natriuretic peptide (BNP) level ≥300 pg/ml or bradycardia ≤50 in the ED/pre-hospital period, a rectal examination showing faecal occult blood, anaemia with a haemoglobin level ≤90 g/l, chest pain associated with syncope, an abnormal electrocardiogram (ECG) showing Q wave but not in lead III, or an SpO2 ≤94% on room air [9]. The SFSR deems patients positive and high risk in the presence of any of the following: a history of congestive heart failure, a haematocrit level < 30%, an abnormal ECG, shortness of breath, and a systolic blood pressure <90 mmHg [10]. In the FAINT rule, the presence of any sign of history of heart failure, history of cardiac arrhythmia, an initial abnormal ECG result, elevated N-terminal pro-BNP, or elevated high-sensitivity troponin T (TnT) puts the patients in the non-low-risk group for adverse outcomes. Abnormal ECG interpretations were similar to previous research [11]. Here, “FAINT2” stands for the cut-off value "2" used for evaluation by the FAINT rule, which was set up according to the latest study [12]. The CSRS rule was developed by assigning points to each of the factors based on the relative magnitude of the coefficient, with a score ranging from -3 to 11, and includes nine elements in the categories of clinical data, investigations, and presumptive ED diagnosis. A score of 1 or higher was judged as high risk [13–14]. In the BSC rule, the presence of any of the factors, such as acute coronary syndrome, cardiac history, a family history of sudden death, valvular heart disease, signs of cardiac conduction disease, circulating volume depletion, persistent abnormal vital signs in the ED, and brain lesions, put the patient in the high-risk group [15].

All patients were followed up by telephone call or by searching the electronic medical record system to identify adverse outcomes within one month of the first referral to the hospital with complaints of syncope. Evaluated short-term adverse outcomes were defined a priori as one of the following events: mortality, cardiac pulmonary resuscitation (CPR), acute myocardial infarction (AMI), cardiac arrest, severe arrhythmia, pacemaker implantation or implanted-cardiac defibrillator (ICD), cardiac stent insertion, stroke, cerebrovascular accidents (CVAs), haemorrhage requiring urgent treatment, nontraumatic intracranial bleeding or pulmonary embolism (PE).

Statistical analysis

A descriptive statistical analysis was carried out to characterize the profile of the study population. The patients were divided into three age groups: 60 to 69, 70 to 79, and ≥80 years of age. Quantitative data are reported as the mean ± standard deviation or standard error, and qualitative data are reported as the frequency and percentage. Differences among variables were evaluated by the chi-square test and Fisher’s exact test when appropriate.

To evaluate each CDR in predicting outcomes, the sensitivity, specificity, accuracy, positive predictive values (PPV), negative predictive values (NPV), positive likelihood ratios (PLR), and negative likelihood ratios (NLR) were calculated to identify patients who experienced adverse outcomes during the follow-up period. Receiver operating characteristic (ROC) curves were generated, and the areas under the ROC curve (AUCs) were compared using a previously proposed method to assess the CDRs’ predictive values [17–18]. To determine the concordance of the CDRs’ assessments with the presence of any adverse events, kappa coefficients for each criterion were calculated. A two-tailed p value

<0.05 was considered to be statistically significant for all analyses. The statistical analysis was carried out using IBM SPSS version 20 (IBM, New York, USA).

Results

Characteristics of the study subjects

In the present study, 171 patients with complete follow-up data at one month were analysed. The characteristics of the study patients are shown in Table 1. The mean age of the study sample was 75.65±8.26 years, and the median age was 75 years. Among the cohort, 48.54% were men and 51.46% were women. Compared with the men, the women were older (78.00±7.99 years vs. 73.16±7.83 years, respectively, p<0.05), and male sex was less common among the very elderly patients with syncope (15/59) but more frequent in the other age groups (68/112). The median concentration of BNP was 122.00 pg/ml, the mean concentration of haemoglobin was 129.82±24.35 g/L, the mean indoor oxygen saturation without oxygen inhalation was 95.46±2.81%, the mean systolic blood pressure was 126.14±16.05 mmHg, and the mean haematocrit level was 38.31±6.73%. There were significant differences among the three age groups in terms of haemoglobin, haematocrit, BNP, TnT, and BUN levels, and the ratio of BUN/creatinine. For CHF and creatinine levels, there were potential differences among the three age groups, with a wider statistical significance of a p value <0.1.

Table 1
Characteristics of Older Adults with Syncope Presenting to the ED

Variable	Age category, No. (%)			P value
	60-69	70-79	≥80	
Adverse outcomes in overall group	12/52 (23.08)	24/60 (40.00)	22/59 (37.29)	
Male	8/34 (23.53)	13/34 (38.24)	7/15 (46.67)	
Female	4/18 (22.22)	11/26 (42.31)	15/44 (34.09)	
Medical history				
Hypertension	33	35	41	0.450
Diabetes	17	25	16	0.219
Coronary heart disease (CHD)	13	7	11	0.189
Congestive heart failure (CHF)	8	16	20	0.083
Chronic obstructive pulmonary disorder (COPD)	6	10	8	0.733
Old myocardial infarction (OMI)	8	9	7	0.838
Cerebrovascular accidents (CVAs)	5	6	3	0.562
Arrhythmia	15	25	16	0.187
Lab test	x̄ ± SE			
Blood pressure	128.00±1.93	124.35±2.06	126.32±2.33	0.411
SpO2	96.02±0.34	95.17±0.41	95.25±0.36	0.857
Haemoglobin	142.00±2.71	133.03±2.71	116.49±3.34	<0.01
Haematocrit	41.44±0.86	38.86±0.72	35.10±0.95	<0.01
BNP	228.69±74.66	365.90±68.22	461.49±73.66	0.012
TnT	0.52±0.32	0.88±0.46	0.40±0.15	0.041
BUN	6.83±0.46	7.79±0.41	10.62±0.83	<0.01
Creatinine	79.43±4.96	90.77±5.29	90.37±4.51	0.084
BUN/Creatinine	89.60±4.86	92.71±4.14	121.27±7.68	<0.01
ALT	24.55±2.72	26.25±1.81	57.61±18.18	0.293
AST	31.33±5.74	45.37±6.99	80.95±26.33	0.324
ALT/AST	0.92±0.06	0.78±0.05	0.76±0.05	0.449
Triglyceride	1.41±0.08	1.51±0.10	1.38±0.08	0.978
Total cholesterol	4.21±0.11	4.13±0.12	3.90±0.13	0.867
Blood glucose	10.03±1.00	9.61±0.57	9.46±0.43	0.959
INR	1.09±0.03	1.13±0.03	1.15±0.02	0.424
D-Dimer	1.41±0.38	1.41±0.33	2.39±0.47	0.313

Among the 171 enrolled patients in our analysis, the cause was classified as neurally mediated syncope (NMS), cardiac syncope (CS), orthostatic hypotension (OH) and unknown syncope. By one month after the index ED visit, 58 patients (33.92%) had suffered the primary serious outcome, including 16 patients with AMI and 16 with arrhythmias. The sex and frequency data are outlined in Table 2. There was a significant difference in the incidence of adverse events between the NMS and CS groups (p=0.017). For the NMS group, there was a significant sex-specific difference in the incidence of adverse events (p=0.016); however, there was no sex-specific difference in the CS group (p=0.552). Regarding the three age groups, there was a significant difference in the adverse incidences of patients between 60-69 years of

age and 70-79 years of age in the NMS group (P=0.047), but there was no obvious age-related difference among the other NMS and CS groups.

Table 2
Comparison of Serious Patient Outcomes Among the Four Diagnostic Categories

	NMS (n=52)	CS (n=104)	OH (n=8)	Unknown (n=7)
Age (y)	74.79±9.26	75.5±7.88	79.25±7.01	80.14±5.79
Sex				
Male	23	52	6	2
Female	29	52	2	5
Serious outcomes				
No. (%)	10 (19.23)	43 (41.34)	5 (62.50)	0 (0)

Factors associated with the incidences of all adverse outcomes

Among all patients in our study, there were no significant differences in adverse incidences among the three age groups (p=0.136). However, there were significant differences in the adverse incidences in patients with or without a history of hypertension, CHF, and COPD, as well as the different levels of SpO2, BNP, and TnT. For the levels of haemoglobin and creatinine, there were potential differences in the adverse incidences with a wider statistical significance of a p value <0.1 (Table 3).

Table 3
Factors Associated with the Adverse Incidences

Variable	Positive	Negative	P value
Sex	83	88	0.961
Medical history			
Hypertension	109	62	0.043
Diabetes	58	113	0.682
CHD	31	140	0.293
CHF	44	127	<0.01
COPD	24	147	<0.01
OMI	24	147	0.185
CVAs	14	157	0.304
Arrhythmia	56	115	0.494
Lab test			
Blood pressure (≥90 mmHg)	167	4	0.493
SpO2 (>94%)	146	25	<0.01
Haemoglobin (>90 g/L)	156	15	0.093
Haematocrit (≥30/L)	154	17	0.519
BNP (≥300 pg/ml)	43	128	<0.01
TnT (≥0.1 ng/ml)	36	135	0.022
BUN (≥8.3 mmol/L)	63	108	0.122
Creatinine (≥93.3μmol/L)	57	114	0.053
BUN/Creatinine (≥89.0)	89	82	0.702
ALT (≥41 U/L)	26	145	0.596
AST (≥42 U/L)	38	133	0.228
ALT/AST (≥0.98)	52	119	0.594
Triglyceride (≥1.7 mmol/L)	48	123	0.920
Total cholesterol (≥5.17 mmol/L)	23	148	0.571
Blood glucose (≥11.1 mmol/L)	45	126	0.220
INR (≥1.15)	47	124	0.458
D-Dimer (≥1.5μg/ml)	49	122	0.920

The adverse outcome incidences evaluated by the different CDRs

All the important elements of the ROSE, SFSR, FAINT, CSRS, and BSC rules were evaluated separately for their ability to predict predefined serious events; the number of high-risk patients assessed by the different CDRs was 75, 75, 105, 88, and 104, respectively. The sensitivities, specificities, accuracies, PPVs, NPVs, PLRs, NLRs and areas under the curves (AUCs) of the predefined syncope risk scores to predict adverse events were also calculated (Table 4, Figure 2).

The kappa coefficients in the consistency analyses for the ROSE, SFSR, FAINT, FAINT2, CSRS and BSC rules' applications with follow-up adverse events were 0.800, 0.762, 0.504, 0.608, 0.490 and 0.666, respectively.

Table 4
Comparative Analysis of the Risk Stratification Rules

Risk Score	Risk Assessment	Patient No.	Adverse Events	AUC	Sensitivity(%)	Specificity(%)	Accuracy(%)	PPV (%)	NPV (%)	PLR	NLR
ROSE	Low risk	109	11	0.839	81.03	86.73	84.80	75.81	89.91	6.10	0.22
	High risk	62	47								
SFSR	Low risk	109	13	0.813	77.59	84.96	82.46	72.58	88.07	5.16	0.26
	High risk	62	45								
FAINT	Low risk	48	4	0.660	93.10	38.94	57.31	43.90	91.67	1.52	0.18
	High risk	123	54								
FAINT2	Low risk	128	28	0.701	51.72	88.50	76.02	69.77	78.13	4.5	0.55
	High risk	43	30								
CSRS	Low risk	83	15	0.672	74.14	60.18	64.91	48.86	81.93	1.86	0.43
	High risk	88	43								
BSC	Low risk	67	3	0.757	94.83	56.64	69.59	52.88	95.52	2.19	0.09
	High risk	104	55								

Discussion

Despite some limitations of our study, to the best of our knowledge, this is the first reported cohort study on the comparisons of five key CDRs for syncope patients in an older Chinese population. Since the number of patients suffering from syncope-related adverse outcomes increases sharply after 60 years [19], older patients mostly have multiple comorbid conditions, and risk stratification is based on probable short-term adverse outcomes, it is crucial to distinguish non-low-risk patients for further timely precise therapies. We conducted this study to compare our clinical applications of the CDRs for the assessment of older adults with syncope. A total of 171 enrolled patients were followed up for one month and practical adverse outcomes were compared against the ROSE, SFSR, FAINT, CSRS, and BSC CDRs.

Overall, 33.92% of our study cohort had an adverse outcome at one month. The sex was roughly the same (males 83 vs. females 88), but the women were significantly older than the men ($p<0.05$). Women live longer and pay much more attention to their health care than men [20]. In our exploration, the adverse incidences were affected by the comorbidities of hypertension, CHF, and COPD, as well as the levels of SpO2, BNP, and TnT. In addition, our study also suggested that the levels of haemoglobin and creatinine have potential influences on adverse incidences. SpO2, BNP and haemoglobin are three variables in the ROSE rule, CHF is a variable in the SFSR, FAINT, and BSC rules, and BNP and TnT are two variables in the FAINT rule. In addition, the SFSR, CSRS and BSC rules all emphasize the measurement of blood pressure [21]. However, creatinine has not been involved in any CDRs until now, while the level of creatinine is relevant to inner body fluid metabolism and may affect the body's circulatory perfusion before syncope.

For the four diagnostic categories for syncope, the number of patients and the adverse incidences were greater in cardiac syncope patients than other patients, which is in accordance with previous studies on advanced age [22]. It seemed that NMS patients had sex-specific and age-related differences in the incidence of adverse events, but CS patients suggested no similar results. Compared with CS, NMS is a kind of benign syncope, and neural regulation has differences between sexes and ages, while CS is a serious symptom with high mortality, so the syncope type itself has its own characteristics and clinical prognosis [23–25]. In the research, more than half of the adverse incidences in one month were relevant to AMI and arrhythmia. Cardiac syncope is associated with higher mortality, irrespective of age and sex. Thus, the five CDRs in our investigation all included cardiac elements in their assessments and highlighted the significance of cardiogenic parameters, which reflects the importance of cardiac syncope in the elderly population.

The ROSE and SFSR rules showed higher specificities and NPVs, and AUC areas were greater than 0.8, which meant that they had significance in identifying and screening non-high-risk syncope patients, which was roughly consistent with the previous clinical studies of each CDR [9–10]. In addition, the kappa coefficients for the concordance of these two CDRs with short-term adverse events were greater than 0.7, which suggests more reliable consistency. The AUC areas of the FAINT, FAINT2, CSRS, and BSC rules were all greater than or approximately 0.7. The FAINT and BSC rules had higher sensitivities and NPVs than the other rules, while the CSRS rule had moderate results in our clinical applications. It seemed that the FAINT and BSC rules had advantages in identifying high-risk syncope patients. The BSC rule

has included the most comprehensive elements for syncope assessment until now, indicating high risk if any one item is positive. The kappa coefficient of the BSC rule was greater than 0.6, which suggests substantial consistency. The CSRS rule assigns various points to each of the factors based on the relative magnitude of the coefficient, and its external validation in an Australian cohort of 283 patients was completed in 2020, so larger and more widespread clinical applications are needed in the future. The kappa coefficient of the CSRS rule was close to 0.5, which suggests moderate consistency.

The FAINT rule was set up for elderly patients in 2020, and the preliminary results of the recent multicentre external validation in Europe and the US suggest that it is safe to evaluate elderly patients with scores of 0 or 1 [12]. The cut-off value of "1" was used in the original study for patient evaluation analysis, which means that 24 patients were “misjudged” as positive in our study if the cut-off score was 1, which may cause a higher proportion of low-risk patients to spend more money on further clinical examinations. Therefore, we additionally set “2” as another cut-off score for evaluation by the FAINT rule (FAINT2) to make the comparison with short-term prediction for elderly patients. Our FAINT results indicated that the sensitivity and NPV were higher and the specificity was lower, which was consistent with the original studies by Probst [11]. On the other hand, the results of the FAINT2 rule indicated that the specificity and PLR were higher and the sensitivity was lower. The areas of both AUCs were higher than 0.6, while the area and accuracy of the FAINT2 rule were slightly higher. The kappa coefficients of the FAINT and FAINT2 rules were both greater than 0.5, indicating moderate consistency. In that case, what is the significance of original research on the FAINT rule to improve the evaluation sensitivity at the expense of specificity? Considering that the proportion of cardiac syncope in elderly patients is higher, its complications are more dangerous when it occurs. The higher sensitivity of the FAINT rule may avoid the possibility of missing adverse events at best, but it requires more relevant medical resources, so the FAINT rule may be much more valuable for elderly people who have any history of cardiovascular diseases under the condition of sufficient medical resources. Probst gave a deep explanation of the original exploration: The FAINT rule sets no serious adverse cardiac events’ omission as the main point, so its high sensitivity and low NLR were the original intentions of the study. However, this rule is not suitable for screening low-risk patients at present since international multicentre validation has not been completed. As we know, the FAINT rule has been evaluated in a clinical study of elderly syncope patients with the largest sample size until now, but the population included patients aged 60 years and above with syncope or near syncope (the sensation of the impending loss of consciousness without the actual loss of it), and the patient refusal rate was as high as 53.2% when the study was implemented, which could be a kind of sample bias. The FAINT rule includes two biochemical elements relevant to cardiac function and myocardial damage. Compared with the ROSE rule, which includes only BNP levels, and the SFSR rule without biochemical elements, the FAINT rule certainly improves the laboratory work and medical cost, but it is helpful to reduce the diagnosis rate of "unexplained syncope" in clinics, so its net effect analysis in health economics is worth further exploration in the future. At the same time, the FAINT rule is much simpler than the CSRS and BSC rules to use in assessments. These five rules all showed the assessment values for elderly syncope patients in practice. To date, there is still no syncope risk stratification rule that can be used independently of physician judgement, and it only plays a role in assisting judgement and decreasing the cognitive load for physicians when making clinical decisions.

Overall, the proportion of one-month adverse incidences in our study was 33.92%. It was higher than that reported in the original studies of the ROSE, SFSR, FAINT, CSRS and BSC rules, but similar to that reported in other studies [26–27]. The discrepancy between the proportion of short-term adverse events was relevant to the different levels of public health services and disease preventive abilities in the cohort population. Additionally, it was related to the characteristics of the enrolled patients: the median age of the elderly patients in this study was 75 years, and 69.59% of them were over 70 years, whose incidence of adverse events was higher than that of patients aged 60-69 years (38.66% vs. 23.08%). The incidence of syncope in the elderly population generally increases with age, but the body is in a declining stage as it ages, so the physiological stress response after syncope may be partly damaged, and the complications could be more complex, which leads to the risks of adverse events being much higher [6, 28–31]. Moreover, the original FAINT study included "near syncope" patients whose clinical risk status was relatively low.

Study limitations

Our study was conducted at a single centre with limited resources. First, the international multicentre external validation of the FAINT and CSRS rules is still in progress. Larger sample sizes and multicentre data will certainly result in better assessments of the current risk rules. Second, the well-designed prospective study will be worthy of further exploration of its clinical significance based on previous retrospective work. Third, the confounders used in the risk stratification may not have been inclusive of all causes or influencing factors of syncope. For example, creatinine could possibly have influenced the adverse incidences in our study, which needs further investigation in the future. Fourth, we did not collect information regarding secondary diagnoses when syncope patients arrived at the emergency department, and these data may be useful in further clarifying outcomes among patients. These limitations are expected to be improved in future research.

Conclusions

Our study could be helpful to understand the pros and cons of the risk stratification rules, and the flexible application of the ROSE, SFSR, FAINT, CSRS and BSC rules is bound to improve the efficiency of clinical evaluations. Physicians can judge patients' prognoses or short-term adverse outcomes more quickly and more scientifically under the conditions of overloaded clinical work, considering the complexity of syncope aetiologies and most elderly patients with some chronic diseases.

Abbreviations

T-LOC
Transient loss of consciousness
CDR
Clinical decision rule
ROSE
Risk Stratification of Syncope in the Emergency Department
SFSR
San Francisco Syncope Rule
CSRS
Canadian Syncope Risk Score
BSC
Boston Syncope Criteria
PPV
Positive predictive values
NPV
Negative predictive values
PLR
Positive likelihood ratios
NLR
Negative likelihood ratios
ECG
Electrocardiogram
BNP
B-type natriuretic peptide
TnT
Troponin T
CHD
Coronary heart disease
CHF
Congestive heart failure
COPD
Chronic obstructive pulmonary disorder
OMI
Old myocardial infarction
CVA
Cerebrovascular accident
CPR
Cardiac pulmonary resuscitation
AMI
Acute myocardial infarction:ICD:Implanted-cardiac defibrillator
PE
Pulmonary embolism
NMS
Neurally mediated syncope
CS
Cardiac syncope
OH

Orthostatic hypotension
ROC
Receiver operating characteristic curve
AUC
Areas under the ROC curve

Declarations

Ethics approval and consent to participate

The study was approved by the Ethics Committee of Beijing Tiantan Hospital, Capital Medical University and followed the precepts established by the Declaration of Helsinki. Consent from participants was given in writing or by oral.

Consent for publication

Not applicable.

Availability of data and materials

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to them containing information that could compromise research participant privacy/consent.

Competing interests

The authors declare that they have no competing interests.

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Authors’ contributions

All authors contributed to the study. HM participated in the study design, analyzed and interpreted the data, and drafted the manuscript. JXL, LML and TCY participated in the study design, did critical revision of the manuscript for important intellectual content, contributed with statistical expertise, obtained funding, helped with technical and material support, supervised the study. HFT and CH participated in the acquisition of the data and technical support. All authors read and approved the final manuscript.

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Figures

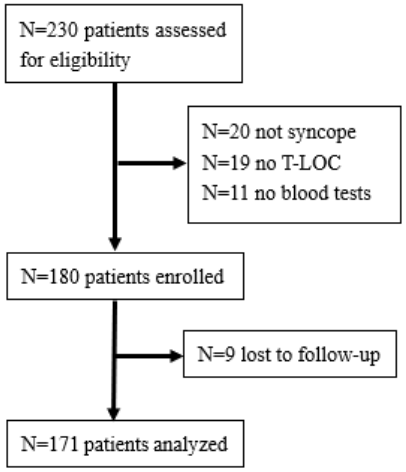

Figure 1

Flow diagram of the study scheme

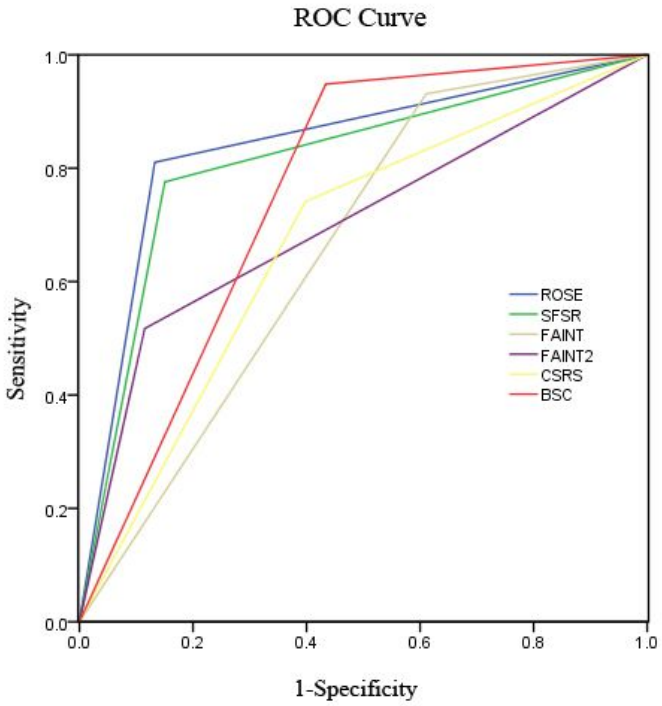

Figure 2

ROC curves of the risk stratification rules