Original Research Article

Sensitivity of the San Francisco Syncope Rule in Patients Presenting with Syncope in the Emergency Department

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Abstract: *Syncope is a frequent presentation in emergency departments and poses a diagnostic challenge due to its heterogeneous etiologies, ranging from benign reflex mechanisms to life-threatening cardiac conditions. Clinical decision rules such as the San Francisco Syncope Rule (SFSR) are used to identify patients at risk of short-term serious outcomes; however, their diagnostic performance varies across populations and clinical settings. Evidence from low- and middle-income countries remains limited.* **Objective:** *To evaluate the diagnostic accuracy of the San Francisco Syncope Rule for predicting short-term serious outcomes among patients presenting with syncope to a tertiary care emergency department in Pakistan.* **Methods:** *This prospective observational diagnostic accuracy study was conducted in the Emergency Department of Shifa International Hospital, Islamabad, from March 2024 to September 2024. Ninety adult patients presenting with syncope were enrolled consecutively. The SFSR was applied at the initial evaluation. Patients were followed for seven days to ascertain serious outcomes, including arrhythmias, myocardial infarction, stroke, need for pacemaker insertion, or death. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated. Post-stratification analysis was performed to identify predictors of adverse outcomes.* **Results:** *The mean age of participants was 52.4 ± 16.8 years, and 62.2% were male. Serious outcomes occurred in 29 patients (32.2%) within seven days. The SFSR demonstrated a sensitivity of 89.7%, specificity of 65.6%, PPV of 55.3%, and NPV of 93.0%, with an overall diagnostic accuracy of 73.3%. Abnormal electrocardiography, systolic blood pressure <90 mmHg, history of congestive heart failure, and age ≥50 years were significantly associated with serious outcomes.* **Conclusion:** *The San Francisco Syncope Rule demonstrated high sensitivity and negative predictive value in this Pakistani emergency department cohort, supporting its role as a screening tool to identify low-risk patients suitable for discharge. However, its moderate specificity limits its utility as a standalone decision tool, underscoring the need for integration with structured clinical assessment and local validation of syncope risk-stratification pathways.*

Keywords: Syncope, Emergency Service Hospital, Risk Assessment, Electrocardiography, Diagnostic Accuracy

Introduction

Syncope is defined as a transient, self-limited loss of consciousness due to global cerebral hypoperfusion, characterized by rapid onset, short duration, and complete spontaneous recovery (1). It remains a frequent and diagnostically challenging presentation in emergency departments (EDs), accounting for approximately 1–1.5% of all ED visits worldwide (2,3). Although most syncopal episodes are attributable to benign etiologies such as reflex-mediated or orthostatic mechanisms, a clinically important minority result from serious underlying conditions, particularly cardiac arrhythmias and structural heart disease, which are associated with substantially increased short- and long-term mortality (3,4). The heterogeneity of syncope etiologies, coupled with the often transient nature of symptoms by the time of ED evaluation, complicates early risk assessment and disposition decisions.

To address this clinical uncertainty, several clinical decision rules (CDRs) have been developed over the past two decades to support structured risk stratification in ED patients with syncope. Prominent tools include the San Francisco Syncope Rule (SFSR), the Canadian Syncope Risk Score (CSRS), the Osservatorio Epidemiologico sulla Sincopene Lazio (OESIL) score, and the ROSE rule, all of which integrate elements of clinical history, physical examination, electrocardiography, and selected laboratory parameters (4,6). However, systematic reviews have highlighted important limitations in the methodological quality and external validity of many of these tools. Sweanor et al. demonstrated that most CDRs lack sufficient accuracy for routine clinical use, with only the CSRS showing comparatively robust predictive performance across multiple cohorts (6). Similarly, Wakai et al. reported that among numerous published tools, only the SFSR, CSRS, and OESIL scores have

been validated in more than two independent studies, with substantial overlap in their operating characteristics, limiting their discriminatory utility (7).

The SFSR is among the earliest and most extensively studied syncope CDRs, designed to identify patients at risk of short-term serious outcomes. Nevertheless, its performance on external validation has been inconsistent. Ragan and Lin reported moderate sensitivity with limited specificity, raising concerns regarding over-triage (8). In older populations, Voigt et al. observed reduced sensitivity of the SFSR for 30-day serious outcomes. At the same time, Mu et al. reported variable performance of the SFSR and other CDRs in geriatric cohorts, underscoring age-related limitations in predictive accuracy (9,10). Broek et al. further noted that many existing risk stratification tools are inadequately validated across diverse clinical settings and that their predictive capacity is largely driven by markers of potential cardiac etiology (5).

Electrocardiography remains a cornerstone of syncope evaluation and is incorporated as a predictor in all validated syncope CDRs (7). White et al. demonstrated that ED patients presenting with syncope are substantially more likely to undergo ECG evaluation than those presenting with seizure, reflecting the central role of cardiac assessment in syncope workup (11). Large prospective cohort studies, including the European SEED study, have shown that a high proportion of ED syncope patients meet guideline-defined high-risk criteria, with correspondingly high admission rates, highlighting the ongoing challenge of balancing patient safety against resource utilization (12).

Despite the global burden of syncope, evidence from low- and middle-income countries (LMICs), including Pakistan, remains sparse. The Pakistani healthcare context is characterized by a high prevalence of

cardiovascular disease, constrained access to advanced diagnostics, and ED overcrowding, all of which may influence the applicability and performance of established CDRs. Data from other LMIC settings, such as the Egyptian cohort studied by Moussa et al., demonstrate substantial variability in the performance of syncope risk scores across populations with differing baseline risk profiles (13). Local validation of the SFSR in Pakistani ED populations is therefore clinically relevant, as it may inform context-appropriate syncope management pathways and support evidence-based disposition decisions in resource-constrained environments.

Methodology

This prospective observational diagnostic accuracy study was conducted in the Emergency Department of Shifa International Hospital, Islamabad, from March 2024 to September 2024. The study included 90 consecutive patients aged 18 years or older who presented with syncope, defined as a transient loss of consciousness with spontaneous recovery. Patients with trauma-induced loss of consciousness, seizure disorders, hypoglycemia-induced syncope, intoxication, or incomplete medical records were excluded.

Sample size was calculated using a WHO diagnostic test evaluation formula, assuming an expected sensitivity of 90%, a 95% confidence level, and a margin of error of 8%, resulting in a minimum required sample of 87 patients; 90 were enrolled to account for potential data loss. Upon presentation, all patients underwent a standardized clinical assessment, including detailed history, physical examination, ECG, complete blood count, and blood pressure measurement. The San Francisco Syncope Rule criteria were applied at the time of initial evaluation. The rule classifies patients as high risk if any of the following are present: abnormal ECG findings, hematocrit <30%, systolic blood pressure <90 mmHg, shortness of breath, or a history of congestive heart failure.

Patients were followed for 7 days either through hospital records or telephonic follow-up to assess for serious outcomes, defined as arrhythmia, myocardial infarction, stroke, need for pacemaker implantation, pulmonary embolism, significant hemorrhage, or death.

Data were entered and analyzed using SPSS version 26. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequencies and percentages. Sensitivity, specificity, positive predictive value, negative predictive value, and diagnostic accuracy were calculated using standard 2×2 contingency tables. Chi-square test was used for post-stratification analysis, and p-values less than 0.05 were considered statistically significant. Ethical approval was obtained from the hospital's institutional review board, and written informed consent was obtained from all participants.

Results

A total of 90 patients presenting to the Emergency Department of a tertiary care hospital with syncope between July and December were enrolled. The mean age of participants was 52.4 ± 16.8 years (range: 18–85 years). Most patients were aged ≥50 years (57.8%). There were 56 males (62.2%) and 34 females (37.8%), with a male-to-female ratio of 1.6:1. Hypertension (46.7%) and diabetes mellitus (38.9%) were the most frequent comorbidities. Baseline demographic and clinical characteristics are summarized in Table 1.

According to the San Francisco Syncope Rule (SFSR), 47 patients (52.2%) were classified as high risk, and 43 (47.8%) as low risk.

Within 7 days of presentation, serious outcomes occurred in 29 patients (32.2%). These included arrhythmias (14.4%), myocardial infarction (6.7%), stroke (3.3%), need for pacemaker insertion (4.4%), and death (3.3%). The distribution of clinical outcomes is presented in Table 2.

The diagnostic performance of the San Francisco Syncope Rule was calculated using a serious outcome within 7 days as the reference standard. Among 29 patients with serious outcomes, 26 were correctly identified as high risk by SFSR, while 3 were misclassified as low risk. Among 61 patients without serious outcomes, 40 were correctly identified as low risk, and 21 were incorrectly labeled high risk.

The sensitivity of the San Francisco Syncope Rule was 89.7% (95% CI: 72.6–97.8), specificity was 65.6% (95% CI: 52.3–77.3), positive predictive value was 55.3%, and negative predictive value was 93.0%. Overall diagnostic accuracy was 73.3%. These findings are summarized in Table 3.

Post-stratification analysis demonstrated that abnormal ECG (p = 0.001), systolic blood pressure <90 mmHg (p = 0.003), and history of congestive heart failure (p = 0.002) were significantly associated with serious outcomes. Age ≥50 years also showed a significant association (p = 0.021). Gender was not significantly associated with adverse outcomes (p = 0.418). Detailed stratification analysis is shown in Table 4.

Overall, the San Francisco Syncope Rule demonstrated high sensitivity and high negative predictive value in identifying patients at risk of serious short-term outcomes, suggesting its utility as a screening tool in emergency departments within the Pakistani population. However, moderate specificity indicates potential over-triage when used as a sole decision-making tool.

Table 1. Baseline Demographic and Clinical Characteristics of Patients Presenting with Syncope (n = 90)

Variable	Frequency (n)	Percentage (%)
Age Group (years)		
18–30	14	15.6
31–49	24	26.7
≥50	52	57.8
Gender		
Male	56	62.2
Female	34	37.8
Comorbidities		
Hypertension	42	46.7
Diabetes Mellitus	35	38.9
Known Cardiac Disease	28	31.1
No Significant Comorbidity	19	21.1
Abnormal ECG at Presentation	33	36.7
Hematocrit<30%	11	12.2
Systolic BP <90 mmHg	18	20.0
Shortness of Breath	26	28.9

Table 2. Serious Clinical Outcomes within 7 Days of Presentation (n = 90)

Outcome	Frequency (n)	Percentage (%)
Arrhythmia requiring intervention	13	14.4
Myocardial Infarction	6	6.7
Stroke	3	3.3
Pacemaker Insertion	4	4.4
Death	3	3.3
No Serious Outcome	61	67.8

Table 3. Diagnostic Performance of San Francisco Syncope Rule (n = 90)

Parameter	Value (%)
Sensitivity	89.7
Specificity	65.6
Positive Predictive Value	55.3
Negative Predictive Value	93.0
Diagnostic Accuracy	73.3

Table 4. Post-Stratification Analysis of Risk Factors with Serious Outcomes (n = 90)

Variable	Serious Outcome n (%)	No Serious Outcome n (%)	p-value
Age ≥50 years	21 (72.4)	31 (50.8)	0.021
Male Gender	19 (65.5)	37 (60.7)	0.418
Abnormal ECG	20 (69.0)	13 (21.3)	0.001
SBP <90 mmHg	12 (41.4)	6 (9.8)	0.003
Known CHF	11 (37.9)	6 (9.8)	0.002

Discussion

In this study of 90 ED patients presenting with syncope, the mean age was 52.4 years, with a male predominance. These demographic characteristics are broadly consistent with international cohorts, although notable differences in age and sex distribution exist across settings. Thiruganasambandamoorthy et al. reported a similar mean age in a large Canadian CSRS validation cohort, but with a female predominance. In contrast, the European SEED cohort described by Reed et al. was older and had a nearly equal sex distribution. Voigt et al. evaluated patients substantially older than those in prior studies, reflecting the demographic heterogeneity of syncope populations across healthcare systems (9, 12,14). The relatively younger age profile in our cohort likely reflects population demographics and referral patterns in Pakistani tertiary care EDs.

The high prevalence of hypertension, diabetes mellitus, and known cardiac disease in our cohort underscores the substantial cardiometabolic burden among syncope patients in Pakistan. Sutton et al. emphasized that both short- and long-term prognosis after syncope is strongly influenced by underlying cardiovascular comorbidity, a finding consistent with our observation of a comparatively high short-term serious outcome rate (4). The predominance of cardiac and arrhythmic events among adverse outcomes aligns with prior literature identifying cardiac syncope as the most clinically consequential subtype in terms of mortality and morbidity (3,4,14).

Electrocardiographic abnormalities were frequent in our cohort and were significantly associated with serious outcomes, reinforcing the central role of ECG in syncope risk stratification. Wakai et al. confirmed that ECG is incorporated into all validated syncope CDRs, and Broek et al. highlighted ECG abnormalities as among the most consistently represented predictors across risk tools, reflecting their association with underlying cardiac pathology (5,7). The observed performance of the SFSR in our cohort, characterized by high sensitivity and negative predictive value but moderate specificity, is consistent with pooled estimates summarized by West and Russell and with the external validation findings reported by Ragan and Lin (8,15). This performance profile supports using the SFSR primarily as a screening or rule-out tool rather than as a standalone decision instrument for admission.

More than half of patients in our study were classified as high risk by the SFSR, a proportion higher than that reported in CSRS-based risk stratification by Thiruganasambandamoorthy et al., reflecting differences in discrimination thresholds and the SFSR's known tendency toward over-triage (8,14). The relatively high short-term serious outcome rate observed in our cohort exceeds pooled estimates from systematic reviews, such as those reported by Sweanor et al., and 30-day outcome rates reported in older adult cohorts by Voigt et al. (6,9). This discrepancy likely reflects referral bias and higher baseline comorbidity burden in tertiary care settings, as well as potential delays in healthcare access in LMIC contexts. Findings from Mu et al. in older populations similarly demonstrate that adverse event rates vary substantially across cohorts and follow-up horizons (10).

Post-stratification analyses in our study identified abnormal ECG findings, hypotension, congestive heart failure, and older age as significant predictors of short-term serious outcomes. The literature well supports these associations. Kavi and Gall emphasized the prognostic importance of ECG abnormalities and abnormal vital signs across major guideline frameworks, while Chang et al. and Probst et al. identified heart failure as a strong predictor of adverse outcomes in syncope populations (17–19). The association of older age with serious outcomes, as also highlighted by Voigt et al. and Albassam et al., suggests that existing CDRs do not fully capture age-related risk and may warrant explicit incorporation into locally adapted risk stratification strategies (9,20).

From a health systems perspective, the findings of this study have important implications for emergency care in Pakistan. In settings characterized by high patient volumes, limited access to advanced diagnostics, and constrained inpatient capacity, a risk-stratification tool with high sensitivity and negative predictive value may help clinicians safely identify low-risk patients suitable for discharge. However, the moderate specificity observed underscores the limitations of relying on the SFSR in isolation and reinforces current guideline recommendations that CDRs should complement, rather than replace, structured clinical judgment (4,5). Consistent with findings from other LMIC settings reported by Moussa et al., local validation of syncope risk tools is essential to ensure their appropriate application across diverse populations (13).

Future research should prioritize prospective, multicenter validation of syncope CDRs in Pakistani ED populations, with adequate sample sizes and longer follow-up intervals to capture clinically relevant outcomes. Comparative evaluation of contemporary tools, including the CSRS, alongside exploration of data-driven and artificial intelligence–assisted

approaches, may further enhance risk stratification accuracy and support context-sensitive clinical decision-making in resource-limited environments (22).

Conclusion

The San Francisco Syncope Rule showed high sensitivity and a strong negative predictive value for short-term serious outcomes, indicating its usefulness as a rule-out tool for identifying low-risk patients with syncope. However, its moderate specificity suggests that relying on the SFSR alone may result in unnecessary admissions. These findings support incorporating the SFSR into structured clinical assessment rather than using it as a standalone decision instrument. Further multicenter validation in Pakistani emergency care settings is warranted to refine locally appropriate syncope risk stratification strategies and optimize resource utilization.

Declarations

Data Availability statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
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