



Research Article

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VALIDATION OF WITNESS-DERIVED SECONDARY CINCINNATI PREHOSPITAL STROKE SCALE SCORES FOR PREHOSPITAL STROKE TRIAGE

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Abstract

Objectives: Prehospital delay in acute ischemic stroke is driven by decision delay between symptom recognition and taking action. Although witnesses recognise symptoms early, the value of translating witness-reported symptoms into standardised stroke assessment tools remains unclear. This study aimed to evaluate the predictive value of witness-derived, physician-administered secondary Cincinnati Prehospital Stroke Scale (CPSS) scores.

Materials and Methods: This prospective, cross-sectional validation study was conducted in a tertiary ED between August and November 2025. Secondary CPSS scores were independently assigned by two blinded emergency physicians using the three-item CPSS, based on structured interviews with untrained witnesses of stroke-like patients. Predictive validity was assessed using final ED diagnoses, and decision delay was derived from standardised prehospital timelines. Statistical analyses included Cohen's kappa, diagnostic accuracy metrics, and chi-square tests.

Results: A total of 235 patient-witness pairs were included. More than 70% of witnesses delayed action for over 30 minutes, accounting for 56.3% of prehospital delay. Interrater reliability was substantial ($\kappa = 0.788$). Secondary CPSS scores showed low sensitivity and negative predictive value but high specificity and positive predictive value, indicating limited rule-in utility. Scores ≥ 1 were not associated with shorter decision delay ($p = 0.789$).

Conclusion: Secondary CPSS based on witness reports is reliably scored but has limited diagnostic accuracy and does not facilitate faster decision-making, limiting its utility as a standalone tool for prehospital stroke triage. Future studies should address cognitive barriers and improve witness response.

Keywords: Stroke, bystanders, risk assessment, decision making, predictive value of tests, emergency department.

Introduction

In patients with stroke-like symptoms, prehospital delay (PD) comprises decision delay (DD)—from symptom recognition to seeking help—and transfer delay (TD), from help activation to hospital arrival. DD is the main contributor to total delay (PD).¹⁻² Despite advances in acute stroke care, reperfusion therapy reaches only 1%–8% of eligible patients, underscoring the need for improved public stroke recognition.³ Prehospital timelines are influenced by behavioural, logistical, emergency medical service (EMS)-related, and socioeconomic factors.²⁻¹⁰ Witness presence, public settings, not living alone, and accurate symptom recognition shorten DD.²⁻⁶ In contrast, denial, misattribution, limited knowledge, reduced mobility, chronic illness, and delayed or absent EMS activation prolong DD, reflecting patient- and witness-level decision-making and routing choices during the prehospital period.⁵⁻¹² Primary care services are frequently contacted early in the symptom trajectory. Therefore, understanding how patients and witnesses navigate “first-contact” options and how these decision processes influence EMS activation and time to hospital arrival is critical for optimising stroke awareness strategies and strengthening time-sensitive prehospital triage.^{4, 6, 7, 12}

Stroke witnesses are often the first to observe neurological symptoms and can substantially influence DD.⁴ Although the Cincinnati Prehospital Stroke Scale (CPSS) is a validated screening tool when used by healthcare professionals,¹³⁻²⁰ its validation based on witness-guided scoring remains limited. To our knowledge, this study is the first to evaluate the diagnostic accuracy of witness-derived Cincinnati Prehospital Stroke Scale (CPSS) scores. These scores were obtained through structured interviews conducted by blinded emergency physicians with untrained witnesses in the emergency department (ED). It also examines their association with decision delay and whether performance varies by witness characteristics. This study examines whether witness descriptions within the CPSS framework can be translated into standardised, measurable clinical indicators. The findings aim to inform the development of witness-focused prehospital stroke triage awareness strategies. These strategies target early recognition, first-contact choices, and subsequent routing decisions while integrating with primary care pathways.

Cincinnati Prehospital Stroke Scale

The CPSS is a brief screening tool based on three clinical signs: facial droop, arm drift, and speech abnormality.¹³ It was originally developed for paramedics, physicians, and other EMS providers to rapidly identify suspected stroke. CPSS-related studies can be grouped into four categories: reproducibility studies by prehospital providers;¹³⁻¹⁸ ED-based reproducibility and comparative studies by emergency physicians;^{19, 20} dispatcher-guided telephone assessments;^{21, 22} and lay bystander studies evaluating recognition of CPSS-equivalent signs rather than formal scoring.^{23, 24} Each abnormal finding scores 1 point

(range 0–3), and a score ≥ 1 indicates high stroke probability. The CPSS demonstrated 66% sensitivity and 87% specificity in the original study¹³ and sensitivities of 75%–95% with specificities of 24%–100% in external validations.^{14–20}

The primary objective was to evaluate the predictive value of witness-derived secondary CPSS scores in the ED. The secondary objective was to assess associations between secondary CPSS scores, decision delay, and witness characteristics. Hypothesis 1: Witness-derived secondary CPSS scores predict ischemic stroke. Hypothesis 2: Secondary CPSS scores ≥ 1 are associated with shorter decision delay.

Materials and Methods

This prospective, analytical, cross-sectional validation study was conducted in the ED of Ankara Bilkent City Hospital, a tertiary academic hospital in Ankara, Türkiye and approved by the Medical Research, Scientific and Ethical Evaluation Board of Ankara Bilkent City Hospital (Project No: TABED 1-25-1588; August 13, 2025). The study followed the STROBE guidelines (Supplementary File 1). Clinical Trials ID: NCT07277790; Dec 14, 2025. Written informed consent was obtained from all participants, and data were anonymised and handled in accordance with the Declaration of Helsinki.

Study setting and flow

The study was conducted in a tertiary academic ED in Ankara Bilkent City Hospital, Türkiye, between August 15 and November 15, 2025. Witness interviews were performed face-to-face by two blinded emergency physicians (a senior resident and an attending physician) during initial patient assessment.

The study comprised two phases (Figure 1). Phase 1 assessed interrater reliability, in which a senior emergency medicine resident and an attending emergency physician independently assigned secondary CPSS scores after standardised orientation and CPSS training. Emergency team assistant staff received a brief 20-minute protocol training focused on data collection and blinding procedures. The two raters completed a 30-minute CPSS training. Phase 2 evaluated predictive validity by comparing secondary CPSS scores with final diagnoses and assessing associations with witness characteristics and decision delay.

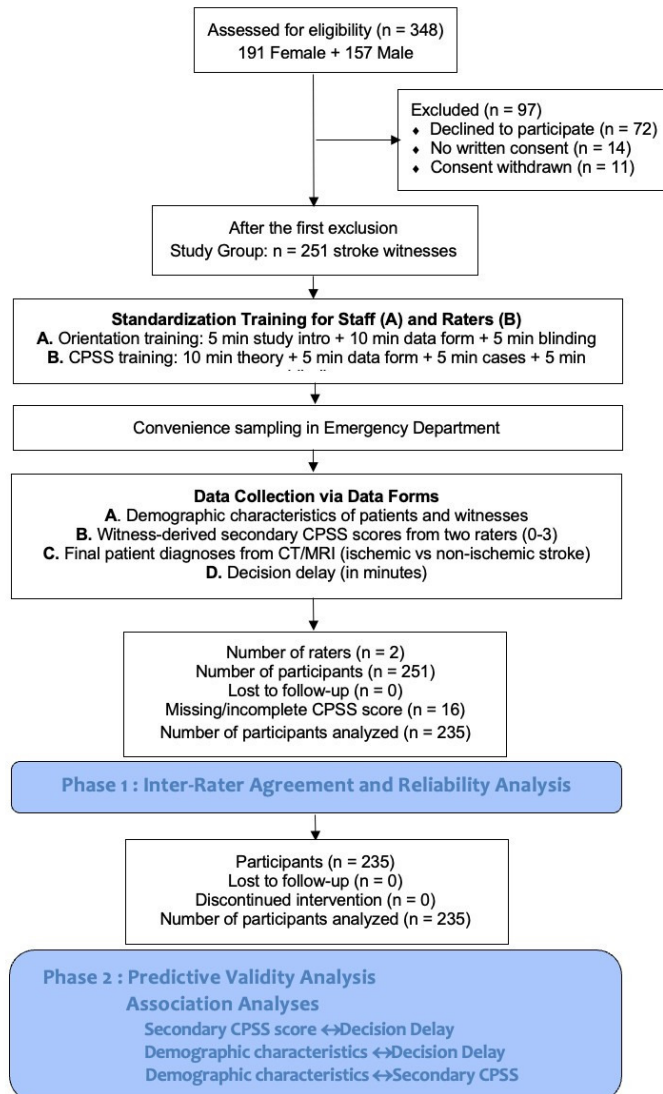


Figure 1. Study design and participant flow diagram

Study population and sample size

Suspected stroke patients were defined as individuals presenting sudden facial asymmetry, arm weakness, speech disturbance, or other focal neurological deficits, who underwent neuroimaging to confirm or exclude stroke.²² Suspected stroke refers to cases in which clinicians in the emergency department consider stroke as a possible diagnosis based on the clinical presentation. In contrast, stroke-like symptoms denote a broader, symptom-based construct that may also arise from various neurological or metabolic conditions and therefore do not imply a definitive diagnosis. In this study, stroke-like symptoms were defined as signs observed by witnesses or relatives. Patients presenting with such symptoms were included based on clinical

suspicion of stroke in the emergency department. Neuroimaging was performed in most patients as part of routine evaluation, but was not defined as a mandatory inclusion criterion.

Eligible participants were adult witnesses (≥ 18 years) who directly observed the onset of stroke-like symptoms. Witnesses were required to accompany the patient during ED evaluation and to be the primary decision-makers for EMS activation or private transport. Convenience sampling was used. Witnesses were primarily family members but also included friends, neighbours, or caregivers. Witness exclusion criteria were defined based on both witness-related criteria and predefined patient-related conditions. Witnesses were excluded if they had cognitive impairment, prior stroke-recognition training, a healthcare professional background, were not the decision-maker for EMS activation or transport, refused to provide informed consent, or had incomplete CPSS-based interview data. In addition, witnesses were excluded if the accompanying patient had been transferred with a confirmed stroke diagnosis.

Sample size was calculated using G*Power based on a 7.4% prevalence of stroke-like presentations in the ED,²² an assumed odds ratio of 1.8, $\alpha = 0.05$, and 80% power. The required sample size was 182; accounting for attrition, the target was 228. Of 348 eligible witnesses, 235 met the inclusion criteria and provided informed consent.

Outcomes and variables

Primary CPSS was assigned directly by healthcare providers through patient examination, whereas secondary CPSS was derived by blinded emergency physicians based solely on witness reports. The primary outcomes were witness-derived secondary CPSS scores and final patient diagnoses. Secondary outcomes included decision delay and witness characteristics. The main independent variable was the secondary CPSS score (range 0–3), derived from structured ED interviews with witnesses. Decision delay (DD) was the study's dependent variable, defined as the time between symptom recognition and taking action. As quantitative variables, secondary CPSS scores (0–3) were analysed as continuous and dichotomised variables (≥ 1 vs. 0), and decision delay was analysed continuously and categorically (< 30 vs. ≥ 30 minutes). Witness characteristics were treated as potential confounders, while perceived symptom clarity or severity and contextual factors were considered potential effect modifiers.

Data collection instruments

Data were collected prospectively using two structured research data forms. Secondary CPSS scores were derived from standardised witness interviews (Supplementary Files 2). Each CPSS item was scored dichotomously (yes/no). Unmarked or "I don't know" responses were considered incomplete. Total CPSS scores ranged from 0 to 3, and two blinded raters independently scored each report. Emergency team

assistant staff documented final diagnoses, demographics, and prehospital timeline variables (Supplementary Files 3). Predictive validity was assessed by comparing secondary CPSS scores with final diagnoses. For final diagnoses, Computed Tomography (CT) or Magnetic Resonance Imaging (MRI) findings were interpreted by radiologists blinded to the study. Data were entered into a secure database, anonymised, and analysed by an independent statistician. Secondary CPSS scores were not used to guide clinical decision-making and had no impact on the timing of patient diagnosis or treatment.

Blinding and bias

Physicians were blinded to clinical findings, final diagnoses, and each other's assessments, while witnesses were blinded to patient examination findings and final diagnoses. Selection bias was minimised through consecutive sampling. Standardised interviews, protocolized training, blinding, and timeline clarification reduced information, interviewer, recall, observer, and diagnostic review bias. Social desirability bias was addressed by assuring participants that responses would not influence patient care.

Statistical analysis

Analyses were performed using IBM SPSS Statistics for Mac (Version 31.0). Interrater reliability was assessed using Cohen's kappa with 95% confidence intervals. Diagnostic accuracy metrics were calculated from 2×2 contingency tables using CT or MRI as the reference standard. Two-tailed p-values <0.05 were considered statistically significant.

Results

Figure 1 summarises the flow of eligible participants. The study population comprised 235 patients and their 235 accompanying stroke witnesses. Among witnesses, the mean age was 44.1 years; most were aged 18–65 years (90.2%) and were predominantly first-degree relatives (83.0%). More than half were female (53.2%) and employed (57.0%), and educational attainment varied, with 31.9% having a tertiary education. Decision delay was substantial: 72.4% initiated action more than 30 minutes after symptom recognition, and 60.9% waited more than 60 minutes. (Table 1). Median prehospital delay was 240 minutes, largely driven by a median decision delay of 135 minutes, whereas median transport time was shorter at 45 minutes. All time intervals showed wide variability (Table 1).

Table 1. Witness demographic characteristics

Witness demographics			
Variables	Characteristics	Measurement	
		n	%
Age (years)	18-65	212	90.2
	>65	23	9.8
Gender	Female	125	53.2
	Male	110	46.8
Degree of relationship	First-degree relative	195	83.0
	Not a first-degree relative	40	17.0
Education level	Illiterate	12	5.1
	Primary	65	27.7
	Secondary	83	35.3
	Tertiary	75	31.9
Employment status	Employed	134	57.0
	Unemployed	101	43.0
Decision delay (min)	<10	20	8.5
	10-30	45	19.1
	31-60	27	11.5
	>60	143	60.9
PD = DD + TD	Mean (SD)	Median (IQR)	Min-Max Values
Prehospital delay (PD) (min)	1005.5 (2176.0)	240.0 (90.0 - 945.0)	15.0 - 18600.0
Decision delay (DD) (min)	885.3 (2153.2)	135.0 (30.0 - 780.0)	1.0 - 18570.0
Transport delay (TD) (min)	120.2 (319.1)	45.0 (30.0 - 85.0)	5.0 - 2700.0

First-degree relative: Spouse, child, mother, father, sibling. Not first-degree relative: Other family members, friends and neighbours. Primary: Literate and elementary school. Secondary: Middle and /high school. Tertiary: University. Unemployed: Housewife, or retired. SD: Standard deviation. IQR: Interquartile Range (25%-75%).

Among the 235 patients, the mean age was 63.2 years; 56.6% were older than 65 years, and 51.9% were female. Most lived with family members (86.4%) and arrived by private vehicle (57.4%). CT or MRI imaging was performed in more than 90% of cases. Final diagnoses showed that 73.2% had ischemic stroke and 9.4% had hemorrhagic stroke. A total of 22 hemorrhagic stroke cases were identified. However, one patient had both subarachnoid and intraparenchymal haemorrhage; therefore, the descriptive statistics of haemorrhage subtypes include 23 events. Hypertension was the most common risk factor (34.0%). The most frequent presenting symptoms were slurred speech (35.3%) and arm weakness (30.6%) (Table 2).

Table 2. Patient demographic characteristics

Patient Demographics			
Variables	Characteristics	n	%
Age (years)	18-65	102	43.4
	>65	133	56.6
Gender	Female	122	51.9
	Male	113	48.1
Living style	Alone	12	5.1
	With family members	203	86.4
	Living with assistance	20	8.5
Education level	Illiterate	49	20.9
	Primary	110	46.8
	Secondary	38	16.2
	Tertiary	38	16.2
Employment status	Employed	161	68.5
	Unemployed	74	31.5
Transfer way to the hospital	Ambulance	94	40.0
	Private vehicle	135	57.4
	Outpatient	6	2.6
CT scan	Done	224	95.3
	Not done	11	4.7
MRI scan	Done	220	93.6
	Not done	15	6.4
Exitus	Yes	-	-
	No	235	100.0
Diagnoses	Ischemia	172	73.2
	Hemorrhage	22	9.4
	Other CNS diagnoses	27	11.5
	Non-CNS diagnoses	34	14.5
Ischemic stroke	Cerebral	110	64.0
	Cerebellar	20	11.6
	Transient ischemic attack	42	24.4
Hemorrhage	Subarachnoid	7	30.4
	Subdural	4	17.4
	Epidural	-	-
	Intraparenchymal	11	47.8
	Cerebellar	1	4.4
Risk factors	Hypertension (HT)	80	34.0
	Diabetes mellitus (DM)	29	12.3
	Hyperlipidemia (HPL)	10	4.3
	Coronary artery disease	28	11.9
	Atrial fibrillation	6	2.6
	HT + DM	21	8.9
	HT + DM + HPL	8	3.4
	Others	211	89.7
Symptoms	Facial droop	25	10.6
	Arm drift	72	30.6
	Slurred speech	83	35.3
	Face + arm + speech	3	1.3
	Others	151	64.2

Living with assistance: Nursing home/Home care. Primary: Literate and elementary school. Secondary: Middle and /high school. Tertiary: University. Unemployed: Jobless, housewife, or retired. CT: Computed Tomography. MRI: Magnetic Resonance Imaging. CNS: Central Nervous System

Interrater agreement for secondary CPSS scoring was high. As shown in Table 3, both raters assigned a CPSS score of 0 in 38.3% of cases, while scores of 1, 2, and 3 were assigned in 48.5%, 11.9%, and 1.3%, respectively. Per cent agreement for individual CPSS items was high (93.6%–95.7%), with kappa coefficients indicating substantial to almost perfect agreement (facial droop: $\kappa = 0.791$; arm drift: $\kappa = 0.848$; slurred speech: $\kappa = 0.889$; all $p < 0.001$). Overall agreement for total CPSS scores was 84.7%, with $\kappa = 0.788$ (95% CI: 0.726–0.850; $p < 0.001$) (Table 4).

Table 3. Cross-tabulation of total Cincinnati Prehospital Stroke Scale (CPSS) scores by emergency medicine (EM) resident and emergency medicine attending physician

Raters	EM Attending Physician n (%)					
	CPSS	0	1	2	3	Total
EM Resident n (%)	0	86 (36.6)	4 (1.7)	-	-	90 (38.3)
	1	-	98 (41.7)	16 (6.8)	-	114 (48.5)
	2	-	16 (6.8)	12 (5.1)	-	28 (11.9)
	3	-	-	-	3 (1.3)	3 (1.3)
	Total	86 (36.6)	118 (50.2)	28 (11.9)	3 (1.3)	235 (100.0)

EM: Emergency medicine, CPSS: Cincinnati Prehospital Stroke Scale

Table 4. Inter-rater agreement on Cincinnati Prehospital Stroke Scale (CPSS) items: EM resident vs. EM attending physician

CPSS Items	Percent agreement (%)	Kappa (κ) [95% CI]	p-value
Facial droop	95.7	0.791 (0.666 to 0.916)	<0.001
Arm drift	93.6	0.848 (0.774 to 0.922)	<0.001
Slurred speech	94.9	0.889 (0.828 to 0.950)	<0.001
Total	84.7	0.788 (0.726 to 0.850)	<0.001

CPSS: Cincinnati Prehospital Stroke Scale

In predictive validity analyses, secondary CPSS components demonstrated low-to-moderate sensitivity (12.2%–43.0%) with consistently high specificity (74.6%–98.4%). Among individual components, slurred speech showed the most favourable diagnostic profile, with a sensitivity of 43.0%, specificity of 85.7%, PPV of 89.2%, and the highest accuracy (54.5%). Arm drift demonstrated moderate sensitivity (32.6%) and strong specificity (74.6%), with an accuracy of 43.8%, whereas facial droop showed low sensitivity (12.2%) but high specificity (93.7%). PPVs were generally high (>82%), with comparatively lower values for arm drift (77.8%) and the full triad (66.7%); while NPVs remained uniformly low (26%–35%). Combined CPSS item pairs and the full triad yielded very high specificity (>93%) but very low sensitivity (1.2%–11.1%), resulting in modest accuracy values (27%–33%). Positive likelihood ratios were low to moderate across individual CPSS components (PLR range: 1.28–3.01) and low for combined patterns (PLR \leq 2.56), indicating limited rule-in capability. Negative likelihood ratios were uniformly high (NLR range: 0.66–1.00), reflecting poor rule-out performance. Accuracy values were low, ranging from 27.2% to 54.5% across individual items and combinations (Hypothesis 1) (Table 5).

Table 5. Reliability and predicting performance metrics of the CPSS and its components with frequencies (%) and (95% confidence intervals)

Items	Sensitivity	Specificity	PPV	NPV	PLR	NLR	Accuracy
Facial droop	12.21 (7.72 to 18.06)	93.65 (84.53 to 98.24)	84.0 (65.22 to 93.63)	28.10 (26.41 to 29.85)	1.92 (0.69 to 5.38)	0.94 (0.86 to 1.02)	34.04 (28.01 to 40.49)
Arm drift	32.56 (25.62 to 40.11)	74.60 (62.06 to 84.73)	77.78 (68.53 to 84.91)	28.83 (25.33 to 32.61)	1.28 (0.80 to 2.06)	0.90 (0.76 to 1.08)	43.83 (37.39 to 50.43)
Slurred speech	43.02 (35.51 to 50.78)	85.71 (74.61 to 93.25)	89.16 (81.43 to 93.91)	35.53 (31.86 to 39.37)	3.01 (1.61 to 5.65)	0.66 (0.56 to 0.78)	54.47 (47.87 to 60.96)
Face arm +	2.91 (0.95 to 6.65)	98.41 (91.47 to 99.96)	83.33 (37.33 to 97.67)	27.07 (26.28 to 27.88)	1.83 (0.22 to 15.37)	0.99 (0.95 to 1.03)	28.51 (22.83 to 34.74)
Face speech +	4.07 (1.65 to 8.21)	98.41 (91.47 to 99.96)	87.50 (46.77 to 98.24)	27.31 (26.45 to 28.19)	2.56 (0.32 to 20.43)	0.97 (0.93 to 1.02)	29.36 (23.62 to 35.63)
Arm speech +	11.05 (6.78 to 16.71)	93.65 (84.53 to 98.24)	82.61 (62.70 to 93.07)	27.83 (26.19 to 29.53)	1.74 (0.62 to 4.92)	0.95 (0.87 to 1.03)	33.19 (27.20 to 39.61)
Face arm speech + +	1.16 (0.14 to 4.14)	98.41 (91.47 to 99.96)	66.67 (15.58 to 95.59)	26.72 (26.04 to 27.42)	0.73 (0.07 to 7.94)	1.00 (0.97 to 1.04)	27.23 (21.65 to 33.40)

CPSS: Cincinnati Prehospital Stroke Scale, PPV: Positive predictive value, NPV: Negative predictive value, PLR: Positive Likelihood Ratio, NLR: Negative Likelihood Ratio.

Witnesses with CPSS ≥ 1 did not act faster than those with CPSS = 0; the proportion acting within 30 minutes was similar (63.1% vs. 36.9%; $p = 0.789$). Accordingly, higher secondary CPSS scores were not associated with shorter time to action (Hypothesis 2) (Table 6). No demographic factors—including age, gender, relationship to the patient, education, or employment status—were significantly associated with secondary CPSS scores (all $p > 0.05$). Likewise, none were significantly associated with decision delay (≤ 30 min vs. > 30 min), with p -values ranging from 0.113 to 0.504 (Table 6)

Table 6. The association of secondary CPSS scores and witness demographic characteristics with decision delay

Variables	Secondary CPSS score n (%)			Decision delay n (%)		
	CHIS=0	CHIS ≥ 1	p*	≤ 30 Min.	> 30 Min.	p*
Age (years)						
18-65	82 (91.1)	130 (89.7)	0.715	60 (92.3)	152 (89.4)	0.504
>65	8 (8.9)	15 (10.3)		5 (7.7)	18 (10.6)	
Gender						
Female	45 (50.0)	80 (55.2)	0.440	40 (61.5)	85 (50.0)	0.113
Male	45(50.0)	65 (44.8)		25 (38.5)	85 (50.0)	
Degree of relationship						
First-degree relative	76 (84.4)	119 (82.1)	0.638	51 (78.5)	144 (84.7)	0.255
Not a first-degree relative	14 (15.6)	26 (17.9)		14 (21.5)	26 (15.3)	
Education level						
Illiterate	4 (4.4)	8 (5.5)	0.647	5 (7.7)	7 (4.1)	0.390
Primary	21 (23.3)	44 (30.3)		19 (29.2)	46 (27.1)	
Secondary	34 (37.8)	49 (33.8)		25 (38.5)	58 (34.1)	
Tertiary	31 (34.4)	44 (30.3)		16 (24.6)	59 (34.7)	
Employment status						
Employed	57 (63.3)	77 (53.1)	0.124	33 (50.8)	101 (59.4)	0.232
Unemployed	33 (36.7)	68 (46.9)		32 (49.2)	69 (40.6)	
Secondary CPSS score						
CPSS = 0	-	-	-	24 (36.9)	66 (38.8)	0.789
CPSS ≥ 1	-	-	-	41 (63.1)	104 (61.2)	

*Pearson Chi-Square Test

Discussion

Patient characteristics in this study—including mean age, sex distribution, hypertension prevalence, and stroke subtype distribution—were broadly comparable to those reported in prior CPSS diagnostic accuracy studies.^{13,16-18} The high rate of neuroimaging use ($\geq 94\%$) aligns with established CPSS validation standards.^{13,15} Presenting symptoms were dominated by slurred speech and arm weakness. These features have been linked to a higher likelihood of stroke recognition and EMS activation in certain populations.^{5,10} Witness demographics largely mirrored existing literature, with stroke symptoms most often observed by middle-aged family members.^{4,5,12}

Secondary CPSS scoring demonstrated high interrater reliability. Agreement across components was substantial to almost perfect and comparable to clinician-applied CPSS studies¹³⁻²⁰ and dispatcher-assisted assessments.^{22,23} Agreement was higher for slurred speech and arm weakness than for facial droop, consistent with prior witness-based studies.^{24,25} These results suggest that physician-assigned secondary CPSS scores derived from structured witness interviews are reproducible and methodologically robust.

Regarding predictive validity (Hypothesis 1), slurred speech showed the most favourable diagnostic profile among individual CPSS components, combining moderate sensitivity with high specificity. Other components demonstrated lower sensitivity, and combined CPSS patterns—while highly specific—showed poor sensitivity and limited accuracy. PPVs remained relatively high, particularly for slurred speech and arm drift, whereas NPVs were uniformly low, indicating limited rule-out capability. Overall, witness-derived CPSS findings provided modest rule-in value but insufficient discriminatory performance to exclude stroke, offering partial support for Hypothesis 1.

The limited sensitivity and modest accuracy observed for combined CPSS patterns, especially the full triad, likely reflect contextual features of the study population, including very high stroke prevalence and the indirect nature of witness-based assessment. In such settings, restrictive combinations preferentially identify only the most overt cases, underscoring the adjunctive rather than exclusionary role of secondary CPSS scoring in early stroke evaluation. Accordingly, secondary CPSS may be best positioned as a supplementary, rule-in-oriented tool rather than a standalone screening instrument.

Hypothesis 2, which proposed an association between higher secondary CPSS scores and shorter decision delay, was not supported. Witnesses with CPSS ≥ 1 did not initiate action faster than those with CPSS = 0, and no demographic characteristic was associated with CPSS scoring or timeliness. Although this contrasts with studies suggesting that symptom severity accelerates help-seeking,^{2,5,10,12,26,27} recognition of stroke symptoms did not translate into timely action.^{28,29} It aligns with evidence emphasising the multifactorial

nature of prehospital delay.⁷⁻⁹ Qualitative research highlights family deliberation, emotional responses, and uncertainty as key barriers to prompt EMS activation, even when symptoms are recognised.^{4,12}

Decision delay accounted for more than half of the total prehospital delay, consistent with prior evidence identifying the recognition-to-decision interval as a major contributor to treatment delay.^{4,5} These findings reinforce the concept of a persistent recognition–action gap in acute stroke care.

In decision-making processes shaped by uncertainty, indecision, and fear, many patients and witnesses (≈ 48 –80%) contact primary care/family physicians first to “clarify urgency” and “validate” the situation.^{4,6,26} While this highlights the pivotal role of primary care in early help-seeking, choosing primary care-oriented routes (telephone advice, appointments, face-to-face assessment, outpatient referral) instead of EMS activation or direct ED presentation may delay or preclude EMS involvement and is associated with longer prehospital times.^{4,6,7,12,26} Despite relatively high awareness, many patients still arrive by private vehicle, reflecting persistent gaps between knowledge, recognition, response, and transport behaviours that manifest as delayed decision-making and non-EMS transport.^{6-8,11,28} This reliance on non-EMS transport remains clinically relevant, as EMS use as the first contact or not calling EMS is consistently associated with shorter PD and improved access to time-sensitive reperfusion therapies.^{9,10} Multiple cognitive and contextual determinants contribute to these patterns, including perceiving EMS as less accessible or appropriate and intending to call EMS but not translating that intention into action.^{6,28} Strengthening the “time is brain” message to trigger rapid emergency care-seeking remains a key priority.

The literature emphasises the need for targeted educational strategies to bridge the recognition–action gap. These strategies should promote rapid symptom recognition and triage, reinforce low-threshold EMS activation for suspected stroke, and prioritise high-risk individuals and their close contacts over broad public campaigns with uncertain cost-effectiveness.^{3,30} Accordingly, awareness initiatives and targeted education for high-risk groups should be aligned with—and supportive of—primary care. In this context, witness-derived CPSS may serve as a practical, rule-in-oriented supplemental prehospital stroke triage tool to support witnesses’ decision-making, whose effectiveness could be enhanced through structured primary care-based public education and technology-assisted triage strategies addressing individual differences, cognitive barriers, and contextual conditions.

Strengths and Limitations

This study benefits from a comparatively large sample, standardised data collection procedures, and high interrater agreement, which enhance the methodological consistency and applicability of the findings to comparable emergency care settings. A potential strength of this study is the evaluation of a witness-derived CPSS approach for stroke triage during the prehospital phase. However, several limitations should be

acknowledged. The study was conducted in a single tertiary emergency department, which may restrict external validity. Secondary CPSS scores and prehospital time intervals were derived from witness reports and are therefore subject to recall bias and subjective interpretation. The cross-sectional design precludes causal inference. Additionally, unmeasured confounders—such as health literacy, emotional response, or prior exposure to stroke—may have influenced symptom recognition and decision-making processes. Finally, exclusion of patients without accompanying witnesses may have introduced selection bias. Future multicenter investigations are warranted to further explore cognitive and contextual determinants of delayed action and to assess the effectiveness of structured CPSS-based educational or digital interventions.

Ethical Considerations: Ethical approval was obtained from the Medical Research, Scientific and Ethical Evaluation Board of Ankara Bilkent City Hospital (Project No: TABED 1-25-1588; approved on August 13, 2025).

Conflict of Interest: The authors declare no conflict of interest.

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