Academic Emergency Medicine

ORIGINAL ARTICLE

Diagnostic Yield of Hospitalization for Emergency Department Patients With Syncope and Presyncope

Christopher W. Baugh[1] | Carolyn Winskill[2] | Edward H. Suh[3] | Dana L. Sacco[3] | John DeAngelis[4] | Daniel K. Nishijima[5] | Jonathan Schimmel[6] | Alan B. Storrow[7] | Nancy Wood[4] | Robert E. Weiss[2] | Marc A. Probst[3]

[1]Department of Emergency Medicine, Brigham and Women's Hospital, Boston, Massachusetts, USA | [2]Department of Biostatistics, Fielding School of Public Health, University of California, Los Angeles, California, USA | [3]Department of Emergency Medicine, Columbia University Irving Medical Center, New York, New York, USA | [4]Department of Emergency Medicine, University of Rochester Medical Center, Rochester, New York, USA | [5]Department of Emergency Medicine, University of California Davis, Sacramento, California, USA | [6]Department of Emergency Medicine, The Mount Sinai Hospital, New York, New York, USA | [7]Department of Emergency Medicine, Vanderbilt University Medical Center, Nashville, Tennessee, USA

Correspondence: Christopher W. Baugh (cbaugh@bwh.harvard.edu)

Received: 14 July 2026 | **Revised:** 31 July 2026 | **Accepted:** 3 August 2026

Supervising Editor: Brian Hiestand

Keywords: emergency department | hospitalization | presyncope | syncope | value-based care | yield

ABSTRACT

Objectives: Syncope and presyncope are common emergency department (ED) presentations that may indicate dangerous underlying conditions. For patients without serious ED diagnoses, hospitalization for monitoring and further workup is common, yet the benefits remain unclear. We sought to determine the diagnostic yield of hospitalization among adults with unexplained syncope or presyncope.

Methods: We conducted a secondary analysis of data from a prospective, multicenter, observational study enrolling ED patients aged ≥ 40 years with syncope or presyncope and no serious ED diagnosis. We collected 30-day serious adverse outcomes (SAOs), both cardiac and non-cardiac, including only in-hospital SAOs for admitted patients and all SAOs for discharged patients. Logistic and Cox regression analyses compared admitted and discharged participants using propensity score adjustment and matching.

Results: Among 1263 patients (mean age 64.8 ± 13.1 years), 74 (5.9%) experienced any SAO, including 62 (4.9%) with serious cardiac outcomes. After propensity-score adjustment, Bayesian logistic regression showed a significant difference in diagnostic yield (OR 3.70 [95% CrI 1.85–6.82]) in the hospitalized cohort. In a propensity-score-matched Cox regression analysis, hospitalization was associated with a shorter time to SAO diagnosis, with an HR of 12.43 (95% CI 2.94–52.48).

Conclusion: Hospitalization increased the diagnostic yield for SAOs and accelerated time to diagnosis. It is reasonable to hospitalize select, higher-risk adult patients over 40 years old with presyncope or syncope, even if no dangerous diagnosis is found in the ED.

Trial Registration: ClinicalTrials.gov identifier: NCT04533425

Previous Presentation: 2026 SAEM Annual Meeting, Atlanta, GA.

1 | Introduction

1.1 | Background

Syncope and presyncope account for 1%–2% of all emergency department (ED) visits in the United States (US), generating over $2.4 billion in annual healthcare costs [1–5]. Most of these costs are driven by hospital admissions, which occur in 30%–50% of cases yet frequently fail to identify a causative etiology [6, 7]. A recent systematic review and meta-analysis found insufficient evidence to recommend for or against hospitalizing ED patients with syncope [8]. As the population ages and the syncope incidence rises, pressure on strained healthcare systems will only intensify [9, 10]. The substantial resource utilization associated with syncope evaluation, combined with considerable variation in practice regarding admission decisions, underscores the urgent need to identify which patients truly benefit from hospitalization [11].

Recent evidence supports the safety of outpatient management for low- and intermediate-risk patients when no dangerous etiology is identified during ED evaluation [12, 13]. Carefully selected patients can be discharged with appropriate follow-up without increased risk of serious adverse outcomes (SAOs) [12, 13]. Yet admission decisions remain highly variable and often appear discretionary rather than evidence-based, suggesting that many hospitalizations are driven by defensive medicine rather than objective clinical risk [14, 15].

Despite the frequency of syncope presentations, few investigations have rigorously examined whether hospitalization provides a meaningful diagnostic benefit among patients without a dangerous diagnosis identified in the ED [8, 12, 13]. This gap is consequential: amid widespread hospital overcrowding and the well-documented harms of avoidable admissions, understanding the true incremental value of hospitalization is paramount [16–18]. If hospitalization yields little additional diagnostic or therapeutic benefit in this population, discharge with outpatient follow-up represents the optimal strategy. If hospitalization is necessary to detect time-sensitive conditions, current discharge practices may expose patients to unacceptable risk.

The objective of this investigation was to determine the diagnostic yield of hospitalization for detecting short-term SAOs among US patients aged 40 years or older presenting with syncope or presyncope, in whom no dangerous diagnosis was identified during the index ED visit.

2 | Methods

2.1 | Study Design and Setting

We conducted a prospective, multicenter, observational study of adults aged 40 years or older presenting with either syncope (transient loss of consciousness [LOC] with spontaneous return to baseline) or presyncope (an acute sensation of impending LOC) who did not have a serious diagnosis identified during their index ED visit. This current study was a planned secondary analysis to assess the diagnostic yield of hospitalization. The primary objective of the parent study was to validate two syncope risk-stratification tools [19]. We enrolled patients at six urban US EDs between September 2020 and September 2024. We obtained study approval from a central institutional review board (IRB) and from the IRBs of each participating center, and written informed consent from all participants or their legally authorized representatives.

2.2 | Selection of Participants

Trained research staff prospectively enrolled participants at each site and performed screening between 8 AM and 10 PM, 5 to 7 days a week, depending on each study site's resources. Our target sample size was 1232 patients with complete data, assuming a 4.5% rate of serious adverse outcomes at 30 days, to yield sufficiently precise confidence intervals for sensitivity, specificity, and predictive values to validate two syncope risk-stratification tools.

We excluded patients under age 40 with syncope, as they are at much lower risk for SAOs than middle-aged or older adults and are responsible for relatively little resource utilization [20–22]. Younger patients often have different causes of syncope. Exclusionary diagnoses included significant cardiac arrhythmia, acute myocardial infarction, new significant structural heart disease, pulmonary embolism, aortic dissection, significant hemorrhage or anemia requiring blood transfusion, acute pulmonary edema, pneumonia, sepsis, acute renal failure, intracranial bleeding, major traumatic injury requiring inpatient management, acute surgical illness, or death.

We also excluded patients whose symptoms were suspected to be caused by intoxication, seizure, stroke, significant head trauma, or hypoglycemia, as well as patients with pregnancy, confusion, prolonged LOC ($\geq$ 5 min), those who required intervention to restore mental status, who had a ventricular assist device, who were unable to communicate in English or Spanish, or who were otherwise unable to consent and had no legally authorized representative available.

2.3 | Measurements

We abstracted baseline clinical and demographic variables from the electronic health record, including age, sex, presenting symptoms, past medical history, vital signs, electrocardiogram (ECG) findings, laboratory test results, and ED disposition. Elements of the medical history that were not explicitly charted or verbally reported by ED clinicians were inferred to be negative. These variables were then confirmed with the ED provider in real-time during the visit. Race and ethnicity were obtained from patient self-reports. Blood samples were obtained after consent for N-terminal pro-brain natriuretic peptide (NT-proBNP) and high-sensitivity cardiac troponin T, then sent for analysis at a central research laboratory (CER Lab, Boston, MA). ED clinicians were blinded to these biomarker results, and clinical management was determined by the treating physicians. Disposition was dichotomized as hospital admission (including observation unit hospitalization at sites with this capacity and transfer to other inpatient facilities) versus discharge from the ED. Chart abstraction was performed manually by full-time research staff using a standardized electronic instrument on a secure web-based research

management platform (REDCap), with predefined clinical variables [23]. All research staff were trained by the principal investigator and the site investigators over a 4-week period. Regular quality control was performed by the principal investigator and project manager, who met weekly with all sites throughout the data collection period. A risk-stratification score, FAINT, was calculated for each patient. This tool uses past medical history, ECG findings, and cardiac biomarkers to provide a dichotomous result: FAINT =0 (low risk) versus FAINT ≥1 (non-low risk) [13]. The FAINT score has been externally validated with an AUROC for a serious cardiac outcome at 30 days of 0.76. A low-risk score (FAINT = 0) had a sensitivity of 96.7% and an NPV of 98.8% [19].

2.4 | Outcomes

The primary clinical outcome was an SAO within 30 days of the index ED visit. SAOs included death from any cause, significant cardiac arrhythmia, MI, new diagnosis of significant SHD, cardiopulmonary resuscitation, posterior circulation stroke, subarachnoid hemorrhage, sepsis, pulmonary embolism, aortic dissection, acute hemorrhage requiring transfusion, cardiac intervention, or other serious clinical event related to the syncope that would require treatment. Significant cardiac arrhythmias included ventricular fibrillation, ventricular tachycardia, sick sinus disease, Mobitz II atrioventricular heart block, complete heart block, symptomatic supraventricular tachycardia, symptomatic bradycardia, and pacemaker malfunction. Symptomatic referred to the simultaneous occurrence of dizziness, lightheadedness, hypotension (systolic blood pressure < 90), or syncope with an arrhythmia on ECG monitoring. Cardiac intervention included permanent pacemaker or implantable cardiac defibrillator placement, coronary artery bypass graft (CABG), percutaneous transluminal coronary angioplasty (PTCA), or valvular surgery. Patients with an SAO diagnosis leading to an intervention (e.g., dysrhythmia resulting in implanted cardiac device) were counted as one SAO event. We determined outcomes by a combination of electronic chart review and telephone follow-up with participants or their legally authorized representative. Senior investigators at each site were blinded and conducted chart reviews using a standardized abstraction form at least 30 days after the index visit. All participants were also contacted by blinded research staff by telephone after 30 days to identify any outcomes not captured in the available medical records. To assess interrater reliability of chart review for the detection of serious outcomes, two investigators independently reviewed records of the first 25–50 sequentially enrolled patients at each of the six sites, with disagreements resolved by discussion with a third member of the research team. We adjudicated ambiguous outcomes by a blinded second physician investigator.

We defined diagnostic yield as the occurrence of an SAO diagnosis within 30 days for patients who were discharged from the ED and the occurrence of an SAO during the index hospitalization for patients admitted to the observation unit or hospital from the ED.

2.5 | Analysis

We calculated descriptive statistics for the baseline characteristics of the patient cohort, stratified by ED disposition (hospitalized vs. discharged). We used Chi-square ($\chi 2$) or *t*-tests to assess associations between categorical or continuous variables by ED disposition. We present additional site-level statistics and details of the Bayesian regression models in the Statistical Supplement. We estimated propensity scores (PS) for each subject using a logistic regression model with hospitalization as the outcome. We used 18 prospectively collected covariates to predict hospitalization: age, sex, ethnicity, race, syncope, site, heart failure, arrhythmia, abnormal ECG, elevated BNP, elevated troponin, hypertension, diabetes, coronary artery disease, valvular heart disease, dyspnea, chest discomfort, and hypotension. Multiple imputation (MI) was used to impute missing biomarker data (owing to hemolysis in the research and clinical specimens) using full conditional modeling, which assumes that the outcome and covariates with missing values are jointly normally distributed given the other covariates, with an unstructured covariance matrix [24].

Bayesian logistic regression with MI was used to compare the risk of SAOs within the study period among discharged and hospitalized patients, (i) unadjusted, (ii) adjusted with propensity scores, and (iii) fully adjusted for demographic variables, clinical characteristics, and study sites. Any SAOs included only events during index hospitalization for admitted patients and all SAOs for discharged patients. Bayesian logistic regression was used to support a larger number of predictors and to account for parameter uncertainty.

We fitted Cox regression models to the time to first SAO before ($n = 1263$) and after matching ($n = 786$) with propensity scores. All SAOs within 30 days were included for this analysis, occurring both in and out of the hospital. This analysis adjusts for the hospitalized vs. discharged group indicator, the hospitalization period (in-hospital vs. out-of-hospital) as a time-varying covariate, and their interaction. Discharged patients inherited the hospitalization period from their matched hospitalized patient.

In a subgroup analysis, we compared the diagnostic yield of hospitalization between patients classified as low risk by the FAINT score and those classified as high risk. We performed a Bayesian logistic regression to assess the interaction between FAINT score and hospitalization. Statistical analyses were performed in R (version 4.4.3; R Foundation for Statistical Computing, Vienna, Austria) [25].

3 | Results

3.1 | Characteristics of Study Subjects

We present the patient flow for this study in Figure 1. Of the 1263 patients in our final cohort, the mean age was 64.8 ± 13.1 years, and 562 (44.5%) were hospitalized. Of those hospitalized, 170 (30.2%) were admitted, and 393 (69.8%) were observed. The mean length of stay for the hospitalized cohort was 3.6 days (SD 6.1 days). We present patient characteristics in Table 1, highlighting key differences between hospitalized and discharged patients, including age, comorbidities, and laboratory results. Differences in patient characteristics in the unmatched vs. matched groups are shown in the Statistical Supplement.

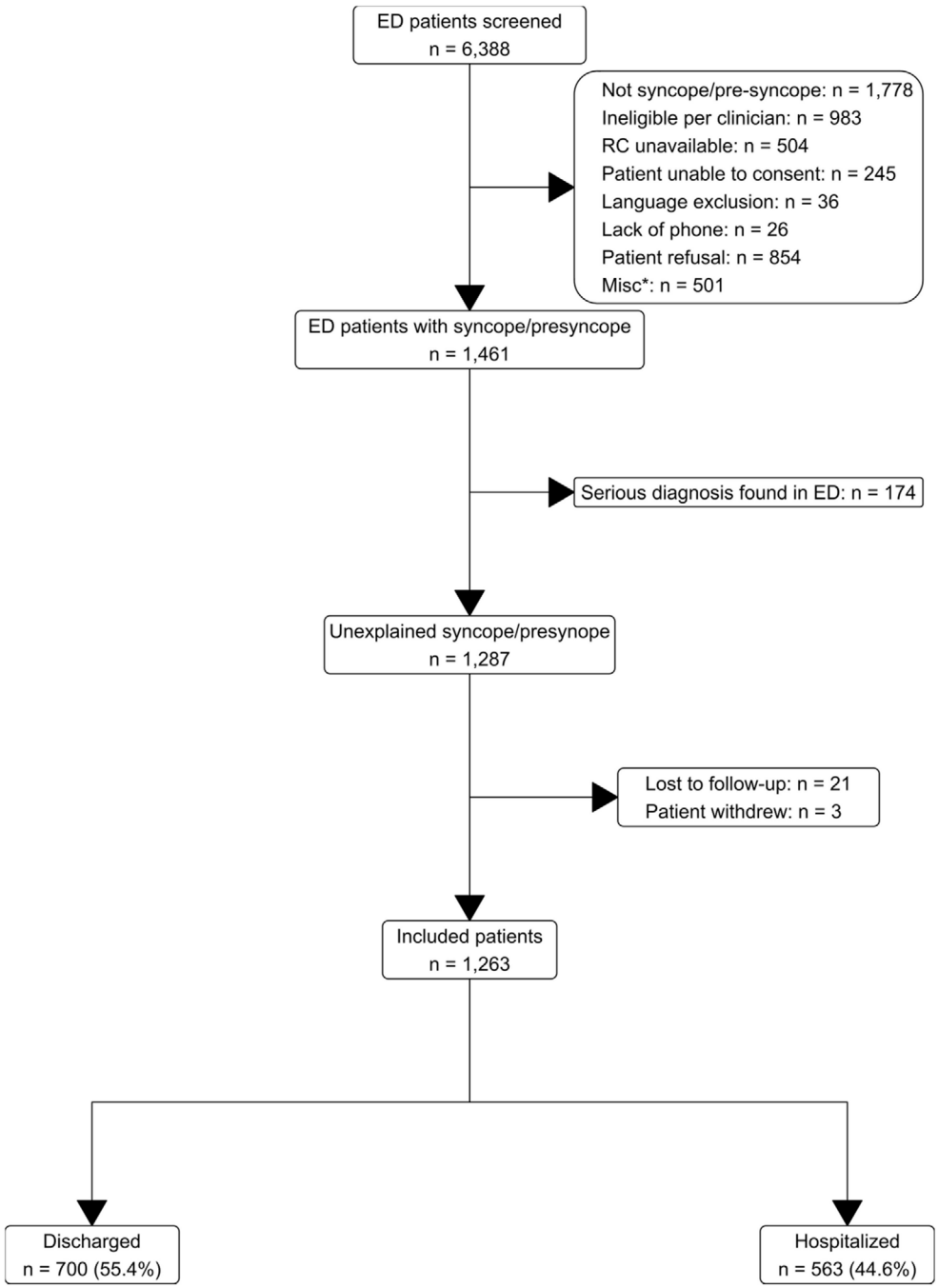

FIGURE 1 | Patient flow diagram. *Misc includes: Blood unable to be obtained $n = 29$, EKG not obtained $n = 7$, LVAD $n = 7$, previously enrolled $n = 6$, provider request $n = 15$, other $n = 437$; RC, responding clinician.

3.2 | Main Results

Among 1263 patients, 74 (5.9%) experienced any SAO within 30 days, including 62 (4.9%) with serious cardiac outcomes. The time to SAO by each ED disposition group is illustrated in Figure 2. Table 2 describes the type and frequency of each SAO by disposition. The most common serious outcome was serious cardiac arrhythmia ($n = 37$; 2.9%), of which symptomatic supraventricular tachycardia was the most frequent ($n = 17$; 1.3%).

After propensity-score adjustment ($N = 1263$ with multiply imputed biomarker results), Bayesian logistic regression showed a significant increase in diagnostic yield (OR 3.70 [95% CrI 1.85–6.82]) in the hospitalized cohort compared to the discharged group (Table 3). Hospitalization was associated with a shorter time to diagnosis after propensity-score matching ($N = 786$), with an HR of 12.43 (95% CI 2.94–52.48) (Table 4). For hospitalized patients with SAO during index admission ($n = 45$), mean time to SAO was 3.8 days.

We found a significant interaction between FAINT score categorization (low versus non-low) and ED disposition (hospitalized versus discharged). Among low-risk patients (FAINT = 0), there was no difference in diagnostic yield between hospitalized and discharged patients (OR: 1.57, 95% CI 0.14–17.53). Among non-low risk patients (FAINT ≥ 1), hospitalization was

TABLE 1 | Characteristics of subjects presenting to the ED by disposition.

Characteristic	Overall $n = 1263$[a]	Discharged $n = 700$[a]	Hospitalized $n = 563$[a]
Age			
Mean (SD)	64.8 (13.1)	61.8 (13.1)	68.5 (12.0)
Median (Q1, Q3)	66.0 (55.0,74.0)	61.0 (51.0,71.0)	70.0 (59.0,77.0)
Age Category			
40 to < 50	183 (14.5%)	144 (20.6%)	39 (6.9%)
50 to < 60	272 (21.5%)	170 (24.3%)	102 (18.1%)
60 to < 70	311 (24.6%)	176 (25.1%)	135 (24.0%)
70 to < 80	325 (25.7%)	141 (20.1%)	184 (32.7%)
80 to < 90	146 (11.6%)	59 (8.4%)	87 (15.5%)
90+	26 (2.1%)	10 (1.4%)	16 (2.8%)
Sex			
Male	587 (46.5%)	292 (41.7%)	295 (52.4%)
Female	676 (53.5%)	408 (58.3%)	268 (47.6%)
Hispanic/Latino Ethnicity	455 (36.0%)	297 (42.4%)	158 (28.1%)
Race			
Asian/PI/AI	30 (2.4%)	19 (2.7%)	11 (2.0%)
Black/African-American	283 (22.4%)	148 (21.1%)	135 (24.0%)
Multiracial	45 (3.6%)	30 (4.3%)	15 (2.7%)
Other	367 (29.1%)	237 (33.9%)	130 (23.1%)
White/Caucasian	538 (42.6%)	266 (38.0%)	272 (48.3%)
Eligible Complaint			
Syncope	721 (57.1%)	364 (52.0%)	357 (63.4%)
Presyncope	542 (42.9%)	336 (48.0%)	206 (36.6%)
Hypertension	852 (67.5%)	416 (59.4%)	436 (77.4%)
Heart Failure	144 (11.4%)	39 (5.6%)	105 (18.7%)
Coronary Artery Disease	243 (19.2%)	81 (11.6%)	162 (28.8%)
Arrhythmia	217 (17.2%)	86 (12.3%)	131 (23.3%)
Diabetes	363 (28.7%)	153 (21.9%)	210 (37.3%)
Valvular Heart Disease	242 (19.2%)	100 (14.3%)	142 (25.2%)
Dyspnea (Shortness of Breath)	296 (23.4%)	159 (22.7%)	137 (24.3%)
Chest Discomfort/Pain	198 (15.7%)	108 (15.4%)	90 (16.0%)
Hypotension (SBP < 80 mmHg)	42 (3.3%)	12 (1.7%)	30 (5.3%)
Abnormal ECG	750 (59.4%)	352 (50.3%)	398 (70.7%)
Creatinine (mg/dL)			
Mean (SD)	1.2 (1.1)	1.1 (1.0)	1.4 (1.3)
Median (Q1, Q3)	1.0 (0.8,1.3)	0.9 (0.7,1.1)	1.1 (0.9,1.5)
Missing	17	16	1
log Creatinine (mg/dl)			
Mean (SD)	0.1 (0.5)	−0.1 (0.4)	0.2 (0.5)
Median (Q1, Q3)	0.0 (−0.3,0.3)	−0.1 (−0.3,0.1)	0.1 (−0.2,0.4)
Missing	17	16	1
NT-proBNP (pg/mL)			
Mean (SD)	550.0 (2042.1)	256.6 (985.1)	909.3 (2803.9)
Median (Q1, Q3)	111.2 (39.6320.5)	74.5 (22.1192.0)	211.3 (63.6653.0)
Missing	33	23	10

(Continues)

TABLE 1 | (Continued)

Characteristic	Overall $n = 1263$[a]	Discharged $n = 700$[a]	Hospitalized $n = 563$[a]
log NT-proBNP (pg/ml)			
Mean (SD)	4.8 (1.6)	4.4 (1.4)	5.3 (1.7)
Median (Q1, Q3)	4.7 (3.7,5.8)	4.3 (3.1,5.3)	5.4 (4.2,6.5)
Missing	33	23	10
NT-proBNP > 125 pg/mL	577 (46.9%)	242 (35.7%)	335 (60.6%)
Missing	33	23	10
HS-Troponin T (ng/L)			
Mean (SD)	16.4 (26.5)	11.5 (19.6)	22.3 (32.1)
Median (Q1, Q3)	9.5 (3.0,17.4)	7.6 (3.0,12.0)	13.5 (7.9,25.3)
Missing	43	25	18
log HS-Troponin T (ng/l)			
Mean (SD)	2.3 (0.9)	2.0 (0.8)	2.6 (0.9)
Median (Q1, Q3)	2.3 (1.1,2.9)	2.0 (1.1,2.5)	2.6 (2.1,3.2)
Missing	43	25	18
HS-Troponin T > 19 ng/L	272 (22.3%)	77 (11.4%)	195 (35.8%)
Missing	43	25	18
Hospital Length of Stay (days)			
Mean (SD)	—	—	3.6 (6.1)
Median (Q1, Q3)	—	—	1.9 (1.0,4.0)
Missing	—	—	1

[a]n (%).

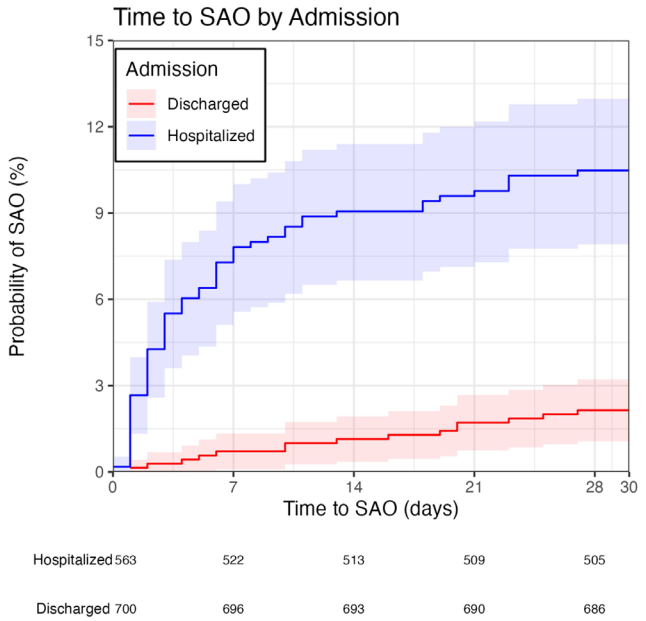

FIGURE 2 | Time to any serious adverse outcome stratified by ED disposition.

associated with greater odds of detecting an SAO (OR: 3.35, 95% CI 1.78–6.31).

4 | Limitations

Our study is subject to certain limitations. Most of our participants were recruited from urban academic EDs; thus, our results may not generalize to patients presenting to community or non-urban EDs. In addition, because of our observational non-randomized study design, unmeasured confounders may have introduced bias. We attempted to mitigate this limitation by using propensity score adjustment to account for numerous clinical variables. However, residual unmeasured confounding that reflects important differences between patient populations may remain, affecting our results. Since a large proportion of patients declined to participate, sampling bias may have occurred. Standardized protocols were not used to guide clinical care for patients in the ED or the hospital. Thus, variation across sites may have occurred. Since we enrolled only patients aged 40 years or older, our findings may not be generalizable to younger patients with syncope.

5 | Discussion

Our results, using a Bayesian propensity score-adjusted logistic regression and a Cox regression model in a matched sample, suggest that among adults aged 40 and above who present to the ED with syncope or presyncope and without a serious diagnosis identified in the ED, hospitalization is associated with a significant increase in detection of SAOs as well as earlier detection of those events. Overall, these findings challenge the notion that hospitalization solely for the purpose of additional monitoring or testing beyond that conducted in the ED is of no value in adults with unexplained presyncope and syncope. The findings from our subgroup analysis of patients deemed low risk by the FAINT score suggest that the incremental diagnostic yield of hospitalizing these patients is negligible, supporting the recommendation of ED discharge for this

TABLE 2 | All serious adverse outcomes at 30 days by disposition.

Characteristic	Overall $n = 1263$[a]	Discharged $n = 700$[a]	Hospitalized $n = 563$[a]	
			During Index Admission	Post Index Admission
Any 30-day SAO	74 (5.9%)	15 (2.1%)	45 (8.0%)	14 (2.5%)
Any 30-day SCO	62 (4.9%)	11 (1.6%)	51 (9.1%)	51 (9.1%)
30-day death	5 (0.4%)	1 (0.1%)	2 (0.4%)	2 (0.4%)
Arrhythmia	37 (2.9%)	5 (0.7%)	23 (4.1%)	9 (1.6%)
Symptomatic supraventricular tachycardia	17	2	9	6
Sick sinus syndrome/pause > 3 s	7	2	3	2
Symptomatic bradycardia	5	0	5	0
Symptomatic ventricular tachycardia (< 30 s)	5	1	4	0
Ventricular tachycardia (> 30 s)	2	0	2	0
Ventricular fibrillation	0	0	0	0
Mobitz type II atrioventricular heart block	1	0	0	1
Myocardial Infarction	3 (0.2%)	1 (0.1%)	1 (0.2%)	1 (0.2%)
Myocarditis	1 (0.1%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Cardiac Intervention	29 (2.3%)	5 (0.7%)	21 (3.7%)	3 (0.5%)
Pacemaker	14	2	10	2
AICD	5	0	5	0
CABG	2	1	1	0
PTCA	2	1	1	0
Other Cardiac Intervention[b]	6	1	4	1
New diagnosis of structural heart disease	2 (0.2%)	1 (0.1%)	1 (0.2%)	0 (0.0%)
Stroke	1 (0.1%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Pulmonary Embolism	2 (0.2%)	0 (0.0%)	1 (0.2%)	1 (0.2%)
CPR	1 (0.1%)	0 (0.0%)	1 (0.2%)	0 (0.0%)
Internal hemorrhage/anemia requiring transfusion	5 (0.4%)	1 (0.1%)	4 (0.7%)	0 (0.0%)
Sepsis	5 (0.4%)	4 (0.6%)	1 (0.2%)	0 (0.0%)

[a]n (%).
[b]4 aortic valve surgeries, 1 electrical cardioversion, 1 left atrial mass excision.

subset. Among patients with a FAINT score ≥1, hospitalization was associated with a higher diagnostic yield.

Our findings align with and extend prior investigations of syncope management strategies. Consistent with secondary analysis of data from the Canadian Syncope Risk Score studies, we observed that a substantial proportion of patients with unexplained syncope in the ED were more likely to have an SAO identified if they were hospitalized during their index visit [26]. Our study also suggests that hospitalization provides diagnostic value beyond ED evaluation alone. This contrasts with some prior work suggesting low yield from routine hospitalization, though methodological differences may explain this discrepancy [27]. Notably, the EDOSP study focused primarily on identifying which patients could be safely discharged rather than on quantifying the incremental benefit of hospital admission [6, 7]. Our results also stand in contrast with a prior study from a US cohort of older adults with presyncope or syncope, which found no difference in serious adverse events at 30 days after propensity-score matching [28].

Healthcare payers have historically scrutinized short-stay hospitalizations for syncope and collapse, particularly targeting diagnosis-related group 312 for audit activity over the past two decades [29].

TABLE 3 | Bayesian logistic regression on any serious adverse event at 30 days.

Characteristic	Unadjusted	PS-adjusted	Fully-adjusted
Hospitalized	3.74 (2.07,6.43)	3.70 (1.85,6.82)	3.71 (1.95,6.56)
Logit PS		1.50 (1.18,1.89)	
Log BNP			1.33 (1.06,1.67)
Log Troponin			1.07 (0.70,1.55)
Log Creatinine			0.76 (0.38,1.36)
Heart Failure			0.70 (0.32,1.32)
Arrhythmia			1.99 (1.08,3.36)
Abnormal ECG			1.34 (0.69,2.41)
Age (10 Year Change)			1.14 (0.89,1.44)
Male			1.40 (0.79,2.30)
Syncope			0.74 (0.42,1.19)
Hispanic/Latino Ethnicity			0.53 (0.21,1.08)
Race			
Race-White			Reference
Race-Black			1.05 (0.50,1.91)
Race-Asian			0.62 (0.09,1.99)
Race-Multiracial			1.02 (0.17,3.13)
Race-Other			2.38 (0.97,4.96)
Site			
Site-Columbia			Reference
Site-Rochester			1.29 (0.60,2.43)
Site-Vanderbilt			1.33 (0.58,2.65)
Site-UC Davis			1.01 (0.31,2.36)
Site-Mount Sinai			2.12 (0.81,4.44)
Site-Allen			0.78 (0.15,2.18)
Hypertension			1.27 (0.63,2.35)
Hypotension			0.95 (0.25,2.32)
Coronary Artery Disease			1.38 (0.74,2.35)
Diabetes			0.71 (0.38,1.20)
Valvular Heart Disease			1.12 (0.60,1.89)
Shortness of Breath			0.88 (0.43,1.56)
Chest Pain			1.55 (0.70,2.88)

Note: Posterior odds ratios with 95% Credible Intervals are reported.
Abbreviations: BNP, *N*-terminal pro-brain natriuretic peptide; ECG, electrocardiogram; PS, propensity-score.

This scrutiny intensified during the early 2010s under Medicare's Recovery Audit Contractor (RAC) program, which frequently classified inpatient payments for brief syncope admissions as retrospectively inappropriate and pursued recovery of facility payments, subject to hospital appeal The regulatory landscape shifted in 2013, when the Centers for Medicare & Medicaid Services introduced the "2-midnight rule" to clarify the appropriateness of hospitalization status and subsequently transitioned oversight to Quality Improvement Organizations (QIOs) [30]. While observation status has been promoted as a more efficient alternative to inpatient admission for selected patients, our findings demonstrate that SAOs in this population can occur both within and beyond the 2-midnight observation period [5, 7].

Our propensity score-adjusted analysis provides more robust evidence that hospitalization accelerates diagnosis and increases

TABLE 4 | Cox regressions on time to any serious adverse outcome before and after matching.

Unmatched ($n = 1263$)			
Contrast	**Period**	**HR**	**95% CI**
Hospitalized versus Discharged	In-hospital	20.66	6.28,67.90
Hospitalized versus Discharged	Out-of-hospital	1.44	0.65, 3.15
Matched ($n = 786$)			
Contrast	**Period**	**HR**	**95% CI**
Hospitalized versus Discharged	In-hospital	12.43	2.94,52.48
Hospitalized versus Discharged	Out-of-hospital	0.85	0.33, 2.15

Note: Any SAOs include only events during hospitalization for admitted patients, and all SAOs for discharged patients. Hospitalized patients are censored at the end of the hospital stay, while discharged subjects are censored at 30 days. This analysis adjusts for hospitalization (in-hospital vs. out-of-hospital, with in-hospital as the reference) as a time-varying covariate and includes an interaction term between the hospitalized vs. discharged group indicator and hospitalization. Matching with elevated BNP and elevated troponin; missing values assumed to be negative.
Abbreviation: HR, hazard ratio.

detection of SAOs, particularly cardiac arrhythmias that may be intermittent and require continuous monitoring to capture. The emergence of remote monitoring technologies and wearable devices presents both opportunities and challenges for the future management of patients with syncope [31]. As the cost and performance of ambulatory cardiac monitors continue to improve, they may offer an intermediate option between inpatient hospitalization and traditional outpatient follow-up for select patients. For patients with concern for recurrent transient arrhythmias, prolonged outpatient monitoring with patch-based or implantable loop recorders may provide a diagnostic yield comparable to hospitalization while avoiding the iatrogenic risks and costs of admission [32]. Admissions for low-risk syncope are associated with iatrogenic harm, including a 13% rate of adverse events e.g., delirium, hypoglycemia, and falls [18]. The average Medicare payment for a syncope-related inpatient admission is over $5500 [33]. However, such an approach requires reliable outpatient follow-up systems, patient compliance with device use, and timely clinician response to detected abnormalities, which may not be universally available and often require close proximity to rescue care if needed. Further research is needed to directly compare the diagnostic yield, cost-effectiveness, and patient outcomes of hospital-based monitoring versus advanced ambulatory monitoring strategies in this population.

For clinicians, these results support the reasonableness of admission decisions for middle-aged and older adults with syncope or presyncope when no dangerous ED diagnosis is made, particularly for patients with elevated cardiac biomarkers, abnormal electrocardiograms, or significant cardiac comorbidities, resulting in an elevated FAINT score. Emergency physicians should consider hospitalization as a diagnostic tool rather than simply a disposition of last resort for these patients. Factors such as physician concern or gestalt, patient frailty, symptom trajectory, access to social supports, functional status, and access to follow-up should be key factors informing the disposition recommendation. For researchers, our study highlights the need for further investigation into cost-effective monitoring strategies, the clinical significance of arrhythmias detected by different surveillance methods, and the development of decision-support tools to optimize resource utilization while maintaining patient safety. For policymakers and health system leaders, these findings underscore the complexity of value-based care decisions in syncope management. While hospitalization carries costs and risks, our results suggest it also provides diagnostic benefits that may justify admission for carefully selected, higher-risk patients.

While our study provides important insights into the diagnostic yield of hospitalization, several questions remain that should guide future research efforts. First, a randomized controlled trial comparing protocolized hospitalization with structured outpatient management, including advanced monitoring, would provide the highest level of evidence regarding optimal management strategies. Second, studies examining longer-term outcomes beyond 30 days are needed to determine whether earlier diagnosis through hospitalization translates into improved clinical outcomes or enhanced quality of life. Third, cost-effectiveness analyses comparing different monitoring strategies (e.g., inpatient telemetry, observation unit stays, ambulatory patch monitors, implantable loop recorders, and smartwatch-based detection) would help guide resource allocation decisions [34]. Finally, an investigation of patient-centered outcomes, such as anxiety, satisfaction, and functional status, may reveal important considerations beyond purely diagnostic yield [35].

6 | Conclusions

In this secondary analysis of a prospective, multicenter observational study of adults aged 40 years and older presenting to the ED with syncope or presyncope without a serious ED diagnosis, we found that hospitalization was associated with a higher short-term diagnostic yield for SAO and a shorter time to diagnosis after propensity-score adjustment. Our findings suggest that for select, higher-risk patients in this age group with unexplained syncope or presyncope, hospitalization can provide meaningful diagnostic value beyond ED evaluation alone. Future studies should also examine whether earlier diagnosis through hospitalization is associated with improved long-term clinical outcomes and quality of life. Efforts to reduce potentially avoidable hospitalizations should account for the incremental diagnostic value that inpatient monitoring may provide, and policies should support the development of alternative monitoring strategies, such as ambulatory cardiac monitoring, that can deliver similar benefits while minimizing the iatrogenic harm and costs associated with inpatient admission.

Author Contributions

C.W.B.: writing – original draft (lead); formal analysis (supporting); visualization (supporting). M.A.P.: conceptualization (lead); funding acquisition (lead); supervision (lead); investigation (lead); formal analysis (supporting); writing (supporting). C.W., R.E.W.: formal analysis (lead), visualization (lead). J.D., D.K.N., D.L.S., J.S, A.B.S., N.W.: investigation (equal), administration (equal), study administration, including data

collection and cleaning. C.W.B., and all authors: writing – review and editing (equal).

Funding

Research reported in this publication was supported by the National Heart, Lung, and Blood Institute of the National Institutes of Health under award R01HL149680. The content is solely the responsibility of the authors and does not necessarily represent the official views of the National Institutes of Health.

Data Availability Statement

A fully de-identified dataset will be available upon request to qualified individuals within the medical and scientific community, pending publication of the main findings of the PACES study.

References

1. M. A. Probst, H. K. Kanzaria, M. Gbedemah, L. D. Richardson, and B. C. Sun, "National Trends in Resource Utilization Associated With ED Visits for Syncope," *American Journal of Emergency Medicine* 33, no. 8 (2015): 998–1001.

2. K. N. Almulhim, "The Characteristics of Syncope-Related Emergency Department Visits: Resource Utilization and Admission Rate Patterns in Emergency Departments," *Cureus* 14, no. 2 (2022): e22039.

3. M. Ruzieh, C. Bai, S. E. Kimmel, et al., "Trends in Syncope Testing and Admissions in the USA From 2006 Through 2019," *Clinical Autonomic Research* 35, no. 2 (2025): 315–325.

4. B. C. Sun, J. A. Emond, and C. Carlos A, Jr., "Direct Medical Costs of Syncope-Related Hospitalizations in the United States," *American Journal of Cardiology* 95, no. 5 (2005): 668–671.

5. C. W. Baugh, L. J. Liang, M. A. Probst, and B. C. Sun, "National Cost Savings From Observation Unit Management of Syncope," *Academic Emergency Medicine: Official Journal of the Society for Academic Emergency Medicine* 22, no. 8 (2015): 934–941.

6. W. K. Shen, R. S. Sheldon, D. G. Benditt, et al., "2017 ACC/AHA/HRS Guideline for the Evaluation and Management of Patients With Syncope: Executive Summary: A Report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society," *Circulation* 136, no. 5 (2017): e25–e59.

7. B. C. Sun, H. McCreath, L. J. Liang, et al., "Randomized Clinical Trial of an Emergency Department Observation Syncope Protocol Versus Routine Inpatient Admission," *Annals of Emergency Medicine* 64, no. 2 (2014): 167–175.

8. R. Allen, d S. IS, A. Wakai, et al., "Hospitalize or Discharge the Emergency Department Patient With Syncope? A Systematic Review and Meta-Analysis of Direct Evidence for SAEM GRACE," *Academic Emergency Medicine* 33, no. 1 (2026): e15111.

9. D. J. Pallin, M. B. Allen, J. A. Espinola, C. A. Camargo, Jr., and J. S. Bohan, "Population Aging and Emergency Departments: Visits Will Not Increase, Lengths-Of-Stay and Hospitalizations Will," *Health Affairs* 32, no. 7 (2013): 1306–1312.

10. M. Solbiati, R. Sheldon, and C. Seifer, "Managing Syncope in the Elderly: The Not so Simple Faint in Aging Patients," *Canadian Journal of Cardiology* 32, no. 9 (2016): 1124–1131.

11. M. L. Mendu, G. McAvay, R. Lampert, J. Stoehr, and M. E. Tinetti, "Yield of Diagnostic Tests in Evaluating Syncopal Episodes in Older Patients," *Archives of Internal Medicine* 169, no. 14 (2009): 1299–1305.

12. V. Thiruganasambandamoorthy, K. Kwong, G. A. Wells, et al., "Development of the Canadian Syncope Risk Score to Predict Serious Adverse Events After Emergency Department Assessment of Syncope," *CMAJ* 188, no. 12 (2016): E289–E298.

13. M. A. Probst, T. Gibson, R. E. Weiss, et al., "Risk Stratification of Older Adults Who Present to the Emergency Department With Syncope: The FAINT Score," *Annals of Emergency Medicine* 75, no. 2 (2020): 147–158.

14. S. A. Grossman, C. Fischer, L. A. Lipsitz, et al., "Predicting Adverse Outcomes in Syncope," *Journal of Emergency Medicine* 33, no. 3 (2007): 233–239.

15. A. J. Mazzella, B. S. Wood, J. Doad, M. J. Hendrickson, L. Rosman, and A. K. Gehi, "Interhospital Variability in Hospital Admissions for Patients With Low-Risk Syncope Presenting to the Emergency Department," *Heart Rhythm O2* 5, no. 7 (2024): 435–442.

16. C. Morley, M. Unwin, G. M. Peterson, J. Stankovich, and L. Kinsman, "Emergency Department Crowding: A Systematic Review of Causes, Consequences and Solutions," *PLoS One* 13, no. 8 (2018): e0203316.

17. S. L. Bernstein, D. Aronsky, R. Duseja, et al., "The Effect of Emergency Department Crowding on Clinically Oriented Outcomes," *Academic Emergency Medicine* 16, no. 1 (2009): 1–10.

18. J. V. Canzoniero, E. Afshar, H. Hedian, C. Koch, and D. J. Morgan, "Unnecessary Hospitalization and Related Harm for Patients With Low-Risk Syncope," *JAMA Internal Medicine* 175, no. 6 (2015): 1065–1067.

19. E. H. Suh, C. Winskill, D. L. Sacco, et al., "Validation of 2 Syncope Risk Scores and Comparison With Physician Risk Estimation," *JAMA Network Open* 9, no. 5 (2026): e2617362.

20. B. C. Sun, J. A. Emond, and C. Carlos A, Jr., "Characteristics and Admission Patterns of Patients Presenting With Syncope to u.s. Emergency Departments, 1992-2000," *Academic Emergency Medicine* 11, no. 10 (2004): 1029–1034.

21. B. C. Sun, J. R. Hoffman, C. M. Mangione, and W. R. Mower, "Older Age Predicts Short-Term, Serious Events After Syncope," *Journal of the American Geriatrics Society* 55, no. 6 (2007): 907–912.

22. N. Colman, K. Nahm, K. S. Ganzeboom, et al., "Epidemiology of Reflex Syncope," *Clinical Autonomic Research* 14, no. Suppl 1 (2004): 9–17.

23. P. A. Harris, R. Taylor, B. L. Minor, et al., "The REDCap Consortium: Building an International Community of Software Platform Partners," *Journal of Biomedical Informatics* 95 (2019): 103208.

24. J. L. Schafer, *Analysis of Incomplete Multivariate Data*, 1st ed. (Chapman and Hall/CRC, 1997).

25. Team RC, R Foundation for Statistical Computing, "R: A language and environment for statistical computing," (2020), https://www.r-project.org/.

26. R. J. Krishnan, M. Mukarram, B. Ghaedi, et al., "Benefit of Hospital Admission for Detecting Serious Adverse Events Among Emergency Department Patients With Syncope: A Propensity-Score-Matched Analysis of a Multicentre Prospective Cohort," *CMAJ* 192, no. 41 (2020): E1198–E1205.

27. P. Kaul, D. T. Tran, R. K. Sandhu, M. Solbiati, G. Costantino, and R. S. Sheldon, "Lack of Benefit From Hospitalization in Patients With Syncope: A Propensity Analysis," *J Am Coll Emerg Physicians Open* 1, no. 5 (2020): 716–722.

28. M. A. Probst, E. Su, R. E. Weiss, et al., "Clinical Benefit of Hospitalization for Older Adults With Unexplained Syncope: A Propensity-Matched Analysis," *Annals of Emergency Medicine* 74, no. 2 (2019): 260–269.

29. American Hospital A, "Exploring the Impact of the RAC Program on Hospitals Nationwide," (2013), Exploring the Impact of the RAC Program on Hospitals Nationwide.

30. Center for M, Medicaid S, "Frequently Asked Questions: 2 Midnight Inpatient Admission Guidance & Patient Status Reviews for Admissions," (2013), http://www.cms.gov/Research-Statistics-Data-and-Systems/Monitoring-Programs/Medical-Review/Downloads/QAsforWebsitePosting_110413-v2-CLEAN.pdf.

31. M. V. Perez, K. W. Mahaffey, H. Hedlin, et al., "Large-Scale Assessment of a Smartwatch to Identify Atrial Fibrillation," *New England Journal of Medicine* 381, no. 20 (2019): 1909–1917.

32. N. Edvardsson, V. Frykman, R. van Mechelen, et al., "Use of an Implantable Loop Recorder to Increase the Diagnostic Yield in Unexplained Syncope: Results From the PICTURE Registry," *Europace* 13, no. 2 (2011): 262–269.

33. M. A. Probst, J. K. McConnell, R. E. Weiss, et al., "Estimating the Cost of Care for Emergency Department Syncope Patients: Comparison of Three Models," *Western Journal of Emergency Medicine* 18, no. 2 (2017): 253–257.

34. M. R. Reynolds, R. Passman, J. Swindle, et al., "Comparative Effectiveness and Healthcare Utilization for Ambulatory Cardiac Monitoring Strategies in Medicare Beneficiaries," *American Heart Journal* 269 (2024): 25–34.

35. M. A. Probst, P. A. Noseworthy, J. P. Brito, and E. P. Hess, "Shared Decision-Making as the Future of Emergency Cardiology," *Canadian Journal of Cardiology* 34, no. 2 (2018): 117–124.

Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Table S1:** Breakdown of patient enrollment by site, stratified by ED disposition; NYP: New York-Presbyterian, UC: University of California. **Table S2:** Logistic regression on being hospitalized vs. discharged (reference), for propensity score calculation; posterior odds ratios with 95% Credible Intervals are reported; BNP=*N*-terminal pro-brain natriuretic peptide, ECG = electrocardiogram. **Figure S1:** Love plot showing differences in covariates between hospitalized and discharged patients used in propensity score matching in unmatched ($N = 1263$) and matched analysis ($N = 786$) for Cox regression.