HEALTH CARE REFORM

Yield of Diagnostic Tests in Evaluating Syncopal Episodes in Older Patients

Mallika L. Mendu, MD; Gail McAvay, PhD; Rachel Lampert, MD; Jonathan Stoehr, MD; Mary E. Tinetti, MD

Background: Syncopal episodes are common among older adults; etiologies range from benign to life threatening. We determined the frequency, yield, and costs of tests obtained to evaluate older persons with syncope. We also calculated the cost per test yield and determined whether the San Francisco syncope rule (SFSR) improved test yield.

Methods: Review of 2106 consecutive patients 65 years or older admitted following a syncopal episode.

Results: Electrocardiograms (in 99% of admissions), telemetry (in 95%), cardiac enzyme tests (in 95%), and head computed tomographic (CT) scans (in 63%) were the most frequently obtained tests. Results from cardiac enzymes tests, CT scans, echocardiography, carotid ultrasonography, and electroencephalography all affected diagnosis or management in less than 5% of cases and helped determine the etiology of syncope less than 2% of the time. Postural blood pressure (BP) recording, performed in only 38% of episodes, had the highest yield with respect to affecting diagnosis (18%-26%) or management (25%-30%) and determining etiology of the syncopal episode (15%-21%). The cost per test affecting diagnosis or management was highest for electroencephalography ($32 973), CT scans ($24 881), and cardiac enzymes test ($22 397) and lowest for postural BP recording ($17-$20). The yields and costs for cardiac tests were better among patients meeting, vs those not meeting, the SFSR. For example, the cost per cardiac enzymes test affecting diagnosis or management was $10 331 in those meeting, vs $111 518 in those not meeting, the SFSR.

Conclusions: Many unnecessary tests are obtained to evaluate syncope. Selecting tests based on history and examination and prioritizing less expensive and higher yield tests would ensure a more informed and cost-effective approach to evaluating older patients with syncope.

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SYNCOPE, DEFINED AS THE SUDden, transient loss of consciousness with spontaneous recovery, accounts for 1% to 3% of emergency department visits and up to 6% of hospital admissions.[1,2] Older patients present more often with syncope, have higher rates of hospitalization, and have greater morbidity than younger patients.[3] Evaluation of older patients following a syncopal episode is challenging because there is a wide spectrum of possible etiologies, ranging from benign to life-threatening conditions.[4] Because of the varied causes of syncope, clinicians may pursue a range of diagnostic investigations. Despite thorough evaluations, however, the etiology of syncope frequently remains undetermined.[5,6]

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Several authors[7,8] have suggested schemes for evaluating syncope, based primarily on expert consensus rather than empirical evidence. Studies[9-13] have attempted to reduce unnecessary testing by the use of algorithms to improve syncope evaluation methods. The algorithms increased the percentage of patients in whom an etiology was identified but did not decrease the use of low-yield testing or reduce the cost associated with diagnostic testing. The few studies[14,15] examining the utility of individual tests found that cardiac enzymes test, electroencephalography (EEG),[16] head computed tomographic (CT) scan,[17] and carotid ultrasonography (US)[18] seldom identified the etiology. Neurological testing was less useful diagnostically than cardiac testing in 1 study.[19] The contribution of magnetic resonance imaging (MRI), echocardiogram, telemetry, and other tests remains unknown, as does cost of tests rela-

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Author Affiliations: Departments of Internal Medicine (Dr Mendu), Internal Medicine (Drs McAvay, Lampert, Stoehr, and Tinetti), and Epidemiology and Public Health (Dr Tinetti), Yale University School of Medicine, New Haven, Connecticut.

tive to their effect on diagnosis or management. Also unclear is whether the yield and cost-effectiveness of evaluation can be improved by identifying older adults presenting with syncope in whom test results are likely to affect diagnosis or management. Patient characteristics such as those used in the San Francisco syncope rule (SFSR)[20] may serve this latter purpose. The SFSR was developed to improve prediction of the likelihood of serious outcomes in patients presenting with syncope and has been prospectively validated for this purpose.[21]

We determined how often diagnostic tests were obtained to evaluate older persons presenting with syncope and whether these tests helped establish the etiology of the syncopal episode or affected diagnosis or management. We also calculated the cost per test that affected diagnosis or management. Finally, we examined whether the SFSR was associated with the likelihood of test results affecting diagnosis or management.

METHODS

STUDY DESIGN AND POPULATION

The study included all patients 65 years or older admitted to an acute care hospital, after presentation to the emergency department, from July 1, 2002, to December 31, 2006, with an admission or discharge diagnosis of syncope. Patients were identified based on the presence of an *International Classification of Diseases, Ninth Revision, Clinical Modification* (*ICD-9-CM*) code of 780.2 as a primary or nonprimary diagnosis in the hospital billing records. Up to 10 diagnoses are listed, enhancing the likelihood that patients with syncope were identified. Based on review of the medical records, all patients with presumed loss of consciousness were included. Patients in whom absence of loss of consciousness (eg, near-syncope) was documented were excluded. The study was approved by the institutional review board of the Yale University School of Medicine (New Haven, Connecticut). Consent was not obtained from participants because we reviewed existing data; in accordance with federal guidelines, no subject identifiers were included in the data collected.

Medical records from 2209 admissions in 2009 patients were reviewed. We excluded 103 admissions because of the complete absence of laboratory data, imaging, electronic medical record, or paper medical chart. Admissions were included if partial data were available; there were 2106 admissions included for 1920 patients.

DATA COLLECTION

For each admission, emergency department, inpatient admission, and progress notes; discharge summaries; and laboratory and imaging data were abstracted. We used methods recommended to ensure the validity and reliability of data collected, including a standardized abstraction form, precisely defined variables and criteria, and a pilot study of 60 medical charts to refine criteria.[22]

Data collected included patient age and sex; dates of admission and discharge; whether presumed loss of consciousness was documented in the medical record and whether the episode was witnessed; symptoms and activity at the time of the episode; health conditions; cardiac and neurological examination findings; postural blood pressure (BP) recordings; and cardiac enzymes test. Reported etiology of the syncopal episodes was ascertained from the discharge summary. If no etiology was reported in the discharge summary, then progress note documentation was used. Results of electrocardiogram, echocardiogram, head CT scans, carotid US, stress testing, head MRI scans, and EEG were abstracted from the test reports and progress notes.

A second reviewer blindly abstracted a random sample of 40 admissions. To measure interrater agreement, we used the prevalence-adjusted, bias-adjusted κ statistic,[23,24] and the mean (SD) was 87% (20%) for the diagnostic test variables.

CRITERIA FOR DEFINING RESULTS OF DIAGNOSTIC TESTS

An abnormal finding for imaging was defined as any abnormality, no matter how minor, not seen on prior testing as written in the test reports (for example, mild mitral valve regurgitation on echocardiogram and mild slowing on EEG). If no mention was made of prior testing, the result was assumed to be new. Abnormal cardiac enzyme results were defined as any troponin I level greater than 0.05 ng/mL (the hospital's reference value; to convert to micrograms per liter, multiply by 1.0). For postural BP, recordings were documented based on position (changing from lying to sitting, lying to standing, or lying to sitting to standing). Postural BP was defined using 2 sets of criteria, "strict" and "loose." The strict criteria for postural hypotension was a drop in systolic BP of at least 20 mm Hg, or a drop in diastolic BP of at least 10 mm Hg while changing from a lying position to a standing position.[25] The loose criteria for postural hypotension was a drop in systolic or diastolic BP of at least 10 mm Hg or a systolic BP drop to 90 mm Hg or lower while changing from a lying position to a sitting or standing position. This definition incorporated the variability in methods used to assess BP changes and the wide range of definitions used in the literature, particularly for older patients.[26-28]

A test result was considered to have affected diagnosis or management if it was noted in any test reports, progress notes, or discharge summaries that the test had contributed to, confirmed, or established any diagnosis or management decisions. This definition included documentation of negative and positive test results and all diagnoses, including those not related to syncope. We also recorded whether it was documented anywhere in the medical record that a test result had helped determine the etiology of the syncopal episode. Examples of a test affecting diagnosis included an electrocardiogram identifying atrial fibrillation and postural BP recordings identifying postural hypotension. Examples of a test affecting management included an electrocardiogram resulting in the management of atrial fibrillation with anticoagulation and β-blockers and postural BP recordings resulting in the management of postural hypotension with hydration. The criteria detailed herein for test results were defined independently such that a test result could be abnormal but not considered to have affected diagnosis or management or vice versa. Patients were considered to have met the SFSR criteria if they had a history of congestive heart failure, a hematocrit level lower than 30%, abnormal results from an electrocardiogram, shortness of breath, or systolic BP lower than 90 mm Hg at presentation.[20]

COST CALCULATIONS

Standard billing charges for this hospital were used to calculate the charge per test. For imaging and electrocardiography, this included professional fees associated with interpretation. Similar to the method used in other studies, we converted billing charges to costs by multiplying charges by the hospital's cost to charge ratio[29,30] because the hospital calculates costs based on a patient's admission rather than on individual tests or services provided. A cost to charge ratio for a given hospital is determined by dividing the cost incurred to the hospital for an admission divided by the amount charged to an admitted patient. A cost to

charge ratio of 0.34 was used based on this hospital's cost to charge ratio from the State of Connecticut's Annual Report on the Financial Status of Connecticut's Acute Care Hospitals for Fiscal Year 2007.[31] This ratio was similar to the cost to charge ratio of 0.35 for patients with syncope admitted during the study period. The cost for telemetry was estimated as the difference in cost between a monitored bed and an unmonitored bed. For postural BP, we estimated $5 per test, assuming that it required 5 minutes at a nurse's wage of $60 per hour, the highest nursing salary on a medicine service. Nurses most often obtain postural BP recordings at this hospital. We defined the cost per test affecting diagnosis or management as the cost per test multiplied by the number of tests obtained divided by the number of test results that affected diagnosis or management.

STATISTICAL ANALYSIS

Statistical analysis was performed using SAS software (version 9.1; SAS Inc, Cary, North Carolina). Yields were reported as percentages. Denominators were the number of tests obtained, and the numerators were the number of tests in which findings were abnormal, affected diagnosis, affected management, or helped determine the etiology of the syncopal episode. We stratified patients into those meeting or not meeting SFSR criteria to compare test results and cost per test affecting diagnosis or management. The Fisher exact test was used to compare test results in patients meeting and patients not meeting the SFSR. A 2-sided *t* test *P* value of $<.05$ was used to indicate statistical significance.

RESULTS

Characteristics of the 1920 patients are presented in **Table 1**. Their mean (SD) age was 79.3 (7.9) years; 53% were female. A total of 163 patients (8.5%) had had 2 or more admissions for syncope during the 4½-year period, resulting in 2106 admissions. The most common preexisting health conditions included hypertension (66%), hyperlipidemia (32%), and coronary artery disease (32%). The most commonly reported etiologies were vasovagal and orthostatic hypotension. For 47% of episodes, the etiology was reported as unknown or not reported in the medical records. Ninety percent of admissions were to a general internal medicine service, 6% to a cardiology service, and 3% to neurology. We did not find any important differences in testing between patients admitted to the different services.

The frequencies of tests obtained, abnormal findings, and yields are shown in **Table 2**. The most frequently obtained tests were electrocardiogram (99% of admissions), telemetry (95%), and cardiac enzymes test (95%). Only 5% of patients admitted had abnormal values for cardiac enzymes, defined as any elevation in troponin I level. Echocardiograms had the highest frequency of abnormal findings (63%); most of these were minor structural changes, such as mild mitral valve regurgitation. Only 2% of echocardiograms revealed findings, most often aortic stenosis, reported to have contributed to the syncopal episode. Similarly, for electrocardiograms and telemetry, most findings were minor, such as premature ventricular contractions. Telemetry results helped determine the etiology, such as atrial fibrillation or bradycardia, for 5% of syncopal episodes.

Postural BP recording was performed in 38% of patients; only 24% of patients had recordings obtained while changing from a lying to a standing position. Postural BP had the highest yield with respect to affecting diagnosis (18% using strict criteria) and management (25% using strict criteria) and was the test most frequently reported to have helped determine the etiology of the syncopal episode. The tests with the lowest likelihood of affecting diagnosis or management or determining the etiology of the syncopal episode were head CT scans, carotid US, EEG, and cardiac enzymes test. In the 8 of 9 admissions in which a cardiac enzymes test helped determine the etiology of syncope, abnormal electrocardiogram changes were also noted.

Table 1. Characteristics of Study Patients[a]

Characteristic	No. (%)
Age, mean (SD), y	79.3 (7.9)
Female	1022 (53)
Length of stay, mean (SD), d	3.0 (4.0)
Previous admission for syncope[b]	163 (8.5)
Hypertension	1265 (66)
Hyperlipidemia	666 (32)
Coronary artery disease	607 (32)
Diabetes mellitus	396 (21)
Atrial fibrillation	348 (18)
History of stroke	301 (16)
Dementia	251 (13)
Previous myocardial infarction	171 (9)
Atrial ventricular block	103 (5)
Sick sinus syndrome	67 (4)
Symptoms preceding syncopal episode	
Light-headedness	492 (26)
Chest pain	82 (4)
Mental status change	81 (4)
Symptoms suggestive of stroke[c]	24 (1)
Seizure	9 (0.5)
Physical examination findings	
Abnormalities on cardiovascular examination[b,d]	656 (34)
Neurological deficits on examination[e]	112 (6)
Etiologies for syncopal episodes[f]	
No etiology listed or unknown[f]	980 (47)
Vasovagal	453 (22)
Orthostatic hypotension	282 (13)
Arrhythmia	253 (12)
Dehydration	178 (8)
Other cardiac causes[f]	85 (4)
Situational[f]	68 (3)
>1 Etiology listed	199 (9)

[a] A total of 1920 patients with 2106 admissions.
[b] Previous admission for syncope includes admissions during the 4½-year study period.
[c] Symptoms suggestive of stroke included acute neurological symptoms or signs such as motor deficits and dysarthria, excluding acute mental status changes.
[d] Abnormalities on cardiovascular examination included any of abnormal rate, abnormal rhythm, murmurs, or S3 or S4 heart sounds.
[e] Neurological deficits on examination included any of sensory, motor, cranial nerve, or mental status deficits.
[f] Reported etiology of syncopal episode was ascertained primarily from discharge summary. If no etiology was reported in the discharge summary, then progress note documentation of an etiology was used. The sum of percentages, calculated using a denominator of total number of episodes (2106), does not equal 100% because more than 1 etiology may have been listed for a patient. No etiology listed or unknown included patients for whom no documentation of etiology was noted in the discharge summary or progress notes and patients for whom it was documented that no etiology could be determined. Other cardiac causes included aortic stenosis, cardiac ischemia, and so forth. Situational etiology included etiologies such as micturition or defecation-related syncope.

Table 2. Diagnostic Tests Obtained in Evaluation of Syncopal Episodes in Older Patients[a]

Test	Obtained	Abnormal Findings[b]	Affected Diagnosis[c]	Helped Determine Etiology[c]	Affected Management[c]
Electrocardiogram	2081 (99)	438 (21)	147 (7)	72 (3)	153 (7)
Telemetry	2001 (95)	314 (16)	212 (11)	95 (5)	245 (12)
Cardiac enzymes test	1991 (95)	108 (5)	31 (2)	9 (0.5)	29 (1)
Head CT	1327 (63)	138 (10)	28 (2)	7 (0.5)	28 (2)
Echocardiogram	821 (39)	516 (63)	35 (4)	13 (2)	36 (4)
Postural BP recording	808 (38)				
Strict criteria[d]		230 (28)	142 (18)	122 (15)	202 (25)
Loose criteria[d]		445 (55)	212 (26)	173 (21)	241 (30)
Carotid US	267 (13)	122 (46)	2 (1)	2 (0.8)	6 (2)
EEG	174 (8)	68 (39)	2 (1)	1 (0.6)	2 (1)
Head MRI	154 (7)	46 (30)	20 (13)	3 (2)	19 (12)
Cardiac stress test	129 (6)	53 (41)	13 (10)	2 (2)	12 (9)

Abbreviations: BP, blood pressure; CT, computed tomography; EEG, electroencephalogram; MRI, magnetic resonance imaging; US, ultrasonography.

[a] A total of 2106 admissions for 1920 patients. Data are given as number (percentage).

[b] Abnormal findings were defined as abnormal values for cardiac enzymes tests and postural BP recording as outlined in the "Methods" section; for imaging studies, abnormal findings were defined as any abnormalities that were not seen on prior testing as noted in the test reports.

[c] Denominators were the number of tests obtained. "Affected diagnosis" was defined as any test results that were noted in test reports, progress notes, or discharge summary to have contributed to, confirmed, or established any diagnosis; examples included an electrocardiogram identifying atrial fibrillation or postural BP measurements meeting criteria for postural hypotension. "Helped determine etiology" of syncope was defined as any test results that were noted in test reports, progress notes, or discharge summary to have helped determine the etiology of the syncopal episode; examples included cardiac enzymes test confirming findings on abnormal electrocardiogram of ischemic disease or head CT demonstrating ischemic infarction of indeterminate age. "Affected management" was defined as any test results that were noted in test reports, progress notes, or discharge summary to have contributed to any management decision; examples included electrocardiogram resulting in the management of atrial fibrillation with anticoagulation and β-blockers or postural BP recordings resulting in the management of orthostatic hypotension with hydration.

[d] The strict criteria for postural BP was a drop in systolic BP of at least 20 mm Hg or a drop in diastolic BP of at least 10 mm Hg while changing from a lying to a standing position. The loose criteria for postural BP was defined as a drop in systolic or diastolic BP of at least 10 mm Hg or a drop in systolic BP to 90 mm Hg or less while changing from a lying position to a sitting or standing position.

Head CT scans affected diagnosis or management in only 28 of 1327 admissions (2%); 25 of these involved clinically suspected neurologic disease such as brain metastases, new neurological symptoms, or recent head trauma. Similarly, 17 of the 20 cases in which the MRI result affected diagnosis or management were suspected based on history or examination.

The costs per test affecting diagnosis or management are shown in **Table 3**. This cost was highest for EEG ($32 973), head CT scan ($24 881), and cardiac enzymes test ($22 397) and lowest for postural BP recording ($17-$20). Examples of the cost per test that helped determine the etiology of syncope include $99 525 for head CT scan, $77 144 for cardiac enzymes test, $65 946 for EEG, and $23 to $33 for postural BP recording.

As shown in **Table 4**, with the exception of cardiac stress testing, cardiac test results were much more likely to have affected diagnosis or management or helped determine the etiology of the syncopal episode in patients meeting the SFSR than in patients not meeting criteria. The costs per cardiac test affecting diagnosis or management also were much higher among patients not meeting the SFSR among those meeting the SFSR. For example, for cardiac enzymes tests, the cost per test affecting diagnosis or management was $10 331 in those meeting, vs $111 518 in those not meeting, the SFSR.

COMMENT

In this study, we found that cardiac and neurologic tests were commonly obtained in the evaluation of syncope in older patients despite a minimal effect on diagnosis or management. In the few cases in which neurological tests were helpful, neurological conditions were suspected based on history or examination. Cardiac testing also had low yields overall. Conversely, postural BP recordings had the highest yield but were performed in only about a third of admissions and frequently were performed inadequately. Application of the SFSR markedly improved yields and lowered costs without compromising the identification of persons with life-threatening cardiac conditions.

As in previous studies, vasovagal episodes and orthostatic hypotension were the most frequently reported etiologies. The lack of an etiology in almost half of patients despite extensive testing was also similar to prior reports of older adults.[1,4] Algorithm-based evaluations, which were not used in the study hospital, result by design in higher percentages of patients with a diagnosed etiology.[9-13]

The lowest likelihood of useful test results, and, therefore, the highest costs per yield, was incurred by EEG, head CT scans, and cardiac enzymes tests. Although only troponin I level was used to define abnormal results,[32,33] the total cost per set of cardiac enzymes test included creatine kinase and creatine kinase–MB levels. If the troponin I level alone was obtained, the cost per cardiac enzymes test affecting diagnosis and management would decrease from $22 397 to $4813. Postural BP measurements represented the lowest cost per test affecting diagnosis and management at $17. This figure maybe lower or higher in actual practice based on who is performing the BP measurements, but the magnitude is likely accurate for comparison to other testing costs.

Many of our findings are consistent with prior studies. Grossman et al[14] and Link et al[15] found that serial car-

Table 3. Costs of Diagnostic Tests in the Evaluation of Syncopal Episodes[a]

Tests Obtained	Cost Per Test, $[b]	Total Cost, $[c]	Cost per Test Affecting Diagnosis or Management, $[d]
EEG	1115 × 0.34 = 379	65 946 = (379 × 174)	65 946/2 = 32 973
Head CT scan	1545 × 0.34 = 525	696 675 = (525 × 1327)	696 675/28 = 24 881
Cardiac enzymes test	357 × 0.34 = 121	694 298 = (121 × 5738 sets)	694 298/31 = 22 397
Troponin I alone	78 × 0.34 = 26	149 188 = (26 × 5738 sets)	149 188/31 = 4813
Carotid US	1294 × 0.34 = 440	117 480 = (440 × 267)	117 480/6 = 19 580
Head MRI	3316 × 0.34 = 1127	173 558 = (1127 × 154)	173 558/20 = 8678
Cardiac stress test	2492 × 0.34 = 848	109 392 = (848 × 129)	109 392/13 = 8415
Echocardiogram	809 × 0.34 = 275	225 775 = (275 × 821)	225 775/36 = 6272
Electrocardiogram	221 × 0.34 = 75	156 075 = (75 × 2081)	156 075/153 = 1020
Telemetry	255 × 0.34 = 87	174 087 = (87 × 2001)	174 087/245 = 710
Postural BP[e]	5	4040 = (5 × 808)	4040/241 = 17

Abbreviations: BP, blood pressure; CT, computed tomography; EEG, electroencephalogram; MRI, magnetic resonance imaging; US, ultrasonography.

[a] A total of 2106 admissions in 1920 patients.

[b] Cost per test was calculated as the charge per test multiplied by the cost to charge ratio of 0.34, based on the 2007 Yale–New Haven Hospital cost to charge ratio from the State of Connecticut's Annual Report on the Financial Status of Connecticut's Acute Care Hospitals for Fiscal Year 2007.[31]

[c] The total cost is equal to the number of tests obtained multiplied by the cost per test.

[d] Cost per test affecting diagnosis or management was calculated as the total cost divided by the number of tests that affected diagnosis or management. An "affected diagnosis" was defined as any test results that were noted in test reports, progress notes, or discharge summary to have contributed to, confirmed, or established any diagnosis; examples included an electrocardiogram identifying atrial fibrillation or postural BP measurements meeting criteria for postural hypotension. An "affected management" was defined as any test results that were noted in test reports, progress notes, or discharge summary to have contributed to any management decision; examples included electrocardiogram resulting in the management of atrial fibrillation with anticoagulation and β-blockers or postural BP recordings resulting in the management of orthostatic hypotension with hydration.

[e] A cost of $5 calculated based on 5 minutes of a nurse's time at a $60 per hour wage. Loose criteria for postural BP, as defined in the "Methods" section, were used to calculate costs. If strict criteria, as defined in the "Methods" section, were used, then the cost per test affecting diagnosis or management was $20.

diac enzymes tests had little impact on diagnosis in syncope. Head CT scans, carotid US, and EEG are all known to rarely identify lesions contributing to syncope.[16-18] Our findings confirm these earlier reports that neurological imaging is not warranted in the evaluation of syncope unless a neurological disease or event is suspected. As has been previously shown,[34] our results suggest that the etiology of syncope can often be determined solely by history. The high yield of postural BP recordings in our study supports guideline recommendations that the initial evaluation of syncope should entail medical history, physical examination, electrocardiogram, and postural BP measurements.[3,7,8,35]

The strengths of our study include a large sample size, standardized medical abstraction, consistent definitions and criteria, and blinded reabstraction to ensure reliability. The evaluation of syncope entails identifying the presence of underlying diseases in addition to determining the etiology of the syncopal episode. Therefore, we complemented existing research by determining the effect the tests had on establishing any diagnosis or on any management decision.

There are limitations to our study. First, we report the retrospective experience of a single hospital, although comparison to previous studies[3,14-19] suggests that this experience is representative of other hospitals. Second, because we used *ICD-9-CM* code 780.2 to identify syncope admissions, it is possible that we may have missed some patients diagnosed as having syncope whose admission did not have this *ICD-9-CM* code. However, because we included patients with an admission or discharge, primary or nonprimary diagnosis, the number of missed patients is likely small and should not affect our results. Third, all clinical decisions may not have been documented in the medical record. For example, we likely underestimated the contribution of negative results to diagnosis or management because only 3% of test results that were reported to have affected diagnosis or management were negative results. Fourth, we did not evaluate tests performed after the hospitalization, such as loop recorders and tilt-table testing, and commonly performed laboratory testing, such as hematocrit and glucose levels. Finally, our calculation of costs using a cost to charge ratio is an estimation based on charges—an approach to cost calculation used by other studies in the absence of hospital estimates of cost. The hospital's cost to charge ratio used in the calculation was nearly identical to the cost to charge ratio of patients admitted with syncope, which supports the accuracy of our estimation. Our calculation of costs may have underestimated total costs because it does not include all tests and procedures performed or the cost of hospitalizations, estimated to be $7460 to $9950 per admission.

Perhaps the finding in this study that causes the most concern is the extent to which unhelpful, and presumably unnecessary, testing in the evaluation of syncope continues to be performed despite the compelling evidence against the practice dating back 20 years.[7-19] The current study complements earlier work by showing the high costs associated with this unnecessary testing. Extrapolating our results nationally, assuming approximately 460 000 hospitalizations per year for syncope,[29] yearly costs associated with the most commonly obtained tests may be nearly $6 billion. Investigators have shown that easy availability of low-risk testing contributes to the overuse of resources.[36] The frequency of syncope and wide availability of low-risk testing make its an important source of revenue for hospitals. Unnecessary testing is a substantial contributor to rising health care costs and has been proposed as a target for cost savings.[36,37]

Our results suggest how clinicians might be more selective when obtaining tests to evaluate syncope. One goal

Table 4. Association Between San Francisco Syncope Rule (SFSR) and Cardiac Test Results in Older Patients Presenting With Syncope[a]

CardiacTest Result	Patients, No. (%)		*P* Value
	Met SFSR (n=807)	Did Not Meet SFSR (n=1299)	
Cardiac enzymes test			
Obtained	766 (95)	1225 (94)	.08
Affected diagnosis or management	27 of 766 (4)	4 of 1255 (0.33)	<.001
Helped determine etiology of syncope	8 of 766 (1)	1 of 1255 (0.08)	.003
Cost per affect on diagnosis or management, $	10 331	111 518	
Telemetry			
Obtained	770 (95)	1231 (95)	.54
Affected diagnosis or management	146 of 770 (19)	99 of 1231 (8)	<.001
Helped determine etiology of syncope	54 of 770 (7)	41 of 1231 (3)	<.001
Cost per affect on diagnosis or management, $	457	1078	
Echocardiogram			
Obtained	333 (41)	488 (38)	.10
Affected diagnosis or management	26 of 333 (8)	10 of 488 (2)	<.001
Helped determine etiology of syncope	9 of 333 (3)	4 of 488 (1)	.045
Cost per affect on diagnosis or management, $	1877	7151	
Cardiac stress test			
Obtained	56 (7)	73 (6)	.22
Affected diagnosis or management	7 of 56 (13)	6 of 73 (8)	.56
Helped determine etiology of syncope	1 of 56 (2)	1 of 73 (1)	>.99
Cost per affect on diagnosis or management, $	6582	13 423	

[a] A total of 2106 admissions in 1920 patients. The SFSR is defined as a history of at least 1 of the following: congestive heart failure, hematocrit level of less than 30%, abnormal electrocardiogram result, shortness of breath, or systolic blood pressure lower than 90 mm Hg.

of the evaluation of syncope is to detect conditions, particularly life-threatening ones such as arrhythmias, which may be present in patients with syncope. In this study we found the SFSR criteria to be helpful in identifying patients likely to benefit from cardiac testing. Validation studies[21,38] of the SFSR have had conflicting results. Other criteria have been proposed to predict adverse outcomes[39] and may be helpful as well in serving as predictors of diagnostic yield. Our results suggest that using patient characteristics, such as the SFSR, may help identify patients for whom certain tests, particularly cardiac enzymes tests and perhaps telemetry, are indicated, resulting in a marked savings costs. Further research is needed to determine reliable and feasible criteria to screen patients presenting with syncope.

Because almost one-quarter of older patients who experience a syncopal episode experience serious injuries, such as a hip fracture, during the episode,[40] another goal is to identify non–life-threatening, but treatable, etiologies, such as postural hypotension. Even if other etiologies are suspected, assessment and management of postural hypotension are warranted. Our study suggests that inexpensive postural BP testing is greatly underutilized, resulting in many missed opportunities to institute effective treatment strategies such as medication reduction.

Instituting evidence-based diagnostic guidelines, as have been developed by the European Union, might lessen the extent of unnecessary testing.[7] Basing subsequent testing on the results of the initial history and examination and prioritizing higher yield tests would ensure a more informed and cost-effective approach to evaluating older patients with syncope.

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Correspondence: Mary E. Tinetti, MD, Department of Internal Medicine, Yale School of Medicine, 333 Cedar St, PO Box 208025, New Haven, CT 06520-8025 (mary.tinetti@yale.edu).
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INVITED COMMENTARY

Syncope is a common and expensive symptom. It results in 1% to 1.5% of all emergency department (ED) visits, with the annual cost of patients admitted in the United States estimated to be $2.5 billion.[1-3] In most patients, the causes are benign and are aggressively investigated to find the few who may experience clinically significant morbidity or mortality. Despite aggressive investigation, only 50% of patients with syncope ever get a clear diagnosis. This uncertainty of risk and diagnosis leads to tremendous variability among those who are admitted, how they are evaluated, and associated costs. Academic centers in the United States report ED admission rates ranging from 55% to 85%. Other health care systems, including Kaiser Permanente, admit about 35% of patients with syncope, whereas some countries, like Australia (admission rate, <30%) and Canada (admission rate, <20%), admit very few patients with syncope without any real apparent differences in outcome.[1,4]

To help guide admission and investigations, there is evidence to help identify patients at higher risk for both short- and long-term outcomes.[5-7] The San Francisco syncope rule (SFSR) adds to the growing body of evidence that defines patients with syncope at risk.[2] This evidence shows that patients with abnormal results from electrocardiogram and a history of structural heart disease, best determined by a history of congestive heart failure or shortness of breath, are at increased risk. Furthermore, patients with persistent low blood pressure and low hematocrit level are more likely to have poor outcomes. Advanced age is also a risk factor; however, advanced age is nonspecific, ill defined, and is an increased risk for death regardless of