Intensive Education on Evidence-Based Evaluation of Syncope Increases Sudden Death Risk Stratification but Fails to Reduce Use of Neuroimaging

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Background: We sought to determine whether aggressive education on evidence-based guidelines would affect the use of resources. Specifically, we sought to educate providers about the role of neuroimaging as well as sudden death risk stratification.

Methods: We reviewed 1092 consecutive cases involving patients who were admitted for syncope. We retrospectively reviewed 30 months of admissions for baseline characteristics and then initiated an intensive monthly education campaign directed toward internal medicine physicians-in-training focusing on evidence-based guidelines for a 13-month period.

Results: There were 721 patients (66.0%) evaluated before the education intervention and 371 patients (34.0%) evaluated after the education intervention. After the intervention, there was no change in the use of computed tomography (52.3% vs 55.5%; $P = .31$) or magnetic resonance imaging (20.2% vs 16.7%; $P = .16$) of the head or carotid ultrasonography (4.7% vs 6.2%; $P = .30$). The referral rate for electrophysiologic study significantly increased from 6.4% at baseline to 11.3% ($P = .006$) after intervention, with an overall diagnostic yield of 28.4%. Of those with identified structural heart disease, the referral rate went from 5.7% to 19.0% ($P = .03$). Only 66 of 1092 patients who presented with syncope ultimately required a pacemaker or defibrillator implantation during hospitalization.

Conclusions: With intensive education, there was no decrease in neuroimaging, despite a low diagnostic yield. We were able to increase sudden death risk stratification using electrophysiologic studies without evidence of overuse of implantable device–based therapy. Intensive education allows increased adherence to guidelines for mortality reduction; however, further attempts to reduce the lower yield imaging will require methods other than education of hospital-based physicians.

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SYNCOPE IS A COMMON CONDITION and one of the leading single identifiable causes of hospital admissions, accounting for 1.7% of all emergency department visits and 6% of all acute hospital admissions.[1,2] The incidence of syncope, which increases with age, is reported to be 6.2 per 1000 person-years in large cohorts.[3,4] The cost of investigation of syncope is high, ranging from just over \$500 to nearly \$74 000 per diagnostic evaluation.[5] The highly variable cost and increasing incidence in the elderly take on increasing importance given the estimated increase in the elderly population in the next few decades.

The evaluation and management of syncope often are not standardized and are suboptimal.[6,7] In particular, the evaluation of syncope often involves multiple expensive tests, such as electroencephalography, neuroimaging, and carotid Doppler ultrasonography, with low diagnostic yield when performed on a routine basis.[8-10] While there are several published guidelines regarding the appropriate evaluation of syncope from the American College of Cardiology, the American Heart Association, the American College of Physicians, and the European Society of Cardiology,[11-14] these guidelines are not widely known and are sometimes difficult to apply in clinical practice.[15]

Among the patients who present with syncope, the identification of a cardiac syncope portends a poor prognosis in contrast to those with neurocardiogenic or orthostatic syncope.[3,16] Clinical practice guidelines emphasize assessment for structural heart disease during the evaluation of patients for syncope, and referral for an electrophysiologic study is thought to be appropriate (class I) for

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patients with identified cardiovascular heart disease and left ventricular dysfunction.[11,14,17] Also, defibrillator implantation is appropriate (class I) for unexplained syncope and inducible clinically significant ventricular arrhythmia on electrophysiologic studies and should be considered (class IIa) for unexplained syncope with significant left ventricular dysfunction and nonischemic dilated cardiomyopathy.[18]

Recent work has demonstrated a failure to recognize permanent pacing indications that were associated with delays and adverse clinical outcomes.[19,20] To our knowledge, there are no recent studies addressing the failure to recognize the role of electrophysiologic studies and subsequent management of a population that may be at increased risk for sudden death. Improved use of resources for the evaluation of syncope is of utmost importance considering the significant morbidity, mortality, and economic costs involved. We sought to examine the clinical practice and yield of diagnostic testing for the evaluation of syncope, with an emphasis on the use of neuroimaging and referral for electrophysiologic studies using historical control and after intensive education intervention directed toward physicians-in-training.

METHODS

We reviewed consecutive cases involving patients with syncope and collapse as a primary complaint for hospital admission from September 2005 to April 2009. We initiated monthly didactic instruction to internal medicine physicians-in-training and rotating faculty regarding evidence-based guidelines for the evaluation of syncope from March 2008 to April 2009. Intensive education of physicians-in-training and faculty included a 30-minute didactic presentation focusing on the overuse of resources on a national level and at our facility. We also provided trainees and faculty a handout dedicated toward syncope and an established algorithm according to guidelines on the evaluation and management of syncope.[14] These lectures focused on obtaining a history and physical examination, on looking for evidence of structural heart disease, and on not performing additional tests in those cases when history and physical examination were in themselves diagnostic of orthostasis or neurocardiogenic etiology. In those cases without a clear cause, there was an emphasis to limit the evaluation if there was no structural heart disease or ischemia. Our internal medicine service comprises 5 ward "teams" that include a board-certified internist, a senior medicine resident, 2 categorical medicine interns, and either interns from other specialties (transitional or categorical requiring inpatient medicine rotations) or medical students. While all level of physicians-in-training are allowed to independently order ancillary testing, the direction of the evaluation is predominantly at the discretion of the senior resident under the supervision of the faculty. Our facility is a state-of-the-art, 450-bed health care facility that provides level 1 trauma and graduate medical education serving military personnel and beneficiary populations. Sources of patient admission include the emergency department, direct admission, or transfer from outside facilities. All faculty health care providers are salaried employees and include uniformed military service, US government employees, and contractors. There is no model that alters provider reimbursement as a function of performance, although metrics are routinely collected.

Patients were included if they had an *International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM)* code of 780.2 as a primary or nonprimary diagnosis according to inpatient billing records. All inpatient records are maintained through an electronic medical record, and demographics, clinical test ordering, and results were compiled using a standardized abstraction method. An initial data collection consisted of patient age; sex; cost of admission; length of stay; source of admission; results of neuroimaging (computed tomography [CT] or magnetic resonance imaging [MRI] and carotid ultrasonography), electroencephalography, echocardiography, treadmill stress test, myocardial perfusion studies, and electrophysiologic studies; and whether implantation of either a permanent pacemaker or an implantable cardioverter-defibrillator was performed. Additional data collected included results of imaging and cardiac and neurologic testing.

Test results were stratified into 3 categories—normal, noncausative, and causative—using predetermined criteria for findings that could have affected diagnosis. Noncausative findings were those with any abnormality, regardless of how minor or if not related to syncope (eg, chronic small-vessel changes on head CT, diastolic dysfunction on echocardiogram). Causative findings were those involving an abnormality that could be directly responsible for a syncopal episode (eg, severe aortic stenosis on echocardiogram) or that is an established predictor of sudden cardiac death (eg, ejection fraction $<40\%$ on echocardiogram, inducible ventricular tachycardia on electrophysiologic study). Findings were also determined to be causative for disorders that resemble syncope in that there is a loss of consciousness but no global hypoperfusion and thus by definition are not syncope (eg, acute ischemic changes on head MRI).

A t test was used for comparison of normally distributed continuous variables, and a χ^2 test was used for categorical variables. Normally distributed variables are reported as mean (SD), and nonparametric parametric data are presented as median (25%-75% interquartile range). Statistical analysis was performed using the JMP Professional Edition (SAS Institute Inc, Cary, North Carolina). P values were considered significant at $<.05$. The study was approved by the institutional review board of Brooke Army Medical Center, Fort Sam Houston, Texas.

RESULTS

There were 721 patients (66.0%) who were evaluated before the education intervention and 371 (34.0%) patients who were evaluated after the intervention, for a total of 1092 patients. The median age of the population was 68 years (interquartile range, 52-79 years), and 55% of the patients were male. The demographic features of these 2 groups are compared in **Table 1** and were not significantly different; however, there was a significant reduction in total median cost per admission after intensive education ($P=.02$) and a trend toward a more expeditious evaluation ($P=.07$). The frequency and diagnostic yield of the neuroimaging tests before and after the educational intervention are shown in **Table 2**. After the intervention, there was no change in the use of CT or MRI of the head or carotid ultrasonography.

After intensive education, the overall use of any neuroimaging modality was unchanged, with an overall diagnostic yield of 2.0%. Independent of education, there was an increased use in head CT among patients who were older than 65 years (64.0% vs 41.0%; $P<.001$) and among those who were directly admitted from the emergency department (58.8% vs 29.1%; $P<.001$). Electroencephalography was performed in 13 cases (1.80%) before the educational intervention and in 10 cases (2.69%) after the

Table 1. Demographic Features Comparing Patients Admitted for Syncope Before and After Education Intervention Focusing on Physicians-in-Training

Variable	Preeducation Intervention (n=721)	Posteducation Intervention (n=371)	*P* Value
Age, median (range), y	67 (52-80)	68 (53-79)	.54
Patients >65 y, No. (%)	377 (52.3)	212 (57.1)	.13
Male sex, No. (%)	392 (54.4)	215 (58.0)	.29
Admission from emergency department, No. (%)	590 (81.8)	309 (83.3)	.55
Length of stay, median (range), d	2 (1-3)	1 (1-3)	.07
Full cost, median (range), $1000	5.5 (3.9-8.4)	4.9 (3.8-7.5)	.02

Table 2. Neuroimaging and Noninvasive Cardiac Risk Stratification Testing Obtained in Evaluation of Patients With Syncope

	No. (%)			
Variable	Preeducation Intervention (n=721)	Posteducation Intervention (n=371)	*P* Value	Causative Finding, No. (%) (n=1092)
Any neuroimaging	425 (58.9)	223 (60.1)	.75	22 (2.0)
CT of the head	377 (52.3)	206 (55.5)	.31	14 (1.3)
MRI of the brain	146 (20.2)	62 (16.7)	.16	12 (1.1)
Carotid US	34 (4.7)	23 (6.2)	.30	0
Any cardiac risk stratification study	393 (54.5)	221 (59.6)	.11	112 (10.3)
Echocardiography	372 (51.6)	214 (57.7)	.06	72 (6.6)
Treadmill stress test	71 (9.8)	24 (6.5)	.06	2 (0.2)
Myocardial perfusion study	79 (11.0)	40 (10.8)	.93	42 (3.8)

Abbreviations: CT, computed tomography; MRI, magnetic resonance imaging; US, ultrasonography.

intervention and was causative in only 1 case involving a patient with a known history of organic brain injury.

The frequency and diagnostic yield of noninvasive cardiac testing studies before and after the educational intervention are also shown in Table 2. Overall, the results of assessment of structural heart disease using echocardiography, treadmill testing, and/or perfusion imaging were unchanged after the educational intervention (relative risk [RR], 1.15; 95% confidence interval [CI], 0.97-1.36; $P=.11$). Among patients younger than 65 years, there was increased use of at least 1 noninvasive cardiac testing study (50.6 vs 62.9; $P=.01$) and echocardiography (61.1 vs 47.7; $P=.004$) after the educational intervention. Overall, the use of 1 or more of these modalities identified structural heart disease 10.3% of the time. Overall, echocardiography was the test that was most frequently performed both before (51.6%) and after (57.7%) the educational intervention, with an overall diagnostic yield of 6.6%.

The referral rate for electrophysiologic study was significantly increased from 6.4% of admissions to 11.3% after the intervention (RR, 1.46; 95% CI, 1.15-1.84; $P=.005$). The referral rate for electrophysiologic study for patients with identified structural heart disease increased from 5.7% to 19.0% after the educational intervention (RR, 1.95; 95% CI, 1.21-3.18; $P=.03$). The diagnostic yield of those referred for electrophysiologic study was unchanged by the education intervention, and the overall diagnostic yield was 28.4%. There was a significant increase in electrophysiologic study in the patients who were older than 65 years (1.1% vs 7.1%; $P<.001$). Device therapy consisted of implantation of either an implantable cardiac defibrillator or a permanent pacemaker. For those patients who were younger than 65 years, the referral rate for either electrophysiologic study or device therapy was unchanged by the education intervention (16.3% vs 17.6%, $P=.07$). For those patients who were older than 65 years, the referral rate for electrophysiologic study or device therapy significantly increased after the education intervention (8.8% vs 16.0%; $P=.01$). There was a trend toward greater use of device therapy after the intensive education intervention (5.1 vs 7.8%; $P=.08$). Only 66 of 1092 patients who presented with syncope ultimately required a pacemaker or a defibrillator implantation device during hospitalization.

COMMENT

In a health care model that is not driven by reimbursement, insurance coverage, or fear of legal retribution, there is a common use of neuroimaging despite its low diagnostic yield, which is in agreement with recent work.[21] However, by educating providers about the focus of a syncope evaluation, we were able to reduce the overall cost to the health care facility by more than 10% and increase the use of testing for death risk stratification for sudden cardiac death.

Blanc et al[22] previously showed that local education of physicians does not lead to a change in the in-hospital evaluation of syncope, particularly in regard to the use of neuroimaging. Education reinforcing previously established guidelines for the evaluation of syncope directed at internal medicine residents produced mixed results overall but did show a significant decrease in the percentage of younger patients receiving any neuroimaging. Specific reduction in neuroimaging was grossly unaffected by education intervention, and this may in part be because of the initiation of such studies by the emergency department compared with those with admission from an alternative source. The possible rationale behind the overuse of diagnostic testing, particularly diagnostic imaging, has been discussed previously.[23] An increase in technological advances, including readily available neuroimaging; patient preference of care; physician fear of malpractice and litigation; and the need to eliminate uncertainty (for patient and physician) have led to the increased use of these modalities.[24]

Local education and access to guidelines did indeed lead to increased referral for electrophysiologic studies, particularly among patients with structural heart disease identified during hospitalization. Electrophysiologic study has a clearly defined role in long-term sudden cardiac death risk stratification among those with structural heart disease and in suggesting a possible cause for unexplained syncope.[25,26] In this study, diagnostic yield (16.3% vs 17.6%; $P=.07$) and device use (6.2% vs 5.7%; $P=.70$) were not statistically significantly different after the education intervention. The "appropriate" referral rate has to be based on the percentage of patients with structural heart disease and idiopathic syncope. Pooled data[3,12,13] fairly consistently show that approximately 35% to 40% of cases of syncope are idiopathic. Given that 30% to 40% of our patients had structural heart disease, then the appropriate rate for electrophysiologic study referral for our unselected population with syncope should be 11% to 16%.

We have affirmed that local hospital education alone is not sufficient to ensure efficient, appropriate evaluations that will result in the recognition and treatment of potentially life-threatening diagnoses. Previous work has called attention to the need for a more organized, cost-efficient process that will help in the evaluation of syncope.[15,27] Use of a standardized evidence- and guideline-based evaluation pathway, often in the setting of an in-hospital syncope unit, has been shown to reduce the costs of evaluation and increase the appropriateness of the diagnostic pathway.[6,28-31]

There are several limitations to our study. The study is retrospective, and there are inherent limitations in this design. Although generalizability to current fee-for-service models, with defensive medicine practice and variable insurance coverage, may be limited, as the nation examines clinical practice models to eliminate these concerns, we offer a glimpse of the continued overuse of resources despite the control of these variables. Because *International Classification of Diseases, Ninth Revision, Clinical Modification* code 780.2 was an inclusion criterion for our study, it is possible that patients who did not meet a clinical definition were inadvertently included. We did not examine tests that were performed before inpatient admission; therefore, the decision to perform sudden cardiac death risk stratification may have been based on the result of previous tests.

Also, perhaps a more focused education for admitting providers, most notably emergency department personnel, would be of higher yield in the reduction of unnecessary tests. Because this intervention was for the purpose of performance improvement, and not for research, our participants were not randomized either to those providers in whom education was provided or to those in whom education was not provided. Given the rotation of the physicians-in-training to multiple teams throughout any particular year, this model would not have been feasible.

While a randomized trial may have been more suitable for the evaluation of admission to a dedicated syncope unit in comparison to standard of care, that was not the intent of this design. Although the model designed is routine in performance improvement, we cannot assert that the findings were causal to intervention, although review of temporal trends did not suggest that the intervention was the result of natural history alone. It was rewarding to note that local hospital education of physicians-in-training and increased awareness of resources led to increased use of electrophysiologic studies for sudden cardiac death risk stratification in patients with structural heart disease, without overuse in pacemaker or defibrillator implantation, and to an overall reduction in facility costs because of the reduction in length of stay. However, it was very disappointing to find that we were unable to reduce the use of unnecessary testing even with increasing awareness. Despite a low diagnostic yield, there continues to be a fairly routine use of neuroimaging in the evaluation of syncope, and given that most patients are low risk, and given the potential for increased cost containment, there needs to be a dedicated focus in syncope pathways. Further attempts to reduce the indiscriminate use of neuroimaging will require methods other than education of hospital physicians, such as the use of inpatient syncope units.

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