Implementing a Guideline to Improve Management of Syncope in the Emergency Department

abstract

BACKGROUND AND OBJECTIVES: Thirty-five percent of children experience syncope at least once. Although the etiology of pediatric syncope is usually benign, many children undergo low-yield diagnostic testing. We conducted a quality improvement intervention to reduce the rates of low-yield diagnostic testing for children presenting to an emergency department (ED) with syncope or presyncope.

METHODS: Children 8 to 22 years old presenting to a tertiary care pediatric ED with syncope or presyncope were included. We excluded children who were ill-appearing, had previously diagnosed cardiac or neurologic disease, ingestion, or trauma. We measured diagnostic testing rates among children presenting from July 2010 through October 2012, during which time we implemented a quality improvement intervention. Patient follow-up was performed 2 months after the ED visit to ascertain subsequent diagnostic testing and medical care.

RESULTS: A total of 349 patients were included. We observed a reduction in the rates of low-yield diagnostic testing after our quality improvement intervention: complete blood count testing decreased from 36% (95% confidence interval 29% to 43%) to 16% (12% to 22%) and electrolyte testing from 29% (23% to 36%) to 12% (8% to 17%). Performance of recommended testing increased, such as electrocardiograms and pregnancy testing in postpubertal girls. Despite a reduction in diagnostic testing among children with syncope, patients were not more likely to undergo subsequent diagnostic testing or seek further medical care following their ED visit.

CONCLUSIONS: Implementation of a quality improvement intervention for the ED evaluation of pediatric syncope was associated with reduced low-yield diagnostic testing, and was not associated with subsequent testing or medical care. Pediatrics 2014;134:e1413–e1421
Up to 35% of children experience at least 1 episode of syncope. Unlike adults, the etiology of syncope in children and adolescents is typically benign, with neurocardiogenic (vasovagal) syncope the predominant cause. Other rare causes of pediatric syncope, such as arrhythmias, are associated with the potential for sudden death. The fear of missing rare but serious causes of syncope often drives the performance of invasive, extensive, and costly evaluations on children in the emergency department (ED). Previous studies have demonstrated that evaluations for patients with syncope have included serum laboratory studies, urine drug screens, electrocardiograms (ECGs), chest radiographs, brain computed tomography (CT) scans, brain MRI, electroencephalograms, echocardiograms, and 24-Holter monitoring. One recent study showed 26% of these patients underwent head CT or MRI, and 38% received intravenous fluids. In one ED-based pediatric study, laboratory testing was obtained in 122 (67%) of 181 patients, and another study found that electrolyte testing was obtained in 90% of children, and a complete blood count (CBC) in 80%. Lack of consensus around the appropriate diagnostic testing and treatment of a child evaluated in the ED with syncope contributes to the widespread variation in management of such patients.

Concerns about widespread variation in utilization and rising health care costs have instigated calls to establish appropriate, safe, efficient, and cost-effective guidelines for the management of common conditions. Currently, there are no well-established guidelines for the diagnostic evaluation and management of pediatric syncope, although algorithms exist to guide adult syncope management. The purpose of this quality improvement intervention was to reduce the rates of low-yield diagnostic testing for children presenting to a single ED with syncope or presyncope, and to evaluate subsequent testing, medical care, and diagnoses received after the ED visit.

METHODS

The Boston Children’s Hospital Committee on Clinical Investigation approved the study.

Study Design, Setting, and Population

Using a quasi-experimental study design, we reviewed clinical data from patients who presented from July 1, 2010, through October 31, 2012, during which time we implemented a quality improvement intervention for pediatric syncope. We included children 8 to 22 years old presenting with syncope or presyncope to the ED of a large urban tertiary care children’s hospital, with an annual volume of 59,000 visits per year. This ED is staffed by 48 board-certified pediatric emergency medicine specialists, 26 board-certified general pediatricians, 18 pediatric emergency medicine fellows, more than 200 rotating pediatric and emergency medicine residents from 4 residency programs, rotating third- and fourth-year medical students, and 100 nurses. We defined syncope as a transient brief loss of consciousness associated with loss of postural tone with spontaneous recovery, and presyncope as a near-fainting episode, which may include lightheadedness, dizziness, severe weakness, and blurry vision without loss of consciousness. We included syncope and presyncope in the study because of the real-time difficulty in ascertaining brief loss of consciousness among these patients, many of whom experience these events witnessed. This is the primary characteristic used to distinguish presyncope from syncope. Patients with complaints of syncope and presyncope overlap significantly, with most sharing the basic physiology of neurally mediated syncope and the concomitant low frequency of serious disease. At their extremes, the distinction between syncope and presyncope is clear (the abrupt convulsive event or the mildly lightheaded patient who is not having to catch himself or herself). In practice, the clarity of whether a child actually lost consciousness or not is often not entirely clear at the time of the ED evaluation. We excluded patients who were ill-appearing as determined by the treating attending physician; had a history of active cardiac or neurologic disease; had significant comorbidity, such as diabetes; had a known toxic ingestion; or had any major trauma preceding the syncopeal episode. In addition, we excluded patients who were transferred from another hospital and had any diagnostic testing performed at the transferring institution. Our study criteria were the same as the inclusion and exclusion criteria referenced on the clinical guideline (Supplemental Information).

Patient Identification/Enrollment

Patients were screened through the use of chief complaint codes, which the triage nurse selects from a prepopulated list to categorize a patient’s reason for visit. To improve capture of patients with possible syncope, research coordinators identified potentially eligible patients by real-time monitoring of an electronic tracking system for chief complaints of either “syncope” or “dizziness.” The physician caring for the child confirmed eligibility for the study based on the stated inclusion and exclusion criteria. Physicians caring for study subjects were asked to complete a tablet-based electronic survey after their evaluation of the patient. The research coordinator approached the patient and parent and obtained written informed consent (or assent) for study participation. Subjects consenting/assenting to participation agreed to be contacted via phone or E-mail 2 months after the initial ED
visit, to quantify subsequent episodes of syncope, additional follow-up visits, or diagnostic testing performed outside the study hospital. Two months was chosen as the follow-up interval to permit enough time for patients or their parents to schedule or attend specialty appointments. An automated E-mail was sent to study investigators on a daily basis containing a list of all patients with chief complaints of dizziness or syncope from the previous day. Patients who were eligible but not enrolled during the ED visit were screened for inclusion by study investigators (SG, AF). The physician survey was generally completed at the time of the patient encounter; however, in an effort to maximize enrollment, we notified clinicians of the missed eligible patients with syncope the following day, and allowed then to complete the survey at that time. This information was collected as soon as possible after the ED visit. We attempted to contact the patient/parent to collect follow-up information 2 months after their visit. For these families, an informational packet was mailed with an opportunity to opt-out of the study before any phone contact. If the family did not opt out, attempts were made by the research coordinators to contact the family and obtain consent for follow-up.

Intervention

Guideline Development

Because of the wide variation in management of pediatric syncope in our ED and across the country, we designed a quality improvement intervention, starting with the development of an evidence-based guideline. The ED-based syncope guideline was based on best available evidence gleaned from a comprehensive literature search and was developed through consensus via a multidisciplinary collaboration between experts from emergency medicine, cardiology, neurology, and nursing. A pediatric emergency physician and nurse led this collaborative team effort through an iterative process from August 2010 to July 2011. Five additional pediatric emergency medicine attending physicians reviewed and provided feedback regarding the guideline before implementation. The guideline was vetted and disseminated by local experts from within cardiology and neurology, who ensured that their colleagues, consulting fellows, and staff were aware of the collaborative ED guideline. The guideline contains recommendations to obtain an ECG for all patients with syncope, as well as a urine pregnancy test for all postmenarchal girls. The guideline states that other tests or interventions are not routinely recommended, unless clinically indicated (Supplemental Information).

Although most cases of pediatric syncope are neurocardiogenic in nature, patients who present with specific additional signs or symptoms may represent a group that is not considered to be at low risk. For example, in our algorithm, we recommend obtaining a cardiology consult if syncope is increasing in frequency, occurs during exertion or swimming, or is accompanied by chest pain, rapid palpitations, 3/6 or other noninnocent murmur, more than occasional premature ventricular contractions, or an abnormal ECG, as defined by the 12-lead ECG checklist contained on the algorithm.20,21 More than occasional premature atrial or more than occasional premature ventricular contractions, or an abnormal ECG, as defined by the 12-lead ECG checklist contained on the algorithm.20,21 More than occasional premature ventricular contractions are accepted at our institution, as more than 1 per minute on average. The wording is intentionally vague to permit discussion with the consultant around patients meeting borderline criteria.

In the algorithm, we also recommend that patients with a family member with congenital long Q-T syndrome be referred to a cardiologist, as this family history places a patient at higher risk of a cardiac etiology for syncope. The algorithm contains a recommendation for the clinician to inquire about a family history of sudden infant death syndrome, congenital deafness, sudden cardiac arrest, or sudden unexplained death at younger than 40 years.22

Guideline Implementation

The ED guideline implementation team led the rollout of the syncope guideline, which was implemented in October 2011. At this time, significant focus was placed on evidence-based practice in our ED. The ED guideline implementation team consisted of 2 physicians, 2 nurses, 1 expert in quality improvement science, 1 data analyst, and 1 administrator. Several other clinical guidelines were implemented successfully before implementation of the syncope guideline.23,24 The current study benefited from the shift in culture that was already occurring in the ED.

Based on the Pathman model, we took the following actions to maximize awareness of the initiative, promote agreement with the recommendations, encourage clinical adoption of the actions, and improve adherence with the guideline.25 We used the following multifaceted strategies and techniques:

- The guideline and the evidence supporting its recommendations were introduced at our weekly division conference. This conference is well attended by staff physicians and fellows, and we encourage questions and discussion around the recommendations to enhance acceptability.
- An E-mail was sent to ED providers that highlighted the major recommendations and included a 1-page attachment with the algorithm (Supplemental Information).
- Copies of the algorithm were displayed in prominent locations within the ED. Online copies of the algorithm were made accessible on the computer desktop of each workstation within the ED.
- We launched an electronic syncope order set, which included only
recommended testing, such as an ECG and urine pregnancy testing in postmenarchal girls.

- Syncope discharge instructions were created to support guideline implementation.
- E-mail reminders were sent to physicians 1 day before each of their ED clinical shifts during the first month of guideline implementation.

Additional strategies included the distribution of pocket cards highlighting the main recommendations.

**Data Collection**

We reviewed the complete medical records via direct chart review of all study patients and abstracted demographic data, historical data, physical examination findings, ancillary test results (laboratory data, ECG, and imaging findings), administration of medications and/or intravenous fluids, consultations obtained, patient disposition, and outcomes.

In an effort to standardize ECG interpretation, we included in the algorithm a standardized checklist to assist clinicians in classifying a patient’s ECG as normal, borderline, or abnormal. This checklist includes moderately stringent criteria for abnormal values to ensure appropriate cardiology consultation at the time of the visit or outpatient follow-up in the cardiology clinic (Supplemental Information). In our ED, the standard practice is for all ECGs to be interpreted by an emergency medicine attending physician. A pediatric cardiology attending physician also reviews every ECG; 85% are reviewed within 24 hours, and 95% within 72 hours of the ED encounter. If an abnormality is identified by the cardiologist that was not identified by the ED physician, the pediatric cardiologist notifies the on-call ED attending to coordinate appropriate patient follow-up.

The questionnaire for the ED physicians aimed to capture information not consistently documented in the medical record. For example, the survey asked the clinicians if anemia was on their differential diagnosis, enabling investigators to speculate if a CBC were obtained for a specific concern of anemia, rather than simply a reflexive screen for syncope.

Patient follow-up via phone or E-mail occurred approximately two months from the index visit (for patients enrolled in the prospective arm of the study) to identify subsequent episodes of syncope, additional follow-up visits, or diagnostic testing performed outside the study hospital. In addition, we inquired about patient and family satisfaction with the initial ED visit. For patients who we were unable to contact, the electronic medical record was queried for 3 months after the ED visit to identify follow-up visits at the study hospital (ED, hospital-affiliated primary care, and subspecialty), additional diagnostic evaluation, and additional diagnoses.

Two chart abstractors (SG, MO) independently reviewed 10% of randomly selected charts to assess intrarater reliability of whether specific diagnostic testing was obtained, using the \( \kappa \) statistic. We observed perfect agreement (\( \kappa = 1.0 \)) for the rates of performance of urine pregnancy testing, CBC, and electrolytes.

Study data were collected and managed using the Research Electronic Data Capture, a secure Web-based application designed to support data capture for research studies.

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**FIGURE 1**

Flowchart of children presenting to the emergency department with syncope or presyncope before and during a quality improvement initiative aimed at reducing unnecessary testing for low-risk patients.
**Statistical Analysis**

We used \( \chi^2 \) tests to compare the proportion of children undergoing diagnostic testing as a summary outcome before and after guideline implementation; \( \alpha \) was set at 0.05 and all tests were 2-tailed. Statistical analyses were conducted by using JMP Pro 10 (JMP Statistical Software, SAS Institute, Inc, Cary, NC). Statistical run charts were constructed to monitor improvement over time. For each outcome, the percent of patients undergoing a specific test was calculated.

**RESULTS**

A total of 721 patients presented to the ED with a chief complaint of “syncope” or “dizziness” during the study period. After applying the exclusion criteria, 349 patients were included (Fig 1). Most patients presented with syncope rather than presyncope, and 97% (95% confidence interval [CI] 94% to 98%) of patients were discharged from the hospital. In both groups, more than two-thirds of patients were girls; the mean age was 14 years. Overall, there were no significant differences in patient characteristics and disposition between patients presenting in the pre and post guideline-implementation periods (Table 1).

**Primary Outcomes**

Table 2 displays the rates of diagnostic testing and other interventions before and after implementations of a Quality Improvement Intervention for the Management of Pediatric Syncope in the ED. The intervention was associated with significant reductions in testing and interventions not routinely recommended by the guideline, including CBC, which decreased from 36% (95% CI 29% to 43%) to 16% (12% to 22%), dextrose sticks, which decreased from 33% (26% to 40%) to 15% (10% to 21%), serum electrolytes, which decreased from 29% (23% to 36%) to 12% (8% to 17%), and intravenous fluid administration, which decreased from 29% (22% to 36%) to 14% (10% to 20%). An ECG was obtained in most patients throughout the time period, and the rate of obtaining a urine pregnancy test among postmenarchal girls increased from 59% (57% to 62%) to 79% (70% to 85%) postimplementation. During this postimplementation period, we identified 2 syncope patients who previously were not aware they were pregnant.

Figure 2 A, B, and C shows statistical process control charts of the monthly percentage of all eligible patients who had CBC testing, electrolyte testing, and intravenous fluid administration. There were no significant preexisting trends in any of these 3 outcomes in the preintervention phase. We found significant improvements in all 3 measures after our multifaceted implementation of the syncope guideline.

**Balancing Measures and Patient Follow-up**

We successfully contacted 69% (122/178) of patients/families in the postimplementation period.
Of the 122 patients contacted, 10 (8%) visited their primary care physician, 16 (13%) were evaluated by a cardiologist, and 8 (7%) patients had an appointment with a neurologist after ED discharge. Overall, 12 of these patients (10%) underwent subsequent diagnostic testing: laboratory studies (n = 4), echocardiograms (n = 4), brain MRI (n = 5), or electroencephalograms (n = 1). All echocardiograms and electroencephalograms were normal. No patients were
subsequently diagnosed with a cardiac or neurologic condition that had been missed in the ED. There were no deaths. Among the patients/families we were able to contact, 108 (89%) of 122 were either satisfied or very satisfied with the care received in the ED. Among the remaining 56 patients (31%) for whom no phone or E-mail follow-up was obtained, 34 had another encounter in our hospital on serial reviews of their medical record. Nine patients were evaluated in a cardiology clinic and 7 in a neurology clinic. As a result of these encounters, there were no patients ultimately diagnosed with a cardiac or neurologic condition.

**DISCUSSION**

We implemented a quality improvement intervention to ensure the provision of high-quality care for children presenting to the ED with syncope. Ample evidence has shown that the vast majority of pediatric syncope is benign, and that the yield of diagnostic testing is low. Before implementation of our intervention, we observed high rates of diagnostic testing among patients presenting to our ED for the evaluation of syncope, consistent with previous studies from other institutions. We observed that the quality improvement intervention reduced the performance of low-yield diagnostic testing, without simply delaying diagnostic testing for the outpatient setting, and without resulting in missed cardiac or neurologic diagnoses.

Rigorous guidelines have been established regarding the development and implementation of guidelines to standardize the management of patients presenting with common conditions. The Institute of Medicine published a guide describing the standards for developing clinical practice guidelines. Despite wide acceptance of the theoretical benefits of evidence-based guidelines, there is concern that they have limited effect on changing physician behavior in practice. However, some studies have shown promising results of successful standardization of care and decreased use after the implementation of guidelines.

There have been no previous studies of the impact of a syncope clinical guideline for the evaluation of pediatric patients in an ED. In our study, most ED clinicians adhered to guideline recommendations, as demonstrated by the increase in urine pregnancy tests obtained and a decrease in laboratory testing and interventions not routinely recommended.

We did not identify any patients with serious heart disease. Although this may lead one to forgo evaluation with an ECG, review of the literature strongly supports ECG use as an important screening tool with exceptionally high negative predictive value. In addition, although it is well recognized that typical syncope in children is virtually always benign, patients present to the ED in part for reassurance to exclude the possibility of significant cardiac disease, such as prolonged QT syndrome. An ECG combined with a reassuring history provides meaningful information to support the notion that the likelihood of cardiac disease is extremely low. With regard to the necessity of urine pregnancy tests in postmenarchal girls,
2 patients who presented with syncope were discovered to be pregnant. Although we cannot state for certain that these syncopal events were related to their pregnant state, previous literature supports the fact that syncope is fairly common during pregnancy. As many as 30% of patients reported an episode of syncope or presyncope during pregnancy. We believe that the yield is high enough to support the routine use of a noninvasive, fast, low-cost test to help identify these adolescent patients early in pregnancy.

Factors contributing to the successful implementation of the guideline may include collaborative efforts to design the guideline, E-mail reminders sent to the physicians and nurses when the guideline was established, a didactic lecture to the ED staff, and the display of a poster of the guideline in the ED charting area. The use of electronic order entry for patients with syncope also may have guided clinicians toward judicious use of diagnostic testing. Finally, the streamlined nature of the guideline, which recommends the routine performance of only 1 or 2 tests, may have facilitated adoption by clinicians.

Our follow-up data demonstrated that despite the decrease in testing and interventions, there were no critically missed diagnoses or deaths, although this study was not powered to detect such differences.

There are several important limitations. First, the study was performed at a single tertiary-care pediatric hospital, which may limit generalizability. Second, the preguideline portion of the study was retrospective, possibly leading to some missing or incomplete data secondary to the variability in the quality of clinical documentation. However, this is mitigated by the fact that diagnostic testing rates, our main outcome measures, are reliably recorded in the electronic medical record, independent of the clinicians’ documentation, as supported by the perfect agreement between data abstractors. Third, although case identification was performed by querying chief complaint codes, the identification in the preintervention group was conducted in a retrospective fashion, whereas identification in the postintervention group was conducted at the time of the ED visit, leading to the possibility of some surveillance bias. Identifying patients prospectively allowed us to obtain information from clinicians in real-time about medical decision-making. Fourth, there is a potential for recall bias among patients/parents when contacted 2 months after the ED visit.

However, we feel that the type of information (further episodes of syncope or additional health care visits related to syncope) asked during that portion of the interview was not likely to be affected greatly by recall bias. Fifth, there is the possibility of temporal trends associated with the use of the historical cohort. Last, we could contact only 69% of patients/families after their ED encounter; limiting our ability to evaluate care provided by pediatricians and specialists outside of our hospital.

CONCLUSIONS

We demonstrated a dramatic reduction in the performance of low-yield testing for children presenting to an ED for syncope after the implementation of a quality improvement intervention, the foundation of which was a syncope guideline. Despite the reduction in testing, patients did not undergo further testing after the ED visit, and no significant cardiac or neurologic conditions were missed.

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