

Pediatric Syncope: Etiological Predictors and Utility of Diagnostic Testing

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Abstract

Background

To evaluate the causes of syncope in the pediatric population, positive and negative etiological predictors, and examine the utilization and utility of specialist evaluations and diagnostic testing in the workup of syncope.

Methods

Retrospective chart review in a tertiary academic center.

Results

750 pediatric patients presenting with syncope over a 5-year period were identified. 76% of patients received electrocardiograms, 36.9% had cardiology evaluations, 23.1% had neurology evaluations, 33.7% had echocardiograms, over 20% underwent neuroimaging, 23.5% had electroencephalograms (EEGs), and 73.6% had additional testing. Over half of all patients initially presented to the emergency department (52%), where they were significantly more likely to get head CTs (OR: 2.49) and additional testing (OR: 3.42). The majority of all testing and evaluations resulted in a diagnosis of neurally mediated syncope (NMS) (74%), while only 2.3% and 1.6% were attributed to cardiac and seizure diagnoses, respectively. Patients with a seizure diagnosis were significantly more likely to report shaking, abnormal movements, post-ictal confusion, and a family history of seizures; Patients with a cardiac diagnosis were significantly more likely to report symptoms with exertion, associated chest pain or palpitations, and an abnormal cardiac history.

Conclusions

Our study demonstrates an opportunity to improve the variability and cost of care in pediatric patients presenting with syncope, as a majority of specialist evaluations, cardiac testing, neuroimaging, and EEGs are not helpful in determining etiology of syncope. We identified

positive and negative predictors of more serious etiologies that can assist in the development of guidelines for managing pediatric syncope.

Key Words

Syncope, Fainting, Neurally mediated syncope, Loss of consciousness, Orthostatic hypotension, Pediatric emergencies, Predictors, Utilization, Utility, Diagnostic testing

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Accepted for Publication

Background

Syncope is a prevalent clinical problem in the pediatric population, affecting 15-25% of all children [1]. Syncope is the abrupt loss of consciousness and posture, usually due to cerebral hypo perfusion or insufficient blood flow to the brain [2]. The transient, but sudden loss of consciousness can be alarming for patients and families. Although there is a wide differential diagnosis for pediatric syncope, the most common cause, neurally mediated syncope (NMS) or neurocardiogenic syncope, is mostly benign, with only about 5-10% of children having symptoms for an extended period of time [1,3]. However, due to the need to rule out more serious cardiovascular and neurological causes of syncope, the workup for syncope is often costly and yields low diagnostic value [4].

There have been many attempts to streamline the evaluations using algorithmic approach. However unfortunately most institutions do not have any protocol for the evaluation and management. There is wide variation in the approach in management of syncope in children, compared to adults. Many children are managed without any medical evaluations, especially in resource poor settings. The outcome and prognosis of these cases is still unknown.

Although currently there are no international well-established guidelines for the management of pediatric syncope, various regional societies and stake holders have formed task forces to bring out their own recommendations and position statements. The European Cardiac Society (ECS) has established guidelines and the American Heart Association (AHA) and American College of Cardiology Foundation (ACCF) have issued a joint consensus statement on the management of adult syncope. Both of these algorithms recommend initial screening with an electrocardiogram (EKG) to rule out life-threatening cardiac conditions and a careful history and physical examination. Additional diagnostic testing, including basic laboratory work, is only

recommended if the initial screening is abnormal [5,6]. Similar guidelines have been published for management of transient loss of consciousness (“blackouts”) in adults and young people by the National Institute for Health and Clinical Excellence (NICE) [7]. The Canadian Cardiovascular Society (CCS) and Canadian Pediatric Cardiology Association Position Statement on the Approach to Syncope in the Pediatric Patient recommend that for children with a history typical of Vasovagal syncope, no family history of arrhythmia, and normal physical examination, no further cardiac evaluation and EKG be performed due to the low yield [8].

It is important to address these from the standpoint of a quality of care and performance improvement to come up with recommendations in reducing the over utilization of resources as well as to provide better management of children with syncope. Is it necessary to do a particular evaluation and what is the utility of these often costly investigations?

We suspect that there is great variability of the care of pediatric patients presenting with syncope at our own health system and this variability and utilization of low-yield diagnostic testing could be improved with the development of a similar guideline.

In Italy, a study of the impact of the 2009 Italian pediatric clinical guidelines on the management of syncope demonstrated that the implementation of guidelines on syncope improve diagnosis, reduce hospital admissions, and decrease the use of unnecessary diagnostic tests [9].

Objective

This study aims to better understand the etiology of syncope in our pediatric population, positive and negative predictors of those causes, and examine the utilization and utility of specialist evaluations and diagnostic testing used in the workup of syncope in an effort to understand how we can improve the clinical care of pediatric patients presenting with syncope.

Methods

University of Missouri Institutional Review Board approval was obtained with appropriate waivers prior to this study.

A retrospective chart review was conducted for the five-year period, 2011-2015, on pediatric patients who presented to a large, Midwestern health system, including outpatient clinics as well as emergency departments within the tertiary care centers, with a diagnosis of syncope.

Inclusion criteria included all patients ages 1-18 with an ICD-9 and ICD-10 diagnosis code for syncope (780.2 and R55, respectively).

Data was abstracted from each patient's chart by a medical student researcher using a data collection form in the secure, database management web application, Research Electronic Data Capture (REDCap). Forty-one fields of data were collected, including the patient age and sex, information on the event history, past medical history, and family history, types of diagnostic testing performed, where the patient entered the MU health system, and the final etiology of the syncopal event(s).

We excluded the patients whose charts only reporting "dizzy spells" or "presyncope", coding errors, and patients who only had diagnostic testing performed without an associated visit.

After these exclusions, 750 patient charts were reviewed. Data was exported from REDCap into Microsoft Excel® for basic analysis and Minitab® 17.3.1 was used to perform Fisher exact statistical tests to determine positive and negative predictors of syncope; α was set at 0.01. Once predictors were determined, positive and negative likelihood ratios were calculated for each statistically significant history item related to a seizure or cardiac diagnosis.

Results and discussion

750 pediatric patients presenting with syncope over a 5-year period were identified. We found that more than half of our cases presented initially to the Emergency department (52%), and the rest presented to Cardiology clinic (21%), Primary Care clinics (14%), Neurology clinic (7%) other specialists (2%), Urgent or Quick care facility (1%), or inpatient observation (3%). Those patients initially presented to the Emergency Department were over twice as likely to get a head CT and nearly 1.5 times as likely to get additional testing. (Table 1).

Table 1: Odds of Testing in the Emergency Department vs. Other Entry Points

Test Performed	Odds Ratio (95% Confidence Interval)
Electrocardiogram	0.88 (0.63-1.23)
Echocardiogram	0.14 (0.10-0.20)
Holter Monitor	0.22 (0.14-0.35)
Brain MRI	0.49 (0.33-0.74)
Head CT	2.49 (1.71-3.63)
Electroencephalogram	0.48 (0.34-0.68)
Additional Testing	3.42 (2.42-4.84)

Among the evaluations performed, a majority had an EKG (76%). Other cardiac-related evaluations included evaluation by a pediatric cardiologist (36.9%), echocardiography (33.7%), and Holter monitoring (16.1%). Evaluation by a pediatric neurologist was performed in 23.1% of the cases. Other neurologic-related evaluations included EEG (23.5%), Head CT scan (20.8%), and Brain MRI (15.7%). 73.6% of patients had at least some other additional testing, including additional imaging (including chest x-ray) or additional laboratory work-up.

The majority of all testing performed resulted in diagnosis of neurocardiogenic syncope (74%), while only 2.3% and 1.6% were attributed to cardiac and seizure diagnoses, respectively.

Patients with a seizure diagnosis were significantly more likely to report abnormal movements,

post-ictal confusion, absence of prodrome, and a family history of seizures; they were significantly less likely to report orthostatic symptoms. (Table 2).

Table 2: Positive and Negative Predictors of Seizure When A Child Presents with Syncope

Finding in History	Positive Likelihood Ratio (95% Confidence Interval)	Negative Likelihood Ratio (95% Confidence Interval)
Post-ictal Confusion	9.88 (6.54-14.93)	0.27 (0.10-0.72)
Abnormal Movements	7.53 (4.02-14.10)	0.54 (0.30-0.94)
Shaking	5.38 (3.20-9.06)	0.47 (0.24-0.91)
Family History of Seizures	5.20 (2.83-9.54)	0.55 (0.31-0.97)
Standing Up/Postural Changes	0	2.65 (2.41-2.90)

History of chest pain, palpitation, exertional syncope and abnormal cardiac history are more predictive of a primary cardiac etiology. (Table 3).

Table 3: Positive and Negative Predictors of Cardiac Diagnosis When A Child Presents with Syncope

Finding in History	Positive Likelihood Ratio (95% Confidence Interval)	Negative Likelihood Ratio (95% Confidence Interval)
Chest Pain/Palpitations	6.44 (4.07-10.18)	0.45 (0.26-0.80)
Abnormal Cardiac History	4.79 (2.18-10.55)	0.75 (0.55-1.02)
Exertion	4.24 (2.13-8.43)	0.71 (0.50-1.0)
Standing Up/Postural Changes	0.47 (0.23-0.99)	1.85 (1.35-2.56)

While the utility of diagnostic testing is hard to quantify, our results suggest that a majority of specialist evaluations, cardiac testing, neuroimaging, of EEGs are not helpful in determining syncope etiology. (Table 4).

Table 4: Utility of Specialist Evaluations and Diagnostic Testing

Specialist Evaluation or Testing Performed	Total Evaluations/Tests Performed in Cohort (n = 750) (%)	Total Evaluations/Tests Performed in Cohort Diagnosed with Neurally Mediated Syncope (n = 555) (%)	Evaluation/Test Performed and Neurally Mediated Syncope Diagnosed (%)

Cardiologist Evaluation	277 (36.9%)	210 (37.8%)	75.8%
Neurologist Evaluation	173 (23.1%)	91 (16.4%)	52.6%
Electrocardiogram	570 (76.0%)	431 (77.7%)	75.6%
Echocardiogram	121 (16.1%)	80 (14.4%)	66.1%
Holter Monitor	253 (33.7%)	185 (33.3%)	73.1%
Brain MRI	156 (20.8%)	90 (16.2%)	57.7%
Head CT	118 (15.7%)	64 (11.5%)	54.2%
Electroencephalogram	176 (23.5%)	88 (15.9%)	50.0%
Additional Testing	552 (73.6%)	408 (73.5%)	73.9%

Conclusions:

Unlike prior studies focusing on primarily vasovagal syncope in children by excluding possible neurological and cardiac etiologies, we have looked all the pediatric cases which presented with syncope regardless of the etiology, primarily to identify the factors which could predict various diagnoses. Benign neural mediated syncope (NMS) accounts for the majority of pediatric syncope cases in this Midwest cohort, which is consistent with previously published data [10]. Despite the benign nature of most of these events, over 50% of patients in our study presented to the ED – where they were more likely to have additional laboratory testing and imaging (e.g., chest X-rays and head CTs). Cardiac and neurologic causes of syncope are concerning, and at times, life-threatening, but combined these causes represented only 7.1% of cases of syncope in our study population, with only a handful of these cases being potentially life-threatening. While we overuse more expensive diagnostic testing, we only screen patients for life-threatening cardiac conditions with an EKG in 76% of cases. Furthermore, our data shows that there is great variability in how syncope is managed in the pediatric population, which is consistent with previous studies [7].

Our results show that there is an opportunity to improve the management of syncope in the pediatric population. Well-established algorithms on the management of syncope in adults recommend that an EKG should initially be performed in all cases to rule out life-threatening cardiac etiologies of syncope and this may be an appropriate initial test in the pediatric population if history and physical examination suggest cardiac etiology. However, when it comes to further workup, we recommend following an evidence-based guideline for the management of pediatric syncope to help provide clinical consistency and reduce costly, low-yield diagnostic testing. Current best evidence as well as our findings related to the positive and negative predictors of more serious etiologies of syncope can be used in guideline development and refinement and to determine when additional workup is warranted. Recently, investigators at another tertiary children's hospital implemented quality improvement interventions to reduce low-yield testing in the management of pediatric syncope in the emergency department (ED). After implementation, the investigators demonstrated a dramatic reduction in low-yield testing for children presenting to the ED for syncope, without significant cardiac or neurologic conditions being missed. This did not increase the likelihood of further testing at 2 months follow up [11].

Since our project has been completed, a guideline for evaluation and management of patients with syncope has been published by the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines, utilizing the studies databases published before 2016. Even though this has been endorsed by the Pediatric and Congenital Electrophysiology Society, this was mostly skewed to situations in adult population [12].

We hope that a suitable pediatric algorithm-based guideline to be followed, taking in to consideration unique clinical conditions in children presenting with syncope, to avoid costly and unnecessary tests in children.

Abbreviations: NMS: neurally mediated syncope, EKG: Electrocardiogram, EEG: Electroencephalogram

Competing interests

No external funding was secured for this study. The authors have no financial relationships or conflicts of interest relevant to this article to disclose.

Authors' contributions

AA conceptualized the study, supervised data collection, drafted the initial manuscript, and critically reviewed and revised the manuscript for important intellectual content. MS designed the study and data collection instruments, collected data, carried out initial analysis, and reviewed and revised the manuscript.

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