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ORIGINAL ARTICLE

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Tilt table testing to diagnose pseudosyncope in the pediatric population

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Abstract

Objective: Pseudosyncope can be difficult to distinguish from true syncope. Often, pediatric patients with pseudosyncope undergo multiple tests and referrals before the appropriate diagnosis is reached. The purpose is to describe the utility of the head-up tilt table test to elicit the diagnosis of pseudosyncope in the pediatric population.

Design: Retrospective chart review from November 2012 to December 2015 of patients age ≤23 years referred for 30-minute, 80-degree tilt table test. Pretest probability for pseudosyncope was high if there was no response to traditional management, atypical episodes, occurrence during undesirable exercise, or prolonged episode duration. Inductive techniques were utilized to persuade patients of the likelihood of experiencing an episode during the procedure. Pseudosyncope was confirmed when a patient had normal vital signs during their event and had reflex responses to disruptive maneuvers.

Results: Tilt table testing was performed on 89 patients [median age 16 years (5–23); 26% male] with the majority (60%) being negative for pseudosyncope, including 51 true negatives and 2 false-negatives. Of the 36 patients with syncope during tilt table testing, 28 were diagnosed with vasovagal syncope and 8 with pseudosyncope [median age 16 years (15–21); 38% male]. Pseudosyncope episodes were observed immediately in 2 patients. All patients with late-onset pseudosyncope required inductive techniques prior to the recorded episode.

Conclusions: Pseudosyncope can be identified during tilt table testing if inductive techniques are utilized in patients with a high index of suspicion. Disruptive maneuvers are excellent adjunctive methods to confirm the diagnosis. Tilt table testing is an effective means to identify pseudosyncope and allow appropriate diagnosis and treatment.

KEYWORDS
pediatric, pseudosyncope, syncope, tilt table testing

1 | INTRODUCTION

Syncope is a transient episode resulting from decreased cerebral perfusion and increased visceral vasoconstriction. Syncope is clinically characterized by transient loss of consciousness, decreased skeletal muscle tone, and no response to voice or painful stimuli. Vasovagal syncope (also called neurocardioinhibitory or neurocardiogenic syncope) is mediated by an abnormal autonomic nervous system response to various stimuli, with vasodepressor (decreased sympathetic tone), cardioinhibitory (increased parasympathetic tone), and mixed subtypes.[1,2] Syncope is a frequent occurrence in pediatric patients, the estimated prevalence of which is as high as 25% in the general population, with vasovagal syncope representing the majority of cases.[3] Characteristic prodromal symptoms described by patients with syncope include lightheadedness, dizziness, blurred vision, and upset stomach—all consequent to decreased cerebral perfusion and increased visceral vasoconstriction. Exacerbating circumstances prior to a typical syncopal event include sustained exercise, prolonged standing, inadequate sleep, and certain environmental conditions such as hot and humid weather.

The underlying cause of syncope is rarely life-threatening.[3] In general, physicians must consider a broad differential diagnosis for pediatric patients presenting with syncope, including cardiovascular,

neurologic, environmental, toxic/exposure, endocrine, and psychogenic causes. The medical evaluation of syncope in children may be expensive and often results in excessive testing. A cost analysis performed in 1987 demonstrated that adolescents received six diagnostic tests on average following the clinical presentation for syncope. Moreover, 40% of the pediatric patients presenting with syncope were admitted to the hospital. The cost for this medical assessment was reported in thousands of dollars per patient.[4]

Pseudosyncope is defined as a transient, apparent loss of consciousness (LOC) in the absence of true LOC. That is, a patient is noted to faint or collapse, but the episode is not associated with the characteristic physiologic triggers of syncope: whereas a patient with vasovagal syncope may have an initial increase in heart rate followed by a decrease in both blood pressure and heart rate, sometimes with the presence of a junctional escape rhythm, a patient with pseudosyncope will have no vital sign changes. Pseudosyncope can be classified as a conversion disorder (functional neurological symptom disorder) and is hypothesized to represent a physical manifestation of internal or psychologic stressors.[5] By history, patients may report that these episodes of pseudosyncope occur in conjunction with stressful situations or are preceded by symptoms of anxiety, including palpitations.

The true incidence of pseudosyncope in the general population is unknown and is likely under recognized by the medical community, as this entity can be difficult to clinically distinguish from classic vasovagal syncope.[6,7] On review of systems, characteristics more often associated with pseudosyncope (compared with vasovagal syncope) include: increased frequency of episodes (2 per month vs. 0.25 per month), delayed recovery of consciousness, episodes with unusual prodrome, atypical triggers, eye closure, and apparent LOC >1 minute.[8] Pseudosyncope has been diagnosed in adult patients using video electroencephalography (EEG) monitoring, utilizing inductive techniques to obtain a diagnosis, including hyperventilation, photic stimulation, and strong verbal suggestion.[6] In addition, diagnostic head-up tilt table test (HUTT) has been described for pseudosyncope and included in some consensus guidelines for the clinical evaluation of syncope.[9–12]

The use of the HUTT to confirm the diagnosis of pseudosyncope in the pediatric population has previously been described on a case report basis, in conjunction with continuous transcranial Doppler.[11] Therefore, the purpose of this study was to determine the utility of performing a HUTT to confirm the diagnosis of pseudosyncope in patients ≤23 years of age presenting with a high pretest probability for pseudosyncope.

2 | METHODS

This study complies with the Declaration of Helsinki and was approved by the Institutional Review Board (IRB) at University Hospitals Cleveland Medical Center, Cleveland, Ohio. A retrospective, single-center review of the electronic medical record (EMR) and the Pediatric Electrophysiology Lab procedure database was performed to identify all patients ≤23 years of age at time of referral for 30-minute, 80-degree tilt with continuous monitoring of electrocardiogram (ECG) and pulse oximetry from November 2012 through December 2015.

Per outpatient clinic protocol, all patients referred to Pediatric Cardiology with a chief complaint of syncope are first seen and evaluated by a pediatric cardiologist. The initial visit includes a full history, review of systems, vital signs, physical exam, and 15-lead ECG. Further cardiac testing and/or imaging is recommended if there are abnormalities in vital signs (e.g., systemic hypertension), physical exam (e.g., outflow tract murmur), or ECG (e.g., voltage criteria for left ventricular hypertrophy). Likewise, exercise stress test or ambulatory heart rhythm monitoring may be consider if there are red flags identified on history (e.g., exercise symptoms) or review of systems (e.g., frequent palpitations), respectively.

Patients presenting with a history consistent with vasovagal syncope and otherwise normal review of systems, vital signs, physical exam, and 15-lead ECG, are prescribed oral salt and fluid management. Follow-up is conducted at 2 weeks. If there are any persistent symptoms despite adherence to salt/fluid management, pharmacologic therapy is considered, with subsequent 2-week follow-up. For patients in which cardiac evaluation is negative and symptoms persist despite standard therapies, HUTT is recommended as a diagnostic test. Likewise, a patient is also referred for HUTT is (s)he exhibits unusual episodes, either by way of surrounding circumstances, timing, or progression of symptoms; experiences episodes during undesirable exercise or activity; or is witnessed to events of an abnormally prolonged duration.

As such, inclusion criteria for this study included that prior to HUTT, all patients were seen and evaluated by a pediatric cardiologist at the same institution. Charts were reviewed for all details surrounding the evaluation and diagnosis of syncope, including history and associated symptoms (lightheadedness, vision and hearing changes, and palpitations, as well as the duration, frequency, location, and timing of episodes), medical history, family history of arrhythmia and congenital heart disease, and all syncope-associated diagnostic tests and treatments.

The nursing team in the Pediatric Electrophysiology Lab performed all tilt table tests, attended by a pediatric cardiologist and a pediatric cardiology fellow-in-training. All documentation reviewed was authored by a single physician (CSS); however, initial management for syncope may have been conducted at an outside institution or by another pediatric subspecialty division prior to referral for HUTT test.

Patients arrived for their procedure in the Pediatric Electrophysiology Lab and underwent a standardized HUTT protocol. Inductive techniques consisted of physician conversations with all patients referred for HUTT that emphasized the diagnostic utility of the HUTT. Here, the patient was reassured that the purpose of the HUTT is to gather specific vital sign information during a period of continuous monitoring. Patients are given the anticipation that it is likely that an episode of syncope will occur during the HUTT, given the persistent, recurrent, and/or refractory presentation of his/her symptoms to clinic. Likewise, clinical justification for the study is also explained in terms of monitoring continuous vital signs in a safe environment during an episode of

syncope, potentially providing diagnostic data. This entire physician-patient conversation was defined as "inductive techniques."

Prior to every HUTT test, inductive techniques were utilized to convince patients of the likelihood of experiencing an episode during the procedure. In particular, inductive techniques routinely were employed in the clinic when discussing the evaluation of syncope with HUTT, as well as in the lab immediately prior to the procedure. These conversations with the patient included the strong suggestion of an episode likely occurring during HUTT, reiterating that it was safe for an episode to occur during HUTT in the presence of the lab staff, such that vital signs during an episode could be accurately measured and recorded to help determine the etiology of syncope. Pretest probability for pseudosyncope was high if the patient had (1) no response to traditional management (salt, fluids, and pharmacologic therapy), (2) atypical episodes of syncope by history (stigmata of seizure, unprovoked occurrence, no symptom prodrome described), (3) occurrence during undesirable exercise, or (4) prolonged episode duration (loss of consciousness >2 minutes).

Following a discussion of the risks and benefits of the procedure, the pediatric cardiologist obtained written consent, as well as verbal assent from children and adolescents, as applicable. Following procedural time-out, patients were secured to the tilt table in the horizontal (0-degree tilt), supine position. Continuous 12-lead surface ECG was recorded; peripheral pulse oximetry monitoring was initiated. The nursing staff asked patients to remain as still as possible during the procedure and to not contract muscles of the lower extremities. The nursing staff obtained blood pressure and heart rate measurements with the patient horizontal (baseline), at 80-degree tilt, every one minute during tilt, upon discontinuation of tilt (return to horizontal, supine position), and in the free upright sitting position at the end of the procedure prior to discharge. The physician team measured baseline ECG intervals directly on the computer workstation (WorkMate Claris Recording System, St. Jude Medical, Inc., St. Paul, MN, USA).

Once the 80-degree HUTT was initiated, the nursing staff encouraged patients to report any symptoms experienced throughout the study: palpitations, lightheadedness, vision changes, diaphoresis, weakness, etc. At the time symptoms were reported, blood pressure, heart rate, and pulse oximetry were simultaneously recorded. If the patient did not voluntarily report symptoms without prompting, the nursing staff asked the patient, "Are you having any symptoms?" at least every 5 minutes during 80-degree tilt. The HUTT test was discontinued if an episode of syncope was recorded or after 30 minutes in the 80-degree tilt position, whichever occurred first. Inductive techniques in the form of verbal reassurance to the patient were employed during HUTT to reiterate the safe monitoring environment.

Pseudosyncope was defined as an episode of apparent LOC during HUTT, during which the patient had no vital sign changes documented and also exhibited reflex response to disruptive maneuvers, including verbal answer to questions, startle to loud noise (hand clap), or avoidance of sternal rub. Pseudosyncope was described as immediate onset if an event occurred <2 minutes into the HUTT test, whereas late onset pseudosyncope occurred >15 minutes after initiation of the 80-degree tilt. If a pseudosyncope event did not occur in the first 2 minutes of the HUTT, inductive techniques were repeated. Here, the physician highlighted the safe environment for an episode of syncope to occur, along with the diagnostic importance of continuous vital sign monitoring during an event.

3 | RESULTS

Overall, 89 patients with chief complaint of syncope were included in the study cohort [median age 16 years (range, 5–23 years); 26% male]. Baseline patient characteristics and presenting symptoms at the time of referral for HUTT are outlined in Table 1. Inpatients comprised 9% of the total cohort.

The majority of HUTT tests (60%) were negative, including 51 true negatives and two false-negatives. Of the 36 patients diagnosed with syncope during HUTT, 28 were diagnosed with vasovagal syncope and 8 were diagnosed with pseudosyncope [median age 16 years (15–21); 38% male]. Pseudosyncope episodes were observed immediately (<2 minutes after the initiation of tilt) in 2 patients, with the 6 others exhibiting late-onset symptoms and had inductive techniques repeated during the HUTT. All patients with late-onset pseudosyncope required inductive techniques prior to the recorded episode. In each case, pseudosyncope was verified by a reflex response to disruptive maneuvers. The two patients with false-negative HUTT tests were both female, ages 15 and 16 years, and were both later diagnosed with pseudosyncope in clinical follow-up after HUTT. The patients diagnosed with pseudosyncope are summarized in Table 2. All 10 of these patients were subsequently referred to outpatient Adolescent Psychology and discharged from further follow-up in the Pediatric Cardiology clinic.

4 | DISCUSSION

Pediatric patients with syncope present to medical attention in a variety of ways, ranging from primary care to the emergency department. Given that syncope is a frequent chief complaint in pediatric practice, effective and efficient evaluation and diagnosis are critically important.[3] In all cases, meticulous history is required to guide further clinical evaluation and management.[13,14] Current clinical practice guidelines for the evaluation of syncope in pediatric patients emphasize the fundamental importance of history and physical exam; however, the diagnosis of pseudosyncope has been omitted from consideration in the differential diagnosis.[15]

TABLE 1 Demographics of patients referred for tilt table test

N	89
Gender M/F (% male)	23/66 (26%)
Median age at diagnosis	16 years (range, 5–23 years)
Symptomatic at presentation, *n* (%)	89 (100%)
Admitted inpatient at time of head-up tilt table test, *n* (%)	8 (9%)

TABLE 2 Presentation and clinical course of patients with pseudosyncope

Age (years)	Gender	Presentation	Pediatric specialties involved	HUTT test findings	Follow-up
16	F	Recurrent syncope and near-syncope after swimming/exercise; failed salt and fluid trial	Cardiology	Patient's head slumped forward with apparent loss of consciousness at 17 minutes into HUTT test with no vital sign changes, at which time the patient replied, "Yes," that he had passed out.	No further episodes documented at 13 months.
17	F	Vasovagal syncope; however, there were additional atypical seizure-like episodes were video recorded at home, involving rhythmic beating of the head and right upper extremity	Neurology Cardiology	Seizure-like episode occurred at 18 minutes into HUTT test with no vital sign changes, consisting of rhythmic movements. Movements were suppressible. There was prolonged apparent LOC after return to the supine position. Episodes continued to start and stop, according to voice commands.	No further atypical episodes at 1 year. Continued water therapy, salt supplementation, and regular exercise.
16	F	Frequent syncope epsiodes with prolonged duration of apparent LOC, for which she had received CPR on a couple occasions	Pulmonology Psychiatry Neurology Cardiology	Immediately upon tilt, developed dyspnea, shaking of the RUE, dizziness, headache, nausea, and hearing changes. Passed out at 12 minutes with normal VS. Deflected from disruptive maneuvers. During apparent LOC, physician gave suggestion that she would begin to have a seizure, which she did. When the physician told the room she would stop, she stopped.	Followed with psychology and psychiatry for pharmacologic management of depression and ADHD. Further history revealed difficulty with peers at school, including fights and bullying. No further syncope or atypical episodes were noted after 22 months.
15	F	Evaluated for posttraumatic vasovagal syncope following a concussion. Then, started having longer episodes of LOC related to emotional situations.	Neurology Sports Medicine Cardiology	Exhibited apparent LOC 30 seconds into tilt, at which time there were no changes in VS compared with baseline.	Referred to Sports Psychologist for continued episodes at 1-month follow-up, each associated with anxiety and/or panic attacks.
15	M	History of autism, developmental delay, and chronic daily headache. Frequent syncope up to 5 times daily with prolonged LOC.	Neurology Gastroenterology Sleep Medicine Psychiatry Cardiology	Patient had a characteristic episode 15 minutes into tilt with no vital sign changes. During the episode, the patient replied that he was "barely holding on."	At 5 months, fainting spells were improving.
15	F	Vasovagal syncope, in addition to atypical episodes of intermittent and frequent (up to 6/day) "spacing out" with eye rolling. Admitted for evaluation.	Gastroenterology Cardiology Infectious Disease Psychiatry Cardiology	Apparent LOC and eye flickering at 10 minutes; deflected from hand clap.	No further syncope at 3-month follow-up.
21	F	History of supratentorial PNET, seizures, and migraine headaches. Admitted for evaluation of dizziness and prolonged LOC.	Neurology Endocrinology ENT Audiology Cardiology	Nausea, lightheadedness, and syncope with 2 minutes of tilt; no VS changes noted compared with baseline.	No further syncope documented at 4 months.
16	M	Frequent episodes of LOC during exercise (football practice), despite full treatment for seizures.	Neurology Cardiology Psychology	Patient stated that he had passed out at 17 minutes into tilt.	At 4-month follow-up with Psychology, anxiety was believed to trigger spells.
15	F	Admitted for evaluation of atypical episodes of sudden weakness while standing, as well as shuddering/dizziness/vision changes while sitting.	ENT Audiology Cardiology Psychiatry	False-negative study.	On further evaluation by Psychology while still inpatient, diagnosed with conversion disorder associated with underlying stress and anxiety.
16	F	Vasovagal syncope in the setting of chronic daily abdominal pain, migraine headaches, and SMA syndrome requiring enteral nutrition via nasogastric tube; intermittent vertigo and tinnitus.	Gastroenterology Cardiology Neurology	False-negative study.	Referred to Psychology.

Of the 10 cases of pseudosyncope described in this study, all presented with an atypical history for classic vasovagal syncope. As a result, pretest probability was increased for pseudosyncope prior to referral for HUTT testing in all 10 cases. Certainly, not all patients referred to Pediatric Cardiology with concern of syncope underwent HUTT. However, HUTT for pseudosyncope should be considered in the clinical practice guideline when a patient (1) has refractory symptoms that fail to improve with standard management of vasovagal syncope, including oral hydration and salt management; (2) exhibits unusual episodes, either by way of surrounding circumstances, timing, or progression of symptoms; (3) experiences episodes during undesirable exercise or activity; or (4) is witnessed to events of an abnormally prolonged duration. In addition, previous study reported that the frequency of episodes in general is higher in patients found to have pseudosyncope. Moreover, of 1,164 HUTT tests performed for adults and adolescents with syncope, 2% of these patients were found to have concomitant vasovagal syncope and pseudosyncope.[5]

Of those pediatric patients with syncope referred for HUTT test at the single center in this study, 11% were diagnosed with pseudosyncope. Previously, a number of strategies have been described for the diagnosis of pseudosyncope in in adults.[16] The goal of diagnostic testing in pseudosyncope is to demonstrate an episode with no concurrent change in vital signs, signifying that perfusion remains appropriately intact without physiologic compensation. In order to increase the likelihood of an episode occurring with HUTT, induction techniques are routinely employed for every patient prior to HUTT. Here, the patient is reassured that it is safe to have an episode during the test and that the value of recording an episode is that any vital sign abnormalities are documented. Moreover, in this study cohort, pseudosyncope episodes were observed immediately (<2 minutes after the initiation of tilt) in two patients. For all others, the same inductive techniques were verbally repeated during the HUTT. The specific utility of these inductive techniques has not been studied during HUTT in pediatric patients. This method should not introduce additional bias to the study, as all patients referred for HUTT received inductive techniques prior to the study. All patients who did not exhibit syncope during the first 2 minutes of the HUTT received repeat inductive techniques.

Several groups have described utilization of HUTT testing for the diagnosis of pseudosyncope.[9,17,18] Incorporation of EEG and/or video monitoring has been considered.[17] In addition, near-infrared spectroscopy (NIRS) technology has been recently described in conjunction with HUTT testing in the pediatric and adolescent population, in order to document that cerebral perfusion remained stable in pseudosyncope, despite recorded symptoms during HUTT testing.[19–22] While these measures increase the complexity of monitoring during HUTT, these modalities likely do not augment the diagnostic ability of unchanged heart rate and blood pressure during an episode of pseudosyncope.

Compared with previous studies, the true incidence of pseudosyncope in the general population may be underreported in the current literature.[18,23] One retrospective review of all 12 HUTT tests performed at a single center during a 6-month period for pediatric patients with syncope reported that 25% were diagnosed with pseudosyncope.[22]

While a positive test for pseudosyncope is not necessarily required for further management, pseudosyncope is not a straightforward diagnosis to deliver to a patient's family. Objective data is valuable when counseling patients and families about a nonhysiologic cause of syncope. Accurate and prompt diagnosis facilitates efficient outpatient referral to adolescent psychology, though further study is needed to define the most appropriate and effective treatment for pseudosyncope.

The differential diagnosis for syncope has not changed significantly over time; however, utilization of diagnostic tools such as HUTT has become more refined. This study was limited by the relatively small number of patients, a retrospective chart review, a variable retrospective protocol, and unavailable follow-up data, as it was not possible to contact those patients with pseudosyncope discharged from further evaluation in outpatient pediatric cardiology clinic. Regardless, physicians need efficient methods to confirm the diagnosis of pseudosyncope. This study highlights the empiric value of accurately diagnosing and prompt referral to outpatient psychology. Further study is required to delineate the cost effectiveness for HUTT utilized in the diagnosis of pediatric patients with pseudosyncope, as well as to define outcomes associated with therapy for pseudosyncope in the setting of adolescent psychology. In the meantime, the use of HUTT for diagnosing pseudosyncope should be added to clinical practice guidelines for the management of syncope in pediatric patients.

5 | CONCLUSION

Pseudosyncope should be considered in all patients that have failed appropriate management of their episodes, exhibited atypical episodes, experienced events during undesirable exercise, or documented prolonged event duration. Pseudosyncope can be identified in pediatric patients by head-up tilt table testing when an event is accompanied by normal vital signs and confirmatory reflex response to disruptive maneuvers. Inductive techniques may be repeated during head-up tilt table testing in patients that do not have an immediate event during tilt table test. Finally, tilt table testing is not diagnostic in all pseudosyncope patients. Therefore, careful outpatient follow-up is necessary to confirm the diagnosis.

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AUTHOR CONTRIBUTIONS

Dr. Robinson conceptualized and designed the study, designed the data collection instruments, drafted the initial manuscript, carried out the initial analyses, reviewed and revised the manuscript, and approved the final manuscript as submitted.

Dr. Shivapour critically reviewed the manuscript, coordinated and supervised data collection, and approved the final manuscript as submitted.

Dr. Snyder conceptualized and designed the study, coordinated and supervised data collection, critically reviewed the manuscript, and approved the final manuscript as submitted.

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