

# Syncope in children and adolescents living in north-eastern Poland – scope of causes

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## ABSTRACT

**Purpose:** To investigate the diagnostic yield of different tests and assess the scope of causes in children referring to the hospital with a syncope in north-eastern Poland.

**Methods:** A review of 386 consecutive patients (age 2–18 years) living in north-eastern Poland presenting to the cardiology department with a new onset syncope (which appeared to be neurally mediated by history) was undertaken. The patients underwent physical examination, laboratory tests, electrocardiography, 24-holter monitoring, head-up tilt-test, exercise test, echocardiography and electroencephalography. All the tests were performed in most of the patients, without ending the diagnostics after finding the first probable cause of loss of consciousness.

**Results:** 229 potential causes of syncope were found in 191 patients (49.4%), with 2 possible causes in 32 patients and 3 potential causes in 3 patients. The top 3 tests with the highest diagnostic yield were: head-up tilt test (41.4%), 24-holter monitoring (14.5%) and echocardiography (8.4%). Electroencephalography was useful in 3 patients (1.5%) and exercise test did not help in any patient.

**Conclusion:** In some children more than one potential cause of syncope was diagnosed. That might confirm multiple factors' causality of syncope. Head-up tilt-test has the highest diagnostic yield in children with syncope. If the diagnostic protocol is not very strict, one might find some crucial conditions in about 8.3% of patients.

**Key words:** syncope, tilt-test, adolescents, children, diagnostics

## INTRODUCTION

Syncope is a sudden and temporary loss of consciousness (TLOC) and postural tone as a consequence of an insufficient cerebral blood perfusion. The incidence of syncope among children and adolescents coming to medical attention is 126/100 000, with a peak around the age of 15 years [1]. However about 20% of males and 50% of females report to have experienced at least one episode of syncope by the age of 20 years [2].

Not every loss of consciousness is a syncope, but loss of consciousness is a manifestation of each and every syncope. That is why syncope must be distinguished from other, more

serious, causes of loss of consciousness, including cardiac (arrhythmia, channelopathies), neurological (epilepsy, transient ischemic attack) and metabolic (hypoglycemia, electrolyte imbalance) disorders, as well as drug poisoning.

We collected the medical data of all patients admitted for evaluation of syncope (in whom the history indicated vasovagal syncope) to the Department of Pediatrics, Endocrinology, Diabetology with Subdivision of Cardiology (formerly 2<sup>nd</sup> Department of Pediatrics) of the Medical University of Białystok, Poland, between 01.01.2006 and 01.01.2009. The purpose of this study was to analyze the usefulness of different investigations in revealing the cause of the complaint and the prevalence of various conditions

underlying the syncope. That is why we did not limit ourselves to a very strict protocol with cut-off points just after revealing one potential cause of the syncope but we performed as many investigations as possible (and reasonable by the patients' history).

## MATERIALS AND METHODS

The study enrolled 386 consecutive patients (252 girls and 134 boys) with suspected syncope who were admitted to our Department, both to scheduled diagnostics and transferred from the Casualty Department by the decision of a cardiologist. The mean age of the group was 13.8 years (2–18 years of age; SD = 2.5).

The patients were assessed by a protocol which included the following investigations (Tab. 1).

### History and clinical examination

Thorough history was taken concerning the circumstances of losing consciousness and preceding symptoms. Only children with strong suspicion of vasovagal syncope (prodromal symptoms, vertigo/dizziness on standing etc.) were included into the study. Physical examination was performed.

### Laboratory tests

Complete blood count, glucose level and electrolytes (Na, K, Cl, Mg, Ca) were analyzed in all patients.

### Cardiac investigations

Electrocardiography (ECG) was performed in every child. The 24-hour ECG monitoring (ECG monitor type 300-7, Suprima System, Oxford, UK), tilt-table test (Westminster protocol) and echocardiography (Sonos 4500, Hewlett Packard, USA) were performed in nearly all of the patients (87.5%, 84.5% and 98.4% respectively). In 71% of the patients – those complaining of syncope, dizziness, heart palpitations or enormous fatigue after exercising – we also performed an exercise test (TM310, Trackmaster, Newton, USA).

### Neurological investigations

A neurologist consulted all of the patients and he qualified 61% of them for electroencephalography (EEG DigiTrack, Elmiko, Warsaw, Poland).

### Statistical analysis

Data was analyzed with SPSS Statistics 17.0 (SPSS, Cracow, Poland).

## RESULTS

In detailed physical examination the most important findings were: 2 or 3 grade heart murmur in 33 patients (8.5%) and unsteady (questionable) Romberg's test in 7 patients (1.8%). Laboratory results revealed anemia (decreased number of red blood cells or hemoglobin threshold) [3] in 1 patient (0.3%) and diabetes (glucose  $\geq 126$  mg/dl) in 2 children (0.5%) [4]. In 383 patients (99.2%) the laboratory results were in norm values.

ECG showed prolonged QT (0.47 and 0.48 sec) in 2 patients (0.5%). The remaining 381 patients (99.5%) had only minor anomalies (intraventricular conduction disturbance etc.) or a normal ECG.

In 24-hour Holter monitoring a probable causes of syncope were as followed: prolonged QTc in 22 (6.4%), pre-excitation syndrome in 12 (3.6%), second degree atrio-ventricular block type II in 12 (3.6%) and over 10% of ventricular ectopic beats in 3 (0.9%). In 289 patients (85.5%) 24-hour Holter monitoring demonstrated no important abbreviations.

Head-up tilt-test was positive in 135 patients (41.4%). Blood pressure dropping was the reason to stop the test in 49 children (15%), the decreasing heart rate in 14 children (4.2%, in 7 pauses longer than 3 seconds were observed) and mixed mechanism in 56 (17.2%). In 16 children (4.9%) the test was discontinued because of prodromal symptoms. Head up tilt-test was accounted negative in 191 children (58.6%).

The exercise test did not show any disorders which account for syncope.

**Table 1** Inclusion and exclusion criteria to the study and investigations.

Inclusion criteria	Study – patients with syncope and/or presyncope who presented prodromal symptoms before loss of consciousness (vertigo/dizziness when standing, weakness, visual disturbances etc.); patients with prodromal symptoms during prolonged standing and/or in crowded places and/or while standing up quickly etc.
	Head-up tilt table test – cooperation with the patient during the test
	Holter and ECHO – as to the study
	Exercise test – syncope, dizziness, heart palpitations or enormous fatigue after exercising
Exclusion criteria	EEG – neurologist's opinion
	Sudden loss of consciousness without prodromal symptoms and without characteristic circumstances for vasovagal syncope (prolonged standing etc.) and/or strong suspicion of epilepsy seizure (patients transferred from the Casualty Department to the Department of Neurology)

Echocardiography (ECHO) revealed mitral valve prolapse in 25 patients (6.6%), hypertrophic cardiomyopathy in 3 (0.8%), II degree aortic stenosis in 2 (0.5%), pulmonary stenosis in 1 (0.3%) and aortic aneurysm in 1 (0.3%). In 348 patients (91.5%) there were no major anomalies.

Electroencephalography enabled to diagnose epilepsy (generalized discharges) in 3 children (1.3%). There were no crucial abbreviations in 235 patients (98.7%).

Psychiatrist diagnosed conversion disorder in 1 child (0.3%) and school refusal in another patient (0.3%).

Summarizing, among 386 patients who had prodromal symptoms before their episode of syncope and were admitted to the hospital for further evaluation, 229 potential causes of losing of consciousness were found in 191 children (49.5%) (Tab. 2). In the remaining 195 patients (50.5%) the history, normal physical examination and normal ECG remained the only clue of neurocardiogenic syncope. Out of all causes 135 appeared to be neurally mediated syncopes, 86 were potential cardiac causes, 3 metabolic/hematological, 3 neurological and 2 mental disorders.

In this study there was no exclusion protocol after finding a specific cause. In 32 patients (8.3%) 2 probable causes were found, and in 3 patients (0.8%) 3 potential causes were present (Tab. 3). For 156 cases with 1 potential cause of losing of consciousness 105 were diagnosed as neurally mediated syncope, 47 as cardiac reasons, 1 as epilepsy, 1 as conversion disorder, 1 as anemia and 1 as diabetes.

**Table 2 The diagnostic yield of the tests performed.**

Test	Number of diagnostic tests/ number of tests performed
Laboratory tests	3/386 (0.8%)
Electrocardiography	2/386 (0.5%)
24-hour Holter monitoring	49/338 (14.5%)
Head-up tilt test	135/326 (41.4%)
Echocardiography	32/380 (8.4%)
Electroencephalography	3/238 (1.5%)
Exercise test	0/274 (0%)
Psychiatric evaluation	2/2 (100%)

**Table 3 Summary of patients with more than one cause of syncope. Some conditions would be missed in 32 of them (8.3% of all patients), if positive vasovagal history, ECG, lab results and positive Tilt-test were the only diagnostic tests.**

Number of causes	Causes	Tests	Number of patients
2 potential causes	vasovagal + cardiological	Tilt test + ECHO	11
		Tilt-test + Holter	13
		Tilt-test + ECG	1
	vasovagal + metabolic	Tilt-test + Lab results	1
	vasovagal + neurological	Tilt-test + EEG	1
	cardiological + cardiological	ECHO + Holter	3
	cardiological + psychiatric	Holter + Psychiatric consultation	1
	cardiological + neurological	Holter + EEG	1
3 potential causes	cardiological + cardiological + vasovagal	ECHO + Holter + Tilt-test	2

For 32 cases with 2 potential causes of the main complaint 25 had positive tilt-test result and a cardiac feature, 1 had positive tilt-test and diabetes and 1 positive tilt-test and epilepsy. In 3 patients 2 probable cardiac disorders were found, 1 had both cardiac disease and epilepsy and 1 cardiac disease and conversion disorder.

In all 3 patients with 3 probable causes of losing of consciousness one was positive tilt-test and 2 were cardiac abnormalities.

## DISCUSSION

Syncope is a challenging condition for the practicing physician, especially in children, as most of the guidelines focus on adults [5, 6]. With routine approach many cases are qualified as neurally mediated depending on just the history of the event, normal physical examination and ECG. This seems to be a rational approach as for limiting the costs of diagnostics [7]. The results are satisfying, with a ratio of unexplained syncope after the evaluation of only 16 to 20% [7, 8]. The most common type of syncope in children is neurally mediated syncope – accounting for 64 to 75% of cases. Cardiogenic syncope is the second common type, but with a different ratio depending on the chosen protocol, usually about 3 to 5% of patients [7–10]. The physical examination did not show a definite diagnose in any patient but gave a slight clue for further evaluation in 40 cases (10%) included in our study. All the authors emphasize the role of physical examination in the management of patients with loss of consciousness but it is not expected to be the only step [11, 12].

Basic laboratory tests seem to be useful only in the diagnostics of metabolic conditions. Anemia or diabetes were found in 0.8% of our patients. This is similar to other reports both in adults [6, 13] and in children [7]. Signs of autonomic dysfunction are not uncommon in children with early stage of diabetes mellitus [14] but this diagnosis in both our patients

was more of incidental, as they were in good condition, with no signs of acidosis. Other laboratory findings that are more often in children with syncope include hypoglycemia, hyponatremia and iron deficiency [15].

ECG is a basic test that is usually performed in most of the patients seeking cardiologists' help. Studies in children with syncope report low diagnostic yield of ECG but authors still recommend its routine use [1, 7, 16, 17]. In our study 0.5% of patients had abnormalities in ECG which might have strongly suggested a cardiac origin (long QT syndrome). Syncope might be the first symptom of LQTS but this syndrome is rarely diagnosed in children seeking medical attention for an initial syncopal episode [18].

The 24-hour Holter monitoring has a controversial diagnostic yield from 0.4 [19] to 19% [7]. Similarly, in our experience it appeared to be a potential cause of syncope in 14.5% of cases. Head-up tilt-test was the most useful diagnostic tool – 41.4% in our study (55–75% in the literature) [7, 20]. In contrast to exercise test, which seems to have no value in predicting a cause of syncope in children without exercise related loss of consciousness.

Echocardiography has a diagnostic yield of 0.5% [16] to about 10% [7]. In our study, abnormalities needing further observation were found in 8.4% of cases. However, only 4 cases (1% – hypertrophic cardiomyopathy, aortic aneurysm) should be considered a potential cause of syncope. The occurrence of syncope in children with mitral valve prolapse is higher than in normal population [16], but most likely, it is not a cause-result relationship. Electroencephalography, as confirmed in our study (diagnostic yield of 1.5%), is stated to be overused in children with syncope [8, 21]. Other evaluations, like psychiatrists' consultation are usually performed when there is some concern from the physician, which is why they have strong diagnostic yield.

In the present study, we focused more on the potential causes of the syncope not on an individual patient. Only children with a history suggesting vasovagal syncope were included. To our knowledge this is the only paper in the literature that sums up all the susceptible conditions in evaluated children, not limiting itself to the main cause. If normal ECG and lab results with positive standing test/tilt test were exclusion criteria from further diagnostics because of the strong indication of neurally mediated syncope, 32 cases (8.3%) would be missed without a diagnosis of 40 conditions, which might have had caused a syncope or need further observation and different approach. The limitation of this study is that because of not including the follow-up the exact cause of syncope in patients with more than one condition wasn't verified by the results of treatment.

## CONCLUSIONS

The main types of syncope in children living in north-eastern Poland were neurally mediated syncope (vasovagal syncope) and cardiac ones. In some patients, more than 1 potential cause of syncope was diagnosed. That confirms multiple factors' causality of syncope. Head-up tilt test has the highest yield of all the tests performed. 24-holter monitoring should be performed routinely in patients referred to a specialist because of syncope. Echocardiography, if possible, is also reasonable.

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