A retrospective analysis of the cost-effective workup of syncope in children[1]

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Syncope in children can result from a wide variety of causes. Consequently, an evaluation that fails to approach this problem in a goal-directed fashion often proves to be extremely expensive, time-consuming, and frustrating to all concerned. In today's medical and economic climate, it is crucial to implement a cost-effective approach to the workup of children with syncope. The authors evaluated 73 children with syncope, using a total of 443 diagnostic tests or consultations at a total cost of $77,419. In a large proportion of patients, the cause of the syncope could not be established. The initial clinical examination with special emphasis on historical data, if it suggests a probable cause, should direct the physician in further diagnostic workup. This examination should include a complete physical and ECG. If warranted, a goal-directed, cost-effective workup can then ensue.

Index terms: Cost and cost analysis•Syncope

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Considering the current medical climate, containing ever-increasing medical costs has become an important priority. Many factors contribute to this alarming increase in the cost of medical care. Among them are the ongoing research and development of sophisticated and expensive technology and the overuse and abuse of health care services as well as the factor over which we have no control, inflation. The factors over which physicians can exert some control include the decision to hospitalize the patient and the diagnostic tests selected. In our retrospective investigation we examined these costs in the diagnosis of a difficult-to-evaluate condition: syncope in children.

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Table 1. Diagnostic tests

Test	No. performed	No. abnormal results	Findings
Neurological consultation	65	1	Muscular dystrophy
EEG	64	1	Right-brain atrophy
CT scan	37	1	DeMorier's syndrome
Cardiological consultation	46	2	Mitral valve prolapse
ECG	68	4	T-wave abnormalities
			Left-axis deviation
			Sinus bradycardia
Chest radiography	43	0	
Echocardiography	43	4	Mitral valve prolapse
Stress test	21	0	
Holter monitoring	43	0	
Electrophysiological study (EPS)	10	3	Sick sinus syndrome (2)
			A-V nodal reentry (1)
Cardiac catheterization	1	1	Primary myocardial disease
Tilt test	2	1	

This is not an infrequent problem. The causes range from imbalance of vascular volume and tone to neurologic or metabolic abnormalities, drugs, psychogenic causes, or life-threatening malignant arrhythmias.[1,2]

Previous studies have found that, despite the use of specific diagnostic criteria and careful evaluation, the cause of syncope could not be established in a large proportion of patients.[3,4] When the cause is not obvious from the initial examination, detailed and expensive tests are often performed that frequently afford one little additional diagnostic information.[5] In our review of 73 cases, we tried to determine the usefulness and cost-effectiveness of various diagnostic tests.

Methods

Between 1981 and 1986, 73 consecutive cases of syncope in children were evaluated at The Cleveland Clinic Foundation. Of these patients, 34 boys and 39 girls, each had at least one witnessed syncopal episode. They ranged in age from 2.5 to 20 years with a mean age of 13 years. Fifty-nine patients had experienced multiple episodes.

Sixty-five patients underwent detailed neurologic examinations, including 64 EEGs and 37 computed tomographic (CT) scans of the head. There were 46 cardiological consultations performed, 68 ECGs, 43 echocardiograms, 21 exercise stress tests, 43 Holter monitor tests, as well as 10 electrophysiologic studies. In addition, 43 chest radiographs were obtained. In all, there were a total of 443 diagnostic tests or consultations initially performed on the 73 patients evaluated, or an average of six diagnostic tests per patient (*Table 1*).

After the workup and test results were analyzed, the following diagnoses were made (*Table 2*): In 27 of 73 patients (37%), the cause remained unknown. A vasovagal reaction was determined to be the cause of syncope in 17 patients (23%). Psychogenic factors were blamed in eight patients, with four children diagnosed as having hyperventilation syndrome. Adjustment disorders were the cause in two patients. There was one patient each with a diagnosis of anxiety, trauma, carotid sinus hypersensitivity, diabetes, hysterical conversion reaction, migraine headache, DeMorier's syndrome (absence of the septum pellucidum), and behavior disorder.

Of the 73 patients, only seven were found to have a serious disease. One patient each had primary myocardial disease, AV nodal reentry tachycardia, and muscular dystrophy. One had documented sick sinus syndrome, and three syncopal episodes were considered secondary to a febrile seizure.

Cost of evaluation

The cost for multiple diagnostic procedures was $77,419 (*Table 3*), with the cost per patient being $1,060.

Of the 73 total patients, 29 (40%) were admitted to the hospital as part of their evaluation. A total of 448 days were spent in the hospital by these 29 patients for an average of 15.5 days per patient. The total cost for hospitalization was $141,568. The average cost for the hospital stay for these patients alone was $4,882. If one also adds to the cost of the hospital stay the costs of diagnostic testing ($29,986), the average cost for the patients requiring hospital stay was $5,916, and, when averaged for our total patient popu-

lation of 73 children, a cost of $2,973 resulted. This cost is comparable to that reported in the workup of adults with syncope ($2,643).[5]

Follow-up

Fifty-five of the 73 patients (75%) were followed from two weeks to five years with a mean follow-up of two years. Ten patients (18%) still experienced syncope. The frequency of syncope had increased in only one patient, remained unchanged in another, and decreased in occurrence in the eight remaining. There were no deaths reported.

Despite the significant cost for the workup of syncope, 49 of 55 families (89%) felt that the workup had been beneficial.

Conclusions and recommendations

The spectrum of diseases resulting in syncope in children ranges from benign to severe, life threatening conditions.

Frequently, the presentation is of a child who has experienced a syncopal episode, but with no obvious etiology. Our data support the contention that careful historical investigation with special focus on the events leading up to the syncopal episode, as well as a complete physical examination with electrocardiogram, should serve as the foundation for further evaluation.

Most children who experience syncope, however, undergo multiple sophisticated tests without adequate consideration of a goal-directed approach, often involving prolonged hospitalization with its inherent costs. This time-consuming diagnostic effort is frequently unrevealing and often quite expensive as well as frustrating for all concerned.

The dilemma, therefore, is how to proceed in a goal-directed, yet cost-effective approach to evaluate the child with syncope. In some patients, the initial clinical examination suggests a probable cause.[6] In this select group, further diagnostic evaluation to define the nature and severity of the disease is necessary. For example, a child whose syncopal episode suggests a seizure disorder should undergo a complete neurological evaluation, including a sleep-deprived EEG. CT of the head is expensive and not indicated unless focal neurological deficits are suggested.

If a metabolic cause is entertained, then a goal-directed workup should include measuring serum potassium, calcium, magnesium, and fasting blood glucose levels.

Table 2. Diagnoses

Diagnosis	No. patients
Unknown etiology	27
Vasovagal reaction	17
Psychogenic	8
Hyperventilation syndrome	4
General febrile seizure	3
Adjustment disorder	2
Sick sinus syndrome	1
Anxiety	1
Trauma	1
Carotid sinus hypersensitivity	1
Diabetes	1
Hysterical conversion reaction	1
Migraine headache	1
DeMorier's syndrome	1
Behavior disorder	1
Primary myocardial disease	1
A-V nodal reentry tachycardia	1
Muscular dystrophy	1

Table 3. Cost of testing.

Test	Number
Neurologic consultation	65
EEG	64
CT scans	37
Cardiac consultation	46
ECG	68
Radiography	43
Echocardiography	43
Stress test	21
Holter monitoring	43
EPS	10
Cardiac catheterization	1
Tilt test	2
TOTAL	443
TOTAL COST	$77,419
COST/PATIENT	$1,060

If the syncope is associated with exertion, one should strongly consider an obstructive cardiac lesion or arrhythmia as a possible cause. To evaluate the former, 2-D or Doppler echocardiography possibly followed by cardiac catheterization is suggested. For arrhythmia evaluation, the ECG is indicated as a baseline study in children with syncope. Although ECGs are normal in over 95% of patients,[7] there are occasions where brady- or tachyarrhythmias are uncovered. Of particular importance is the evaluation of atrial or ventricular ectopies, the QT interval, A-V conduction, and bundle-branch blocks.

If the initial history, physical examination, and electrocardiogram suggest no cause and symptoms suggest arrhythmias, 24-hour ECG monitoring should be performed, despite reports of

its negative yield.[8] The optimal length of monitoring has yet to be determined; however, continuous monitoring until symptoms appear is certainly not cost-effective. For this reason, intracardiac electrophysiological testing is advocated not only as a useful diagnostic adjunct in the workup of syncope, but also as a therapeutic guide in medical management.

Of possible benefit is the use of tilt-table analysis. Although these data are as yet unpublished, these analyses have proved beneficial in the diagnostic workup of several children in our institution.

In this retrospective analysis of 73 children with syncope, serious abnormalities were uncovered in only a small proportion of patients (4%), despite aggressive searches for the cause. The reasons for this low yield compared with other studies[2] remain obscure. Perhaps the patient population has been skewed because this is a retrospective study. One must also consider the episodic, evanescent nature of syncope. Its cause may not be easily realized on initial evaluation, only to be uncovered on close follow-up.

In conclusion, we believe that, with a cost-effective, goal-directed approach and adequate long-term follow-up, children with syncope can be adequately diagnosed and treated, if necessary, while the ever-increasing cost of medicine can still be contained.

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