Diagnostic Yield of head Computed Tomography in Patients with Syncope: Sex Differences

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ABSTRACT **Background:** Syncope is responsible for approximately 1–3% of all emergency department (ED) visits and up to 6% of all hospital admissions in the United States. Although often of no long-term consequence, syncope can be the first presentation of a range of serious conditions such as strokes, tumors, or subarachnoid hemorrhages. Head computed tomography (CT) scanning is therefore commonly ordered in the ED for patients presenting with syncope to rule out any of these conditions, which may present without other associated physical or neurological findings on initial examination. However, the diagnostic yield of head CTs in patients presenting with syncope is unclear.

Objectives: To determine the diagnostic yield of head CT in the ED in patients with syncope.

Methods: We conducted an observational analytical retrospective cross-sectional study on 360 patients diagnosed with syncope who underwent a head CT to determine the diagnostic yield of syncope to determine whether head CT is necessary for every patient presenting with syncope to the ED.

Results: The total of new CT findings was 11.4%. Percentages varied between men (12.8%) and women (9.7%), $P = 0.353$. There were no significant differences between sexes regarding the findings in head CT, yet the incidence increased, especially among elderly males.

Conclusions: Age had a more significant impact on diagnostic yield of syncope than head CT. The use of a head CT scan as a routine diagnosis tool in patients with syncope is unjustifiable unless there is an indication based on medical history or physical examination.

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KEY WORDS: faint, head computed tomography, syncope, transient loss of consciousness (TLOC)

Transient loss of consciousness (TLOC) or *faint* is a broad term that includes all disorders characterized by transient, self-limited loss of consciousness (LOC). The causes of TLOC are diverse and include epileptic seizures, metabolic disorders, and psychogenic issues. Syncope is defined as a form of TLOC in which the mechanism is transient global cerebral hypoperfusion that may be secondary to decreased cardiac output, peripheral vascular resistance, or a combination of both. Four cardinal clinical features characterize the syncopal episode: it is transient, it has a rapid onset, it has a short duration (lasting from seconds to several minutes), and there is spontaneous complete recovery requiring no resuscitative efforts. Appropriate orientation and behavior is restored after the syncopal episode and there is complete return of pre-existing neurological function [1-5].

Syncope has many causes and clinical presentations. The incidence depends on the population being evaluated. Estimates of isolated or recurrent syncope may be inaccurate and underestimated because epidemiological data have not been collected in a consistent fashion or because a consistent definition has not been used. Interpretation of the symptoms varies among the patients, observers, and healthcare providers [6]. The evaluation is further obscured by inaccuracy of data collection and by improper diagnosis. Decision rules such as the Boston Syncope Criteria have been developed to aid clinicians in identifying high-risk patients as well as those who can be safely discharged from the emergency department (ED) [7]. Studies of syncope report prevalence rates as high as 41%, with recurrent syncope occurring in 13.5% [8]. Syncope is common in the general population. The first episode presents at characteristic ages in a bimodal distribution with a high incidence in patients between the ages of 10 and 30 years. It is relatively uncommon in middle-aged adults and peaks again in patients old-

er than 65 years [1]. Syncope is a common problem in the ED. Several reports found that 3–5% of all ED visits and 1–6% of all hospital admissions were due to syncope [8,9]. It is estimated that in the United States, the cost of care per hospital admission is roughly $5300 per stay, and the total cost reaches over $2 billion per year nationwide. Mean evaluation cost was found to be significantly higher in the intensive coronary care unit (ICCU) than in the internal medicine wards, which can be attributed to the additional cost of the significantly longer stay in hospital in the ICCU [1,6,10-13].

There is increased pressure on emergency physicians to evaluate and differentiate between benign and life-threatening causes of syncope.

The starting point of the diagnostic evaluation of TLOC for suspected syncope is the initial syncope evaluation, which consists of patient history, physical examination, and electrocardiogram. Based on previous findings, additional examinations may be performed, such as echocardiogram, carotid sinus massage, head-up tilt tests, and blood tests. Risk stratification during initial evaluation is important for guiding the treatment and preventing long-term morbidity and mortality. Careful clinical evaluation leads to a diagnosis in 50–85% of patients, and therefore computed tomography (CT) and magnetic resonance imaging (MRI) in uncomplicated syncope should be avoided. If neurological examination points out Parkinsonism, ataxia, or cognitive impairment, MRI is recommended. In cases of contraindication for MRI, CT is recommended to exclude brain lesions [9].

Up to 60% of patients do not have a readily diagnosed etiology based on initial history, physical examination, and electrocardiogram. Despite thorough evaluation, a cause is not ultimately established in 38–47% of cases. Thus, the physician may be concerned that potentially well-appearing patients with syncope could be at risk for life threatening events. Head CT scanning is common in the ED for patients presenting with syncope. There is often concern about missing conditions that may present with transient loss of consciousness without associated physical findings on initial examination such as stroke, tumors, or subarachnoid hemorrhage. Brain imaging may also be prompted by suggestions that the episode represented a seizure and is, therefore, a manifestation of intracranial disease. However, current guidelines do not recommend obtaining a head CT for patients presenting with syncope unless there is an indication in the medical history or physical examination. In a retrospective study, head CT did not yield any findings relevant to the evaluation and management for 117 patients with syncope [3,8,9,11,12,14].

According to the European Society of Cardiology (ESC) 2018 guidelines for the management of syncope, a diagnostic head CT is needed in patients with neurologic finding who cannot undergo a MRI scan. Similar studies confirmed that the use of abundant additional testing should be avoided in most patients with syncope, and good clinical evaluation is of paramount importance for optimal management, diagnostic choices, and therapeutic decisions.

PATIENTS AND METHODS

This retrospective cross-sectional study was designed to assess the outcomes of head CT conducted for patients with syncope. The study included 360 patients with the diagnosis of syncope who underwent a head CT at Ziv Medical Center, Israel, between January 2015 and January 2017. The study cohort included 165 females (45.8%) and 195 males (54.2%). Patients were aged 19–90 years. Most patients were older than 60 years of age, with a peak in those older than 80 years [Figure 1]. The total percentage of new imagery findings was 11.4%.

INCLUSION CRITERIA

Of patients who were admitted due to syncope, most were admitted to the internal medicine ward. A few patients were admitted to the neurologic unit. The rest were discharged from the ED.

EXCLUSION CRITERIA

Patients were excluded if they had neurologically diagnosed epilepsy, seizure, coma, tumors, pregnancy, persistent altered mental status, alcohol or illicit drug-related loss of consciousness, transient loss of consciousness caused by head trauma.

The study was approved by the Helsinki Committee at Ziv Medical Center, Safed. Any identifiable information of study patients remains confidential.

STATISTICAL ANALYSIS

Continuous variables were tested for normality by the Kolmogorov–Smirnov test. Values were presented as mean ± standard deviation or in case of non-normally distributed data as median and range. Comparisons of percentages between different groups were conducted using the chi-square test for categorical variables or Fischer's exact test. Spear-

man rank correlation and univariate regression analysis were used to determine the strength of the relationship between the variables and the primary endpoint. A parameter associated with a *P*-value < 0.05 in univariate analysis was used for feature analysis. A multivariate logistic regression analysis was performed to determine the association between the variables and the primary endpoint. Statistical significance was set at 5%. All statistical analyses were performed with the commercial software Statistical Package for Social Science (SPSS version 24.0, IBM, Chicago, IL, USA).

The main variable for this analysis was the diagnostic yield of head CTs. We considered diagnostic yield as successful when it was at least 20%. New imagery findings in head CT was considered as either positive or it was negative without new findings. Other minor variables were taken to better categorize patients, such as age, sex, and admission reason.

Chi square and (ANOVA) tests were used for categorical variables. Logistic regression analysis was used to evaluate the diagnostic yield of head CT in relation to all other minor variables.

RESULTS

The study included 360 patients with the diagnosis of syncope who underwent head CT at Ziv Medical Center, Israel, between 1 January 2015 and 1 January 2017. The group was comprised of 165 females (45.8%) and 195 males (54.2%). Most patients were 60 years of age or older, with a peak age of 80 [Figure 1].

It is important to emphasize that we counted every new finding in the CT scan as positive. However, that does not mean that the cause for the syncope event was found. Most patients with new CT findings needed to continue their investigation with MRI and EEG. In addition, a number of patients did not have any CT records, so each finding was counted as positive, even if it was age related.

The total percentage of new imagery findings was 11.4%. Percentages varied between male (12.8%) and female (9.7%), $P = 0.353$ [Table 1]. There were no significant differences between women and men regarding the findings in head CT, yet the incidence increased, especially among elderly men.

Table 1. Cases divided by sex and total number of cases with head computed tomography findings

		Computed tomography		Total, N	*P*- value
		No new findings, n (%)	New findings, n (%)		
Sex	Female	149 (90.3%)	16 (9.7%)	165	0.353
	Male	170 (87.2%)	25 (12.8%)	195	
Total		319 (88.6%)	41 (11.4%)	360	

Figure 1. Frequency of new imagery findings in patients by age group

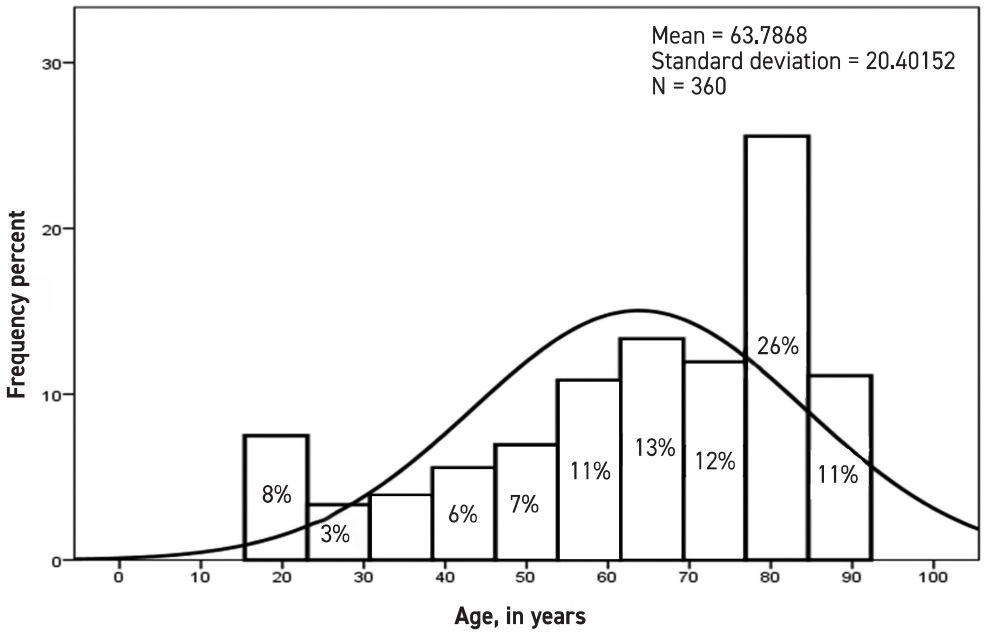
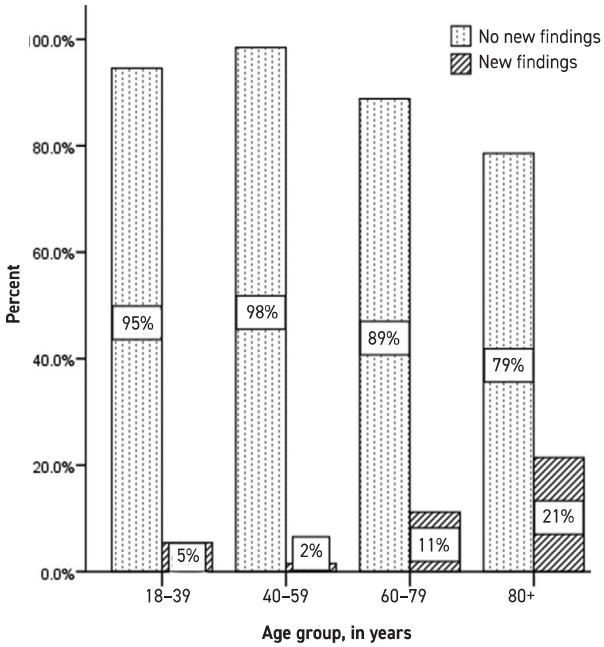


Figure 2: Percentages of head computed tomography results by age group



We divided patients into age groups to better visualize the results; 5% of patients in the age group 18–39 had new findings after a head CT scan, 2% in the age group 40–59, 11% in the age group 60–79, and 21% in the age group older than 80 years. Most findings in patients over 60 years are infarcts, vertebrobasilar insufficiency, and tumors [Figure 2].

We used logistic regression analysis to evaluate the diagnostic yield of head CT in relation to all other minor variables. Using logistic regression, when the dependent variable was a new finding, we found that age had a significant influence on new findings (odds ratio 1.038, 95% confidence interval 1.009–1.067). The probability of a new finding increased by 0.037 for each year of age [Table 2].

DISCUSSION

Syncope is a common complaint evaluated in the ED. Up to 60% of patients do not have a readily diagnosed etiology based on initial history, physical examination, or electrocardiogram. Despite thorough evaluation, a cause is not ultimately established in 38–47% of cases. Thus, the physician may be concerned that potentially well-appearing patients with syncope could be at risk for life threatening events. A head CT scan may be requested to rule out stroke, acute hydrocephalus, and structural causes for seizures. Overuse of head CT for syncope has been reported; however, to the best of our knowledge, there is no literature on this overuse.

We conducted a retrospective cross-sectional study on 360 patients diagnosed with syncope who underwent a head CT to make a diagnosis yield of syncope. The group included 143 patients (39.7%) aged 60–79 years and 98 patients (27.2%) were older than 80 years, which means that most CT scans were made for the elderly. In this retrospective study, 11.4% of patients had CT findings as stroke or tumors, which were considered as new findings when previous CT records were not available. Most elderly patients had findings that were age related. None of the CT reports gave a definite diagnosis, they only led to further investigations with MRIs, electroencephalograms, or a neurology expert. We also found a positive correlation between age and CT findings, which correlated with previous studies [13]. Perhaps age should be considered when deciding whether to request a CT scan.

We conducted this research to justify minimizing the use of unnecessary head CT examinations in patients with syncope who had normal neurological examination, thus avoiding excessive testing that can cause over-utilization of medical resources. A head CT ideally should be used as a diagnostic test rather than as a screening test because of its expense and unnecessary radiation exposure to the patient.

Table 2. Logistic regression of new findings with age, sex, and their interaction

		B	SE	Wald	df	Sig.	Odds ratio for EXP(B)	95% confidence interval for EXP(B)
Step 1[a]	Sex	0.827	1.565	0.280	1	0.597	2.287	0.107–49.116
	Age in years	0.037	0.014	6.870	1	0.009	1.038	1.009–1.067
	Interaction age × sex	-0.017	0.021	0.661	1	0.416	0.983	0.942–1.025
	Constant	-4.426	1.042	18.038	1	0.000	0.012	

df = degrees of freedom, SE = standard error

Similar studies confirmed that the use of abundant additional testing should be avoided in most patients with syncope, and good clinical evaluation is of paramount importance for optimal management, diagnostic choices, and therapeutic decisions [3,9,11,14].

According to the ESC 2018 guidelines for the management of syncope, head CT is needed in cases of contraindication for MRI and in cases of positive neurological findings. Most syncope patients, particularly those with a low-risk profile, were not evaluated in accordance with the ESC guidelines [15]. Despite the high costs of inpatient evaluation associated with more diagnostic tests, longer in-hospital stay, and higher mortality rates, nearly half of the patients were discharged without a diagnosis. Outpatient evaluation should be considered when medically possible [4].

STRENGTH AND LIMITATIONS

The limitations of this study include the use of a single testing site, a small sample size, and lack of long-term follow-up. The diagnosis of syncope was based on many ED physicians taking medical histories and not necessarily following the guidelines for the diagnosis of syncope.

The strength of the study is that it focuses clinicians on the importance of medical history taking and physical examination.

CONCLUSIONS

We found that only 11.4% of patients with syncope who had undergone head CT scan had positive results (new findings). It is important to emphasize that we accounted every new finding in the CT scan as positive; however, that does not mean that the cause for the syncope event was found. Most patients with new CT findings needed to continue their investigation with MRI and electroencephalogram. In addition, a number of patients did not have any CT records, so each finding was counted as positive, even if it was age related, thus, making the actual diagnosis yield of head CT even lower. According to our results, there is a growing probability of 0.038 for each year for a patient to have positive results from a CT scan, pointing at age as an important factor to consider. Most patients presenting to the ED with syncope may not benefit from head CT unless they are older, have a focal neurologic deficit, or have a history of recent head trauma. In addition, we did not find significant differences between women and men regarding the findings in head CT, yet the incidence increases especially among elderly men. We concluded that the use of a head scan as a routine diagnosis tool in patients with syncope is unjustifiable unless there is an indication based on medical history or physical examination. A future large prospective study is needed to develop a robust risk tool and to establish its utility especially in sex differences.

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