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S.A. Grossman • C. Fischer • J.L. Bar • L.A. Lipsitz • L. Mottley • K. Sands • S. Thompson  
P. Zimetbaum • N.I. Shapiro

## The yield of head CT in syncope: a pilot study

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**Abstract** Although head CT is often routinely performed in emergency department (ED) patients with syncope, few studies have assessed its value. *Objectives:* To determine the yield of routine head CT in ED patients with syncope and analyse the factors associated with a positive CT. *Methods:* Prospective, observational, cohort study of consecutive patients presenting with syncope to an urban tertiary-care ED (48 000 annual visits). Inclusion criteria: age  $\geq 18$  and loss of consciousness (LOC). Exclusion criteria included persistent altered mental status, drug-related or post-trauma LOC, seizure or hypoglycaemia. Primary outcome was abnormal head CT including subarachnoid, subdural or parenchymal haemorrhage, infarction, signs of acute stroke and newly diagnosed brain mass. *Results:* Of 293 eligible patients, 113 (39%)

underwent head CT and comprise the study cohort. Ninety-five patients (84%) were admitted to the hospital. Five patients, 5% (95% CI=0.8%–8%), had an abnormal head CT: 2 subarachnoid haemorrhage, 2 cerebral haemorrhage and 1 stroke. Post hoc examination of patients with an abnormal head CT revealed focal neurologic findings in 2 and a new headache in 1. The remaining 2 patients had no new neurologic findings but physical findings of trauma (head lacerations with periorbital ecchymoses suggestive of orbital fractures). All patients with positive findings on CT were  $>65$  years of age. Of the 108 remaining patients who had head CT, 45 (32%–51%) had signs or symptoms of neurologic disease including headache, trauma above the clavicles or took coumadin. Limiting head CT to this population would potentially reduce scans by 56% (47%–65%). If age  $>60$  were an additional criteria, scans would be reduced by 24% (16%–32%). Of the patients who did not have head CT, none were found to have new neurologic disease during hospitalisation or 30-day follow-up. *Conclusions:* Our data suggest that the derivation of a prospectively derived decision rule has the potential to decrease the routine use of head CT in patients presenting to the ED with syncope.

S.A. Grossman (✉) • C. Fischer • J.L. Bar • L. Mottley • S. Thompson  
N.I. Shapiro  
Department of Emergency Medicine  
Beth Israel Deaconess Medical Center  
Harvard Medical School  
WCC2, One Deaconess Road  
Boston, MA 02115, USA  
e-mail: sgrossma@caregroup.harvard.edu

L.A. Lipsitz  
Gerontology Division  
Department of Medicine  
Beth Israel Deaconess Medical Center  
Harvard Medical School  
Boston, MA, USA

K. Sands  
Department of Medicine  
Beth Israel Deaconess Medical Center  
Harvard Medical School  
Boston, MA, USA

P. Zimetbaum  
Cardiology Division  
Department of Medicine  
Beth Israel Deaconess Medical Center  
Harvard Medical School  
Boston, MA, USA

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### Introduction

Syncope accounts for approximately 1%–3% of all ED visits and up to 6% of all hospital admissions nationwide [1, 2]. The cost of care per hospital admission has been estimated at roughly \$5300 per stay for a total cost of over \$2 billion per year nationally [2]. These costs may correlate with the challenges the emergency physician (EP) faces in evaluating syncope. The EP must identify which patients with life-threatening causes of syncope require immediate treatment and which patients, despite appropriate workup, still require further evaluation [3]. Up to 60% of patients do not have a readily diagnosed aetiology based on initial history, physi-

cal exam and EKG [4]. Despite thorough evaluation, a cause is not ultimately established in 38%–47% of cases [1, 5, 6]. Thus, the EP remains with concerns that potentially well appearing patients with syncope could be at risk for life-threatening events [7].

In spite of these concerns, efforts to reduce unnecessary and expensive medical testing have forced a reassessment of the practice of obtaining routine tests in syncope patients. Although computed tomographic (CT) scans of the head are often routinely performed in ED patients with syncope, few studies have assessed its value in demonstrating dangerous disease. Kapoor, based on early data, suggests that head CT may provide new diagnostic information in 4% of patients with syncope [1, 5, 8]. Almost all of these cases were limited to patients with focal neurologic findings or a history consistent with a seizure. Kapoor also suggests that transient ischaemic attacks involving the carotid or verte-brobasilar arteries rarely result in syncope [1].

Despite this data, head CT remains routine in the evaluation of many patients presenting to the emergency department with syncope. Two recent rules, from Canada and New Orleans respectively, have suggested that even in the event of minor head injury, head CT does need to be part of the routine workup [9, 10]. While these 2 studies are useful in the evaluation of minor head trauma, they do not address the utility of head CT in determining the aetiology of syncope.

The objective of this study is to determine the yield of routine head CT in ED patients with syncope and post hoc to find predictors that may be used in a future study looking at the routine workup for syncope. We hope to ensure that no patient with a possible life-threatening aetiology of syncope is discharged without an appropriate evaluation while at the same time institute a more judicious approach in deciding which patients require head CT following a syncopal event.

## Methods

### Study design and setting

We conducted a prospective, observational, cohort study of consecutive patients presenting with syncope 24 h a day, 7 days a week between September 2003 and April 2004. All patients presented to the ED of a large urban teaching hospital with an annual ED census of 48 000 visits. Institutional review board (IRB) approval was received prior to initiation of the study.

Syncope was defined as a sudden and transient loss of consciousness, producing a brief period of unresponsiveness and a loss of postural tone, ultimately resulting in spontaneous recovery requiring no resuscitation measures [11]. Given a lack of a well described definition of near syncope, such patients were not included.

### Selection of participants

Inclusion criteria included age 18 or older and documented loss of consciousness by either EMS/ambulance, witnesses or by patient his-

tory. Exclusion criteria were persistent altered mental status, alcohol- or illicit drug-related loss of consciousness, seizure, coma, hypoglycaemia or transient loss of consciousness caused by head trauma.

### Outcome measures

The primary outcome was a markedly abnormal head CT defined as an acute subarachnoid, subdural or parenchymal haemorrhage, infarction, signs of acute stroke or a newly diagnosed brain mass.

All enrolled patients had at least one episode of syncope meeting the above definition to be eligible for enrolment. Outcomes were determined by inpatient diagnosis, 30-day follow-up phone call and subsequent medical records review.

### Data collection and processing

A trained research assistant prospectively screened patients with complaints of syncope or loss of consciousness and reviewed daily patient logs to ensure enrolment of all possible patients. Patients were identified and brought to the attention of the physician caring for that patient who made the final decision as to whether the patient met enrolment criteria. A study investigator or trained research assistant carried out follow-up phone calls with a structured follow-up form and medical record review at 30 days following initial presentation to the ED (see Appendix 1).

### Primary data analysis

The results are reported as percentages along with the operating characteristics of the rules. Sensitivities, specificities, positive and negative predictive values are reported along with 95% confidence intervals around the point estimates.

## Results

Of 293 eligible patients, 113, 39% (95% CI=33%–44%) underwent head CT and comprise the study cohort. Ninety-five patients (84%) were admitted to the hospital. The average age of the patient population was  $57.8 \pm 24.2$  SD, of which 58% were female. Average age of patients undergoing head CT was  $67.8 \pm 20.1$  SD, of which 51% were female (see Table 1).

Five patients, 5% (0.8%–8%), met our definition of an abnormal head CT. These consisted of 2 subarachnoid haemorrhage, 2 cerebral haemorrhage and 1 stroke. Further examination of these patients with an abnormal head CT revealed focal neurologic findings in 1 and a new headache in 2. The remaining 2 patients had no new neurologic findings but physical findings of trauma (head lacerations with periorbital ecchymoses suggestive of orbital fractures) (see Table 2). All patients with positive findings on CT were >65. Of the 108 remaining patients who had head CT, 45 (32%–51%) had signs or symptoms of neurologic disease including headache,

**Table 1** Basic demographics

Average age	Average age w/o CT	Average age with CT		
57.8	51.4	67.8		
Male With CT	Female CT	Male without CT	Female without CT	
44%	34%	56%	65%	

trauma above the clavicles or took warfarin. Limiting head CT to patients with signs or symptoms of neurologic disease would reduce scans by 56% (47%–65%) in this population. If age >60 were an additional criterion, scans would be reduced by 24% (16%–32%) in this population. Of the patients who did not have a head CT, none had new neurologic disease diagnosed at a later point during their hospitalisation or at 30-day follow-up.

## Discussion

Recently published guidelines on management of syncope suggest that patients with syncope do not require basic laboratory tests [12, 13]. Our data similarly suggest that head CT has a low yield in patients with syncope, particularly in patients not having neurologic deficits or complaints and that these CTs are normal.

Head CT would appear to be useful and appropriate in a patient population with syncope and concomitant signs of trauma above the clavicles, symptoms of neurologic disease such as headache or neurologic deficits on physical exam. Given concerns of significant haemorrhage associated with warfarin anticoagulation [14–17], we postulate that, at a minimum, head CT be routine in this group of patients.

Both the Canadian and New Orleans head CT studies utilise age as a criterion for ordering a head CT [9, 10], even

though both of these studies were based on populations that clearly had both minor head injury and loss of consciousness. If we were to assume that all syncopal patients over the age of 60 had some minor head injury, we might still be able to reduce the number of routine head CTs in syncope by 24%. Although it is unlikely that minor head injury would be associated with most syncopal events, often it is difficult to discern, particularly if the syncopal event was unwitnessed.

Pires et al. retrospectively reviewed 649 patients with syncope; head CT was obtained in 283. The CT scan yielded diagnoses in 5 (2%) of patients, all of whom had a history consistent with stroke [18]. In a retrospective chart review of 128 ED patients with syncope, Giglio et al. recently found that of the 44 patients who had head CT scans, only 1 patient had an abnormal scan related to their ED presentation and suggests the need for a larger prospective study to help define the utility of this neuroimaging modality in syncope [19].

Based on our study and previously published data [1, 5, 18, 19], it may be plausible to suggest guidelines for head CT in syncope. Specifically, we would suggest that head CT be routine in patients with syncope-associated pertinent history findings such as signs of trauma above the clavicles, neurologic deficit or complaint, warfarin use or age greater than 60. All other patients presenting with syncope have a low likelihood of untoward neurologic findings on head CT and may not require head CT.

## Limitations

There are a number of limitations of this study, including use of a single testing site, small sample size and lack of long-term follow-up. We also did not set out to prospectively derive a decision rule. Instead, we examined a cohort of patients and found characteristics that could be used in the future. As mentioned earlier, given a lack of a well described definition of near syncope, such patients were not included. Finally, while the small number of positive CTs (five) shows the low diagnostic yield of head CT in syncope, it also limits the generalisability of our findings.

**Table 2** Positive head CTs 5/113 (4%)

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Age	84	76	79	68	70
Sex	M	F	F	F	M
Neurologic findings on history	Headache	Headache	Confusion for 30 s post event	None	None
Neurologic findings on exam	None	None	None	Head laceration and periorbital ecchymoses	Head laceration and periorbital ecchymoses
CT outcome	Right subdural haematoma	Subarachnoid haemorrhage with aneurysm	Left posterotemporal haemorrhage	Frontal subarachnoid haemorrhage	Intraparenchymal occipital haemorrhage

## Conclusions

Despite careful history and physical examination, the EP still requires guidance in discerning both aetiology and more importantly outcome in syncope. Our data suggest that routine use of head CT leads to a low diagnostic yield in syncope. A prospectively derived decision rule may enable a more judicious use of head CT in patients with syncope and may reduce unnecessary tests and medical costs.

## Appendix 1

### Initial data collection form: *Yield of head CT in syncope*

Name \_\_\_\_\_

Date \_\_\_\_\_

Age \_\_\_\_\_

Gender \_\_\_\_\_

Syncope (transient loss of consciousness w/o seizure, hypoglycaemia, pre-syncope head trauma, alcohol or illicit drug use): yes/no

Head CT: yes/no Date \_\_\_\_\_

Warfarin use: yes/no

Neurologic symptoms: yes/no;  
Please describe \_\_\_\_\_

Neurologic findings on examination: yes/no;  
Please describe \_\_\_\_\_

CT results: abnormal/normal;  
Please describe \_\_\_\_\_

### Follow-up

Head CT: yes/no Date \_\_\_\_\_

New neurologic symptoms: yes/no;  
Please describe \_\_\_\_\_

New neurologic findings on examination: yes/no;  
Please describe \_\_\_\_\_

New CT results: abnormal/normal;  
Please describe \_\_\_\_\_

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