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JOURNAL CLUB:

Head CT Scans in the Emergency Department for Syncope and Dizziness

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Hyo-Chun Yoon²

OBJECTIVE. The purpose of this study was to determine the yield of acutely abnormal findings on head CT scans in patients presenting to the emergency department with dizziness, near-syncope, or syncope and to determine the clinical factors that potentially predicted acutely abnormal head CT findings and hospital admission.

MATERIALS AND METHODS. We retrospectively reviewed the electronic medical records of all patients presenting to an HMO emergency department between July 1, 2012, and December 31, 2012, who underwent head CT for a primary complaint of dizziness, syncope, or near-syncope. The primary outcomes were head CT scans with acutely abnormal findings and hospital admission. Binary logistic regression was used to assess the association between clinical variables and acute head CT findings and between clinical variables and hospital admission.

RESULTS. Of the 253 patients who presented with dizziness, 7.1% had head CT scans with acutely abnormal findings, and 18.6% were admitted. Of the 236 patients who presented with syncope or near-syncope, 6.4% had head CT scans with acutely abnormal findings, and 39.8% were admitted. The following three clinical factors were found to be significantly correlated with acutely abnormal head CT findings: a focal neurologic deficit ($p = 0.003$), age greater than 60 years ($p = 0.011$), and acute head trauma ($p = 0.026$).

CONCLUSION. Our results suggest that most patients presenting with syncope or dizziness to the emergency department may not benefit from head CT unless they are older, have a focal neurologic deficit, or have a history of recent head trauma.

Dizziness and syncope are two common reasons for visiting the emergency department (ED). Dizziness visits account for approximately 3.3% of all ED visits annually, which corresponds to 2.6 million visits per year in the United States [1]. Syncope accounts for approximately 740,000 annual ED evaluations, corresponding to 7.7 per 1000 ED visits, and is responsible for 1.9% of total ED admissions [2]. There is increased pressure on emergency physicians to evaluate and differentiate between benign and life-threatening causes of dizziness and syncope. Despite efforts to develop clinical guidelines, there is considerable uncertainty about how to manage these patients and not miss a life-threatening cause. Utilizing the most cost-effective approach, especially when it comes to cross-sectional imaging, is also a concern.

Head CT scans are not recommended unless the loss of consciousness is suspected not to be syncope [3], and CT in uncom-

plicated syncope should be avoided unless physical or historical features of CNS dysfunction are present [4]. However, head CT scans obtained to evaluate patients with syncope in the ED appears to be a common practice with little evidence of benefit. In one retrospective study, head CT did not yield any findings relevant to the evaluation and management of 117 patients with syncope [5]. Similarly, head CT has a low diagnostic yield for isolated vertigo. In a prospective study of 200 consecutive patients, 100% of head CT scans performed for isolated vertigo were unremarkable [6]. Another retrospective study reported only a 2.2% diagnostic yield for head CT ordered in the ED for acute dizziness [7].

The concern for uncommon but serious causes of dizziness and syncope leads to extensive workup for these patients in the ED that includes head CT. However, there are few published data about the clinical factors associated with acutely abnormal head

Keywords: CT, dizziness, emergency department, syncope, vertigo

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Emergency Head CT for Syncope and Dizziness

CT findings or the clinical factors associated with hospital admission. Investigating the clinical factors associated with these decisions is a step toward improving the evaluation of patients presenting to the ED with dizziness or syncope. Therefore, we analyzed consecutive patients who underwent head CT from the ED for a primary complaint of dizziness, near-syncope, or syncope. Our objectives were: first, to determine the yield of acute findings on head CT in patients presenting to the ED with dizziness, near-syncope, or syncope; and, second, to determine the clinical factors that potentially predicted acutely abnormal head CT findings and subsequent hospital admission in these patients.

Materials and Methods

This study was approved by the institutional review board. All patients were part of an HMO where all clinical encounters, including inpatient and outpatient visits, are recorded in a common electronic medical record. We retrospectively reviewed consecutive patients who presented to the ED of the HMO between July 1, 2012, and December 31, 2012, with a primary complaint of dizziness, syncope, or near-syncope and who underwent head CT ordered from the ED. There were no exclusion criteria. All patient electronic medical records were reviewed. On the basis of results from previous studies, the following clinical factors were collected: age, sex, loss of consciousness, acute head trauma, seizure, headache, slurred speech, altered mental status, history of a neurologic deficit, physical examination finding of a focal neurologic deficit on the ED physicians' examination, laboratory evidence of drug intoxication or hypoglycemia, use of anticoagulation medications, admission to the hospital, and results of the head CT. Only head CT findings that could be responsible for the patient's presentation were considered acutely abnormal. Three-month patient follow-up data were also collected for any clinically significant neurologic event. Because all of these patients were members of a geographically isolated HMO, this follow-up should be relatively comprehensive.

Binary stepwise logistic regression was used to evaluate the best parsimonious model predicting the association of clinical factors—age, sex, loss of consciousness, head trauma, seizure, headache, slurred speech, altered mental status, history of a neurologic deficit, physical examination finding of a neurologic deficit, laboratory evidence of drug intoxication or hypoglycemia, and use of anticoagulation medications—with positive head CT findings in the first model, and with admission

to the hospital in the second model (using acutely abnormal head CT findings as an independent variable). Statistical significance in the model was defined as $p < 0.05$. All of the data analyses, including other descriptive statistics, were performed using SPSS software (version 17.0, IBM).

Results

A total of 489 patients seen in the ED for dizziness, near-syncope, or syncope also underwent a head CT scan over the 6-month period. As shown in Table 1, there were 253 patients in the dizziness group and 236 patients in the syncope and near-syncope group. The average (\pm SD) age was 64.1 ± 18.5 years for the dizzy group and 65.8 ± 20.8 years for the syncope and near-syncope group. There were no statistically significant differences between the groups with regard to mean age, the proportion of men and women, and acutely abnormal findings on head CT (Table 1).

Of the 253 patients who presented with dizziness, 7.1% had an acutely abnormal head CT finding. These findings included eight patients with possible acute infarct, five patients with intracranial hemorrhage, two patients with intracranial mass, two patients with hydrocephalus, and one patient with a skull fracture. Of all the patients who underwent head CT for dizziness, 18.6% were admitted to the hospital (Table 1). Of the 7.1% with an acutely abnormal head CT finding, 10 of 18 (55.6%) were admitted to the hospital. There was a statistically significant higher admission rate for patients with dizziness who also had an acute abnormality on head CT than for those who had an unremarkable head CT (chi-square, $p < 0.001$).

Of the 236 patients with syncope and near-syncope, 6.4% had an acutely abnormal head CT finding. These findings included seven patients with intracranial hemorrhage, four patients with possible acute infarct, three pa-

tients with intracranial mass, and one patient with a skull fracture. Of all the patients who underwent head CT for syncope and near-syncope, 39.8% were admitted to the hospital (Table 1). There was a statistically significant higher admission rate for those with syncope and near-syncope versus those with dizziness (chi-square, $p < 0.001$). Of the 6.4% of patients with an acutely abnormal head CT finding, 11 of 15 (73.3%) were admitted to the hospital. There was a statistically significant higher admission rate for patients presenting with syncope and near-syncope who also had an acute abnormality on head CT than for those with unremarkable head CT findings (chi-square, $p = 0.006$).

Using the data from all 489 patients, binary stepwise logistic regression was performed with all 14 independent clinical variables described in the Materials and Methods section. An acutely abnormal head CT finding was the dependent variable; 93.3% of all patients had no acutely abnormal head CT findings. Of the factors analyzed for the correlation of abnormal head CT findings, the following three clinical factors were found to be statistically significant: focal neurologic deficit (95% CI, 1.5–8.4; $p = 0.003$), age greater than 60 years (95% CI, 1.3–9.7; $p = 0.011$), and acute head trauma (95% CI, 1.1–6.0; $p = 0.026$). Although these three clinical factors were statistically significant, using them within the regression model did not increase accuracy.

Among the 18 patients presenting with dizziness and acutely abnormal head CT findings, one patient had all three of the statistically significant risk factors, four had two of these risk factors, and 12 had one risk factor. One patient with an acutely abnormal CT finding had none of these risk factors. Among the 15 patients presenting with syncope or near-syncope and acutely abnormal

TABLE 1: Demographic Differences Between Patients With Dizziness and Those With Syncope or Near-Syncope Presenting to the Emergency Department

Characteristic	Dizziness (n = 253)	Syncope and Near-Syncope (n = 236)	p
Age (y), mean \pm SD	64.1 \pm 18.5	65.8 \pm 20.8	0.346
Male, no. (%)	121 (47.8)	117 (49.7)	0.699
Admitted to hospital, no. (%)	47 (18.6)	94 (39.8)	0.001
Abnormal head CT findings, no. (%)	18 (7.1)	15 (6.4)	0.738
No. admitted/total no. with abnormal head CT findings (%)	10/18 (55.6)	11/15 (73.3)	
No. with abnormal head CT findings/total no. admitted (%)	10/47 (21.3)	11/94 (11.7)	

head CT findings, one patient had all three statistically significant risk factors, six patients had two risk factors, and eight patients had one risk factor.

Among all 489 patients, 71.2% did not require hospital admission. Of the 15 clinical factors (including head CT findings) analyzed for the correlation of hospital admission, the following six factors were statistically significant: age greater than 60 years (95% CI, 2.8–7.9; $p = 0.001$), loss of consciousness (95% CI, 2.9–7.0; $p = 0.001$), abnormal head CT findings (95% CI, 1.8–8.3; $p = 0.001$), focal neurologic deficit (95% CI, 1.2–4.7; $p = 0.014$), slurred speech (95% CI, 1.2–12.7; $p = 0.026$), and altered mental status (95% CI, 1.1–10.8; $p = 0.037$). By using these six predictors, the overall accuracy increased from 71.2% to 76.5%.

The indication for ordering the head CT scan (syncope, near-syncope, or dizziness) was not a statistically significant predictor of acute abnormality on head CT or hospital admission.

Among the 141 admitted patients, 21 (14.9%) had an acute abnormality on head CT. Among the 348 patients who did not require hospital admission, only 12 (3.4%) had an acute abnormality on head CT (chi-square, $p < 0.001$).

Among patients with dizziness, 10 of 47 (21.3%) patients who required admission had an acutely abnormal head CT finding (Table 1), whereas only 8 of 206 (3.9%) patients who did not require admission had acutely abnormal head CT findings (chi-square $p < 0.001$).

Among patients with syncope or near-syncope, 11 of 94 (11.7%) patients who required admission had acutely abnormal head CT findings (Table 1), whereas only 4 of 142 (2.8%) patients who did not require admission had acutely abnormal head CT findings (Fisher exact test, $p = 0.012$).

Within a 3-month follow-up period, 4 of 456 (0.9%) patients who did not have an acutely abnormal head CT finding were found to have a significant clinical event. One 78-year-old man with syncope who was not admitted to the hospital at the time of initial presentation developed bilateral border zone infarcts documented by MRI 6 days after the initial head CT. Another 62-year-old man with syncope who was admitted to the hospital was found to have a 6- to 7-mm anterior communicating artery aneurysm by MR angiography the next day. A 62-year-old man presenting with dizziness who was admitted to the hospital was found to have an

acute right posterior cerebral artery infarct by MRI the next day. Finally, a 43-year-old man with syncope who was admitted to the hospital was found to have a right middle cerebral artery acute infarct by MRI 1 day later.

Discussion

Patients often present to the ED with non-specific complaints such as “dizziness,” “lightheadedness,” “unsteadiness,” or “passing out.” Some patients have a difficult time describing “dizziness,” and patients presenting with “syncope” may not recall whether they completely lost consciousness. We chose to investigate all patients presenting with dizziness, near-syncope, or syncope together because their medical definitions have some degree of overlap. “Dizziness” is defined as “a sensation of unsteadiness accompanied by a feeling of movement within the head,” “near-syncope” is defined as “the sensation of feeling faint,” and “syncope” is defined as “a transient loss of consciousness and postural tone” [8, 9]. The ED physician faces a very broad differential diagnosis for these patients, and the clinical situation is often confounded by comorbidities, polypharmacy, and difficulty in communicating symptoms.

The ED physician also faces two seemingly conflicting challenges—first, rapidly identifying cases that require emergent care and, ideally, alleviating the symptoms or triaging the patient to a specialist, and second, using resources appropriately. Often, the former becomes the primary goal and patients receive extensive evaluation with laboratory testing and cross-sectional imaging to rule out serious causes. In a multicenter ED study, a higher neuroimaging rate by site for dizziness was poorly predictive of a higher rate of stroke diagnoses by site, with a 1% increase in the percentage of patients diagnosed with stroke per 10% increase in ED neuroimaging rate [10]. Eventually, constructing an imaging algorithm for the ED patient with dizziness or syncope will be important for the emergency physician.

Consistent with prior studies, we report that head CT has a low diagnostic yield (7.1%) for dizziness in the ED setting. Lawhn-Heath et al. [7] reported only a 2.2% diagnostic yield for head CT scans ordered in the ED for acute dizziness and included patients with secondary symptoms such as focal neurologic signs, trauma, and headache. Navi et al. [11] reported that a relevant abnormal head CT finding was seen in 7% of studies in adults presenting to an academic ED with a primary complaint of dizziness, ver-

tigo, or imbalance. We also report an admission rate of 18.6% for patients with dizziness, which is similar to the 22% (204/907) of patients with dizziness admitted to the hospital from the ED in the same study [11].

A statistically significant higher proportion of patients with syncope or near-syncope were admitted (39.8%) compared with those admitted presenting with dizziness (18.6%). This is likely because a large proportion of patients with syncope or near-syncope required inpatient cardiac monitoring as part of their syncope evaluation to rule out an arrhythmogenic cause.

There have been few studies evaluating the diagnostic yield of head CT for patients presenting to the ED with syncope. Goyal et al. [5] reported no head CT findings that were clinically related to 117 patients presenting with a syncopal event, but excluded those who had competing indications for a head CT, such as patients with a history of trauma, patients presenting with seizures, patients with mental status changes, and patients with a neurologic deficit on initial evaluation. Giglio et al. [12] reported one patient with head CT evidence of infarction out of 44 patients with syncope who underwent head CT ordered from the ED. In addition, Grossman et al. [13] reported a diagnostic yield of 5% abnormal head CT findings after excluding patients with persistent altered mental status, drug-related or posttrauma loss of consciousness, seizure, or hypoglycemia.

Our study reported a relatively higher diagnostic yield of 6.4% in patients presenting with near-syncope and syncope; however, unlike previous studies, we included patients who had competing indications because we wanted to determine whether any of these competing indications were predictive of an acutely abnormal head CT.

The ratio of patients presenting with syncope and near-syncope to those presenting with dizziness was nearly 1:1 in our study (236 patients with syncope or near-syncope and 254 patients with dizziness). However, the ratio of number of visits to the ED for these complaints is nearly 3.5:1 (2.6 million ED visits for dizziness and 740,000 visits for syncope) [1, 2]. This discrepancy may have been because a large proportion of patients presenting with dizziness did not require head CT and were presumed to have peripheral vestibular dysfunction, rather than acute intracranial lesions.

Given our overall low diagnostic yield for dizziness and syncope, our findings suggest

that, although ED physicians should maintain a high index of suspicion for serious causes of these symptoms, there are no specific clinical factors or combination of clinical factors that ultimately can predict which patients will have acutely abnormal head CT scan findings. More specifically, although a focal neurologic deficit, age greater than 60 years, and head trauma were statistically significant in predicting an acutely abnormal finding on a head CT, the overall accuracy of that model remained the same (at 93.3%) as if no factors were used.

Our finding that age greater than 60 years, loss of consciousness, abnormal head CT findings, physical examination finding of a focal neurologic deficit, slurred speech, and altered mental status, although statistically significant in determining hospital admission rate, is of limited clinical utility. The overall accuracy of the model increases by only 5.3% (from 71.2% to 76.5%) when including those six predictors.

As expected, patients with dizziness, syncope, or near-syncope with an acute abnormality on head CT had higher admission rates. Similarly, among patients who required hospital admission for dizziness, syncope, or near-syncope, an increased number had an acutely abnormal head CT compared with patients who did not require admission. This suggests that the result of the head CT is clinically important and influences the decision of whether to admit the patient.

Head CT ideally should be used as a diagnostic test rather than a screening one because of its expense and unnecessary radiation exposure to the patient. The diagnostic yield of head CT in our study was only 7.1% in patients presenting with dizziness and 6.4% in patients presenting with near-syncope or syncope. These low rates indicate that head CT is currently being used more as a screening test rather than to confirm or exclude a specific diagnosis. Although a defined acceptable diagnostic yield for head CT in the evaluation of dizziness or syncope has yet to be established, we suggest that, at a minimum, the diagnostic yield should be 10% or greater. Costantino et al. [14], in assessing the utility of CT angiography for acute pulmonary embolism, reported that their 10% pulmonary embolism positivity rate for CT angiography represents overuse of CT angiography as a screening rather than a diagnostic examination.

A clinical algorithm for determining which patients should undergo head CT in the ED for dizziness and syncope is still needed. The fact that important clinical variables, such as altered mental status, do not appear to correlate with acutely abnormal findings on head CT suggests that greater specificity in describing these variables may be required. For example, altered mental status could be assessed in further detail and quantified using a cognitive test such as the Mini-Mental State Examination, or the Six-Item Screener [15, 16]. Similarly, "head trauma" could further be classified into mild, moderate, or severe according to the patient's Glasgow Coma Scale [17].

In summary, our results resemble those of other studies, which found a low yield for acute abnormalities seen on head CT among patients presenting to the ED with dizziness or syncope. Only three factors were found to be statistically significant predictors of an abnormal head CT. Therefore, we suggest that younger patients and those without focal neurologic deficits or recent head trauma may not benefit from head CT. Careful attention to the clinical examination and appropriate follow-up may be used as an alternative to expensive cross-sectional imaging for these patients.

Limitations of this study were its retrospective study design and relatively small sample size, given the small fraction of patients with positive findings on head CT. However, all patients are members of an integrated HMO within a geographically isolated region, resulting in relatively complete data capture.

Conclusion

Our results suggest that most patients presenting to the ED with syncope or dizziness may not benefit from head CT unless they are older, have a focal neurologic deficit, or have a history of recent head trauma.

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FOR YOUR INFORMATION

This article has been selected for AJR Journal Club activity. The accompanying Journal Club study guide can be found on the following page.

Study Guide

Head CT Scans in the Emergency Department for Syncope and Dizziness

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Introduction

1. Is this study timely and relevant? Is an appropriate rationale provided for performing the study? Is the study based on an appropriate review of the medical literature?

Methods

2. What were the inclusion criteria for the study? What were the exclusion criteria? Was the study institutional review board and HIPAA compliant?
3. Is the choice of study design satisfactorily explained? Does the study account for any comorbidities that the patients might have had?
4. What are the limitations of this study? Are these limitations adequately discussed?
5. What statistical methods were used to analyze the data? Did the study design use methods that permitted the hypothesis to be tested?

Results

6. Was the research question answered? Was the hypothesis supported or not supported?
7. Are any of the results surprising? Do the results mirror empirical evidence from practice?

Study Design

8. What is the definition of disease prevalence? How does prevalence differ from incidence? How does prevalence influence diagnostic accuracy?

Discussion

9. How do the results of this study compare with similar studies?
10. Does the patient population in this study match the patient population at your institution or practice? Can the data from this study be extrapolated to other patient populations? Why or why not?
11. What are the implications of the study results? Do you agree with the conclusions drawn about the utility of head CT in the evaluation of patients with dizziness, syncope, or near syncope? To what degree, if any, do the results of this study influence how you practice?
12. How might you improve on this study?

Background Readings

1. Lawhn-Heath C, Buckle C, Christoforidis G, Straus C. Utility of head CT in the evaluation of vertigo/dizziness in the emergency department. *Emerg Radiol* 2013; 20:45-49
2. Wasay M, Dubey N, Bakshi R. Dizziness and yield of emergency head CT scan: is it cost effective? (letter) *Emerg Med J* 2005; 22:312

*Please note that the authors of the Study Guide are distinct from those of the companion article.