

BRIEF REPORT

Geriatrics

Head computerized tomography in emergency department evaluation of the geriatric patient with generalized weakness

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Abstract

Objective: Weakness in older emergency department (ED) patients presents a broad differential. Evaluation of these patients can be challenging, and the efficacy of head computed tomography (CT) imaging is unclear. This study assesses the usefulness of head CT as a diagnostic study of acute generalized weakness in older ED patients.

Methods: This retrospective review of patients aged 65 years and older presenting to 2 community EDs included patients with a chief complaint of generalized weakness who received a head CT. Patients presenting with a focal neurologic complaint, altered mental status, or trauma were excluded. Variables evaluated included additional triage chief complaints, dementia diagnosis, and deficits on physical examination. Primary outcome was acute intracranial finding on head CT. Secondary outcomes included neurology consultation, neurosurgical consultation, and neurosurgical intervention.

Results: Of 247 patients, 3.2% had an acute intracranial abnormality on head CT. Emergent consultations for neurology and neurosurgery occurred for 1.6% and 2.4% of patients, respectively. None required neurosurgical intervention. Patients with objective weakness or focal neurologic deficits on physical examination were more likely to have acute findings on head CT (8.5% vs. 2.0%, odds ratio 4.56, confidence interval 1.10–18.95). Additional characteristics did not predict acute intracranial abnormality or need for emergent consultation.

Conclusion: Few patients with generalized weakness evaluated with head CT had acutely abnormal intracranial findings. Patients with objective weakness or neurologic deficits were more likely to have acute abnormalities. Although head CT is frequently used to evaluate geriatric weakness, its utility is low, especially in patients with normal physical examinations.

KEYWORDS

CT head, emergency department, geriatrics, neuroimaging, weakness

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1 | INTRODUCTION

1.1 | BACKGROUND

Weakness in the geriatric emergency department (ED) patient encompasses a poorly understood and broad differential. The evaluation itself of the older adult patient in the ED is a relatively unguided process. An American College of Emergency Physicians clinical policy provides recommendations for emergency physicians on patients with traumatic brain injury. Similarly, there is some clarity regarding ED evaluation of non-traumatic headache and head computed tomography (CT) for subarachnoid hemorrhage.² These primarily guide the physician in evaluation of headache, neck pain, and loss of consciousness. Additionally, extensive literature exists on the association with vertigo, dizziness, and intracranial pathology.^{3,4} A retrospective review moved toward defining a standard for non-traumatic head CT and included adult patients with specific complaints including presyncope.⁵

1.2 | Importance

Older adult patients presenting to the ED with a chief complaint of generalized weakness have a broad differential diagnosis and the inclusion of a head CT as part of the workup is not well established. There is no widely accepted practice or guideline for evaluation of these patients. To help formulate recommendations and determine the appropriateness of use for head CT imaging in these patients, further investigation is required.

1.3 | Goals of this investigation

This study aims to develop a clearer understanding of the diagnostic utility of non-contrast head CT in the ED evaluation of the older patient with generalized weakness. This study attempts to examine the characteristics of patients presenting to the ED with generalized, non-focal weakness and identify risk factors for intracranial abnormalities.

2 | METHODS

2.1 | Study design and setting

This is a multicenter retrospective case series at 2 community hospitals, located in South Florida, United States, with annual ED volumes between 53,000 and 70,000. This study was approved by the institutional review board of the hospitals' affiliated university.

2.2 | Selection of participants

This study included any patient aged 65 years and older who presented to the ED during the 1-year period between August 2019 and August 2020 with a chief complaint of generalized weakness and received a

The Bottom Line

This retrospective study found that among older emergency department patients, head computed tomography (CT) found few acute abnormal intracranial findings. The authors conclude that the utility of head CT is low in patients with normal physical examinations.

non-contrast head CT for evaluation of that complaint. Patients were excluded if they had history of acute trauma or alternative chief complaint that may have indicated alternative reasons for imaging, such as focal neurologic complaint or altered mental status complaint.

To identify patients, the health information management department queried the hospitals' picture archiving and communication system for patients aged 65 years and older who received a head CT while in the ED. Trained research assistants blinded to the study question then reviewed each emergency physician note and information placed on the head CT order to screen patients for eligibility. Patients were categorized by indication for head CT, including weakness, trauma, headache, stroke, seizure, syncope, dizziness, altered mental status, focal neurologic deficit, and other. If a patient had multiple indications, only the primary reason was selected, which was determined based on the physician notes and CT order. Physician investigators then performed a review of the research assistant screening process to ensure proper categorization by indication for CT head imaging. Finally, the physician investigators further reviewed all patients who had a CT for the purpose of weakness to identify those who presented to the ED with generalized weakness without focality as their chief complaint.

2.3 | Measurements

Patients who met inclusion had complete chart reviews performed by the physician investigators. Data extracted from patients' electronic medical records included patient characteristics, presenting complaints in addition to generalized weakness, specific physical examination findings including objective weakness or focal weakness, findings on head CT, and ED disposition. The additional presenting complaints included altered mental status, headache, chest pain, abdominal pain, other pain, shortness of breath, fever, nausea/vomiting, and other. Neurology or neurosurgery consultation was determined, including whether that consultation was required emergently from the ED and whether the patient required neurosurgical intervention. CT head imaging was read by attending radiologists who were not involved with the study.

2.4 | Outcomes and analyses

The primary outcome was the discovery of an acute intracranial abnormality on head CT. Acute findings on head CT were defined as the

TABLE 1 Background characteristics of patients presenting with generalized weakness by acute findings on head computed tomography imaging, *n* (%).

Characteristic	Acute findings on head CT		Overall N = 247
	No N = 239	Yes N = 8	
Age, years (SD)	82.1 (9.0)	78.4 (10.9)	81.9 (9.1)
English language	230 (96.2%)	7 (87.5%)	237 (96.0%)
Additional triage complaints	84 (35.1%)	2 (25.0%)	86 (34.8%)
Altered mental status	0 (0%)	0 (0%)	0 (0%)
Headache	6 (2.5%)	0 (0%)	6 (2.4%)
Chest pain	1 (0.4%)	0 (0%)	1 (0.4%)
Abdominal pain	2 (0.8%)	1 (12.5%)	3 (1.2%)
Other pain	3 (1.3%)	0 (0%)	3 (1.2%)
Shortness of breath	10 (4.2%)	0 (0%)	10 (4.0%)
Fever	10 (4.2%)	1 (12.5%)	11 (4.5%)
Nausea/vomiting	15 (6.3%)	0 (0%)	15 (6.1%)
Other	44 (18.4%)	1 (12.5%)	45 (18.2%)
Living arrangements			
Home	165 (69.0%)	8 (100%)	173 (70.0%)
Skilled nursing facility	18 (7.5%)	0 (0%)	18 (7.3%)
Unknown	56 (23.4%)	0 (0%)	56 (22.7%)
Dementia diagnosis	82 (39.2%)	3 (37.5%)	85 (39.2%)
Focal examination findings	22 (9.2%)	2 (25.0%)	24 (9.7%)
Unilateral extremity weakness	12 (5.0%)	2 (25.0%)	14 (5.7%)
Slurred speech	6 (2.5%)	0 (0%)	6 (2.4%)
Facial droop	2 (0.8%)	0 (0%)	2 (0.8%)
Other	4 (1.7%)	0 (0%)	4 (1.6%)
Objective weakness	31 (13.0%)	2 (25%)	33 (13.4%)
Objective or focal weakness	43 (18.0%)	4 (50.0%)	47 (19.0%)
Emergency department disposition			
Admit	195 (81.6%)	8 (100%)	203 (82.2%)
Discharge	44 (18.4%)	0 (0%)	44 (17.8%)

Abbreviations: CT, computerized tomography; SD, standard deviation.

radiologist-written interpretation of the imaging as pathology that was not chronic in nature. This included findings of intracranial hemorrhage, mass, ischemic stroke, and other acute findings. Findings such as white matter changes, hygroma, and chronic or known subdural hemorrhage were classified to be chronic and negative for acute findings.

Secondary outcomes included patient disposition, neurologist consultation, neurosurgical consultation, and neurosurgical intervention.

Interrater reliability between the research assistants' screening and physician investigators' review of CT performed for generalized weakness was calculated using Cohen's kappa statistic. For each patient characteristic versus outcome measure, we performed a 2-by-2 chi-square contingency table and calculated odds ratios using SPSS 27.0 (IBM Corporation, Armonk, NY).

3 | RESULTS

3.1 | Characteristics of study subjects

A total of 10,080 patients were screened for inclusion. Of these, 444 were found to have a head CT performed for weakness. Interrater reliability between the research assistants' screening and physician investigators' review of CT performed for generalized weakness was $\kappa = 0.771$ ($P < 0.001$). From this group, 247 patients presented to the ED with the complaint of generalized weakness and were included in this study. These patients were primarily English speaking (96.0%) and 85 (34.4%) had history of dementia. A total of 18 patients (7.2%) arrived from a skilled nursing facility or acute rehab facility, although place of residence was not known for 23% of the study group.

TABLE 2 Description of patients presenting with generalized weakness found to have acute findings on head computed tomography imaging.

#	Age	Dementia	Additional triage complaints	Focal deficit	Objective weakness	Acute CT findings	Neurologist consulted	Neurosurgeon consulted	Neurosurgical intervention	Disposition
1	79	No	None	None	No	Ischemic stroke	Yes	No	No	Admit
2	69	No	None	None	No	Hemorrhage without mass effect	Yes ^a	Yes ^a	No	Admit
3	97	No	None	Unilateral extremity weakness	No	Mass with mass effect	Yes	No	No	Admit
4	82	No	None	None	No	Normal pressure hydrocephalus	No	No	No	Admit
5	65	Yes	Abdominal pain, fever	None	No	Mass without mass effect	No	No	No	Admit
6	73	Yes	COVID-19	Unilateral extremity weakness	No	Hemorrhage with mass effect	No	Yes	No	Admit
7	90	Yes	None	None	Yes	Hemorrhage with mass effect	No	Yes ^a	No	Admit
8	72	Yes	None	None	Yes	Mass without mass effect	No	Yes ^a	No	Admit

Abbreviation: CT, computerized tomography.

^aconsultation placed emergently.

Besides generalized weakness, 86 (34.8%) patients had additional complaints, though none were focal deficits. On physical examination, 33 (13.4%) patients were found to have non-focal objective muscular weakness. 24 (9.7%) patients were found to have focal deficits on examination. This included 14 (5.7%) with unilateral extremity weakness, 6 (2.4%) with slurred speech, 2 (0.8%) with facial droop, and 4 (1.6%) with other deficits including aphasia, residual weakness, and a wide gait. A combined 47 (19.0%) of patients had an abnormal physical examination with either objective muscular weakness or focal neurologic deficits. Background characteristics by acute CT findings are in Table 1.

3.2 | Main results

Eight patients (3.2%) had an acute intracranial abnormality found on head CT (Table 2). These included 3 with intracranial mass, 2 with intracranial hemorrhage, 1 with ischemic stroke, and 1 with enlarged ventricles suggesting normal pressure hydrocephalus. Two of these patients had mass effect from either intracranial mass or hemorrhage. One patient was found to have mastoiditis described on head CT, of unclear acuity. Overall, 4 patients (1.6%) had an emergent neurology consultation and 6 (2.4%) had an emergent neurosurgery consultation. No patients had neurosurgical intervention (Table 3).

Patient characteristics on ED presentation of generalized weakness were not predictive of intracranial pathology on head CT. There were no significant differences in rate of acute intracranial abnormality for history of dementia, presence of an additional triage complaint, objective non-focal weakness or presence of a focal neurologic deficit on

TABLE 3 Rate of acute findings and interventions of patients presenting with complaint of generalized weakness.

Outcome	N	%
Acute intracranial abnormality on head CT	8	3.2%
Emergent neurology consultation	4	1.6%
Emergent neurosurgery consultation	6	2.4%
Neurointervention	0	0%

Abbreviation: CT, computerized tomography.

examination (Table 4). However, a combined objective weakness or focal neurologic deficit found on physical examination did correlate with an odds ratio of 4.56 (95% confidence interval [CI]: 1.10–18.95, $P = 0.023$). Of those with an objective deficit on examination 8.5% had an intracranial abnormality versus 2.0% without (Table 4).

Patient characteristics were also analyzed for neurology consultation (emergent Table 5, routine Table 6), neurosurgery consultation (emergent Table 7, routine Table 8), and neurosurgical intervention. There were no predictors of emergent neurology or neurosurgery consultation. Objective weakness and combined objective weakness or focal deficit on physical examination were predictors of routine neurology consultation with an odds ratio of 4.60 (95% CI: 1.41–15.04, $P = 0.006$) and 5.66 (95% CI: 1.81–17.73, $P = 0.001$), respectively.

4 | LIMITATIONS

This study was limited by the nature of its design as a retrospective review. Certain patient characteristics may have an increased

TABLE 4 Odds of acute finding on head computerized tomography by presence of patient characteristic, *n* (%).

Characteristic	Yes	No	Odds ratio (95% CI)	P value
Dementia diagnosis	3/85 (3.5%)	5/132 (3.8%)	0.93 (0.22–3.99)	0.921
Additional triage complaint	2/86 (2.3%)	6/161 (3.7%)	0.62 (0.12–3.12)	0.553
Objective weakness	2/33 (6.1%)	6/214 (2.8%)	2.24 (0.43–11.58)	0.325
Focal deficit	2/24 (8.3%)	6/223 (2.7%)	3.29 (0.63–17.28)	0.138
Objective weakness or focal weakness	4/47 (8.5%)	4/200 (2.0%)	4.56 (1.10–18.95)	0.023

Abbreviation: CI, confidence interval.

TABLE 5 Odds of emergent neurology consultation in the emergency department by presence of patient characteristic, *n* (%).

Characteristic	Yes	No	Odds ratio (95% CI)	P value
Dementia diagnosis	1/85 (1.2%)	2/132 (1.5%)	0.77 (0.07–8.67)	0.835
Additional triage complaint	0/86 (0%)	4/161 (2.5%)	-	0.141
Objective weakness	1/33 (3.0%)	3/214 (1.4%)	2.20 (0.22–21.78)	0.490
Focal deficit	1/24 (4.2%)	3/223 (1.3%)	3.19 (0.32–31.92)	0.298
Objective weakness or focal deficit	2/47 (4.3%)	2/200 (1.0%)	4.40 (0.60–32.08)	0.112

Abbreviation: CI, confidence interval.

TABLE 6 Odds of any neurology consultation during hospitalization by presence of patient characteristic, *n* (%).

Characteristic	Yes	No	Odds ratio (95% CI)	P value
Dementia diagnosis	2/85 (2.4%)	10/132 (7.6%)	0.29 (0.06–1.38)	0.100
Additional triage complaint	3/86 (3.5%)	10/161 (6.2%)	0.55 (0.15–2.04)	0.361
Objective weakness	5/33 (15.2%)	8/214 (3.7%)	4.60 (1.41–15.04)	0.006
Focal deficit	3/24 (12.5%)	10/223 (4.5%)	3.04 (0.78–11.93)	0.095
Objective weakness or focal deficit	7/47 (14.9%)	6/200 (3.0%)	5.66 (1.81–17.73)	0.001

Abbreviation: CI, confidence interval.

TABLE 7 Odds of emergent neurosurgery consultation in the emergency department by presence of patient characteristic, *n* (%).

Characteristic	Yes	No	Odds ratio (95% CI)	P value
Dementia diagnosis	3/85 (3.5%)	2/132 (1.5%)	2.38 (0.39–14.54)	0.334
Additional triage complaint	0/86 (0%)	6/161 (3.7%)	-	0.070
Objective weakness	2/33 (6.1%)	4/214 (1.9%)	3.39 (0.60–19.27)	0.145
Focal deficit	0/24 (0%)	6/223 (2.7%)	-	0.416
Objective weakness or focal deficit	2/47 (4.3%)	4/200 (2.0%)	2.18 (0.39–12.26)	0.366

Abbreviation: CI, confidence interval.

TABLE 8 Odds of any neurosurgery consultation during hospitalization by presence of patient characteristic, *n* (%).

Characteristic	Yes	No	Odds ratio (95% CI)	P value
Dementia diagnosis	4/85 (4.7%)	2/132 (1.5%)	3.21 (0.58–17.92)	0.162
Additional triage complaint	1/86 (1.2%)	6/161 (3.7%)	0.30 (0.04–2.57)	0.247
Objective weakness	2/33 (6.1%)	5/214 (2.3%)	2.70 (0.50–14.51)	0.230
Focal deficit	1/24 (4.2%)	6/223 (2.7%)	1.57 (0.18–13.64)	0.679
Objective weakness or focal deficit	3/47 (6.4%)	4/200 (2.0%)	3.34 (0.72–15.46)	0.103

Abbreviation: CI, confidence interval.

association with acute intracranial abnormality in the geriatric population but were not sufficiently documented. Additionally, this study found only a small number of patients who had positive CTs for acute intracranial abnormality. This limited the ability to draw conclusions regarding association with specific patient characteristics or physical examination findings. Further, patients with weakness that did not have CTs were not included in the study. Although not policy at this hospital, the standard practice is to evaluate all geriatric ED patients with weakness with a head CT. Presumably, patients who did not have a head CT performed would be less likely to have had acute abnormal CT findings, which would make the rates of concerning findings even lower.

5 | DISCUSSION

Head CT is commonly used in evaluation of geriatric ED patients, although its usefulness is not well studied. In our cohort of patients, the overall incidence of acute intracranial abnormalities was low. Notably, no one with a head CT performed for generalized weakness required neurosurgical intervention.

Our study focused on patients with the chief complaint of generalized weakness who obtained head CT imaging for this complaint. Those with objective findings of motor weakness or a focal neurologic deficit on physical examination were more likely to have acute intracranial abnormality on head CT. This stresses the importance of performing a comprehensive physical examination including a thorough neurologic assessment. However, no patient characteristic or examination finding independently predicted the need for change in ED management, specifically emergent consultation or neurosurgical procedure. Although the presence of dementia presumably limits the ability to obtain an accurate history, these patients were not found to be more likely to have acute findings on CT head, need for neurology consultation, or need for neurosurgery consultation.

Patients who present to the ED with generalized weakness may ultimately be found to have concerning underlying processes, though an acute neurologic process requiring emergent diagnosis seems less likely. The most common etiologies for weakness in older adult patients primarily consist of infections, metabolic dysfunction, and malignancy.⁶ The general workup typically consists of basic laboratory testing, electrocardiogram, chest x-ray, and urinalysis. From one review, CT head imaging is recommended to be performed when there are new focal neurologic deficits or in the setting of suspected intracranial hemorrhage, tumor, or central nervous system infection.⁷

Research has shown that patients with ultimate diagnoses of classic diseases may present with non-specific complaints or atypical signs and symptoms, particularly in the older population. Part of a broad evaluation often includes head CT, with increased age considered a clinically significant predictor of abnormal findings.⁸ A cohort analysis found weakness and fatigue as the fifth most common ED visit complaint in geriatric patients, using head CT as a diagnostic tool 10% more often in these patients than in the control geriatric group,⁹ and head CT as a diagnostic tool is only becoming more prevalent.¹⁰ A prospective analysis of 218 ED patients with a median age of 82 presenting with

non-specific complaints found that 59% of these patients had a serious diagnosis made within the next 30 days after initial presentation.⁶

Despite this widespread understanding, little guidance is available regarding the diagnostic usefulness of head CT. The American College of Radiology Appropriateness Criteria suggests that in presyncope and syncope, a non-contrast head CT is usually not appropriate, but this particularly refers to patients in whom there is high suspicion of cardiac etiology¹¹ and references literature including patients presenting with focal neurologic complaints.¹² Clarifying appropriateness of high-cost and high-risk imaging has become a top priority for emergency medicine, making the "Top Five List" of the policy and research agenda identified by the Robert Wood Johnson Foundation.¹³

A previous longitudinal cohort study found the incidence of spontaneous intracerebral hemorrhage in patients ≥ 75 years old was 0.11%.¹⁴ Incidence of intracranial tumors in the adult US population is estimated to be around 0.02% with incidence of primary brain tumors in the geriatric population to also be around the same, at 0.02%.¹⁵⁻¹⁷

Comparing to these general population figures, our data demonstrate a relatively low incidence of acute intracranial abnormality in the geriatric population presenting to the ED for generalized weakness who had head CT imaging performed for this complaint. However, a negative head CT study may still provide value. A negative CT provides reassurance to a wary patient who may be reluctant to be discharged home. This may facilitate a faster discharge and prevent an unnecessary period of observation resulting in a longer length of stay. Furthermore, if a patient requires hospitalization for another identified reason, admitting services may still request or require a head CT in this population. With readily accessible CT machines, performing head imaging on patients with generalized weakness may have the potential to improve overall hospital utilization.

Our study suggests that using non-contrast head CT has low yield to discover acute intracranial pathology in patients with generalized weakness. Importantly, this analysis also suggests that results of this diagnostic tool as well as associated patient characteristics did not change ED management, specifically the requirement for emergent consultation or intervention planned from the ED. It also supports existing literature that recommends maintaining a broad differential in the geriatric patient, as most of the reviewed patient characteristics do not have clinically significant increased likelihoods to narrow the physicians' diagnostic pathway.

In summary, although non-contrast head CT is frequently used in the evaluation of weakness in geriatric ED patients, the value of this imaging appears to be low, especially for patients with normal neurologic examinations and no objective weakness.

AUTHOR CONTRIBUTIONS

Elizabeth A. Calhoun, Richard D. Shih, Patrick G. Hughes, Joshua J. Solano, Lisa M. Clayton, and Scott M. Alter participated in the conception and design of the study. Elizabeth A. Calhoun performed the literature review and the data collection. Scott M. Alter performed the data analysis. Elizabeth A. Calhoun wrote the initial draft. Richard D.

Shih, Patrick G. Hughes, Joshua J. Solano, Lisa M. Clayton, and Scott M. Alter critically revised and finalized the article.

CONFLICT OF INTEREST STATEMENT

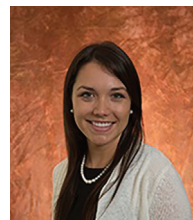
The authors have no financial conflicts of interest to disclose.

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