



Contents lists available at ScienceDirect

American Journal of Emergency Medicine

journal homepage: www.elsevier.com/locate/ajem

Utilization of head CT during injury visits to United States emergency departments: 2012–2015 ☆☆☆☆☆

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ARTICLE INFO

Article history:

Received 20 March 2018

Received in revised form 9 May 2018

Accepted 12 May 2018

Available online xxx

Keywords:

CT scan

Head trauma

Intracranial hemorrhages

Traumatic brain hemorrhage

Traumatic subdural hematoma

Traumatic brain injuries

Traumatic subarachnoid hemorrhage

Brain concussion

Traumatic cerebral hemorrhage

Neurosurgery

ABSTRACT

Introduction: Studies have shown increasing utilization of head computed tomography (CT) imaging of emergency department (ED) patients presenting with an injury-related visit. Multiple initiatives, including the *Choosing Wisely™* campaign and evidence-based clinical decision support based on validated decision rules, have targeted head CT use in patients with injuries. Therefore, we investigated national trends in the use of head CT during injury-related ED visits from 2012 to 2015.

Methods: This was a secondary analysis of data from the annual United States (U.S.) National Hospital Ambulatory Medical Care Survey from 2012 to 2015. The study population was defined as injury-related ED visits, and we sought to determine the percentage in which a head CT was ordered and, secondarily, to determine both the diagnostic yield of clinically significant intracranial findings and hospital characteristics associated with increased head CT utilization.

Results: Between 2012 and 2015, 12.25% (95% confidence interval [CI] 11.48–13.02%) of injury-related visits received at least one head CT. Overall head CT utilization showed an increased trend during the study period (2012: 11.7%, 2015: 13.23%, $p = 0.09$), but the results were not statistically significant. The diagnostic yield of head CT for a significant intracranial injury over the period of four years was 7.4% (9.68% in 2012 vs. 7.67% in 2015, $p = 0.23$).

Conclusions: Head CT use along with diagnostic yield has remained stable from 2012 to 2015 among patients presenting to the ED for an injury-related visit.

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1. Introduction

Head computed tomography (CT) is highly sensitive for intracranial injury, and is thus the recommended initial imaging modality to evaluate traumatic head injuries. A number of well-validated clinical decision rules, including the Canadian Head CT Rule and New Orleans Criteria, are available to improve the efficiency of head CT utilization for the

evaluation of patients with traumatic head injury in the emergency department (ED) [1].

Several prior studies have shown an increasing trend in CT usage [2,3]. Hussein et al. found that head CT use for injury-related visits significantly increased from 9.6% in 2007 to 11.6% in 2010 ($p < 0.001$), a relative increase of 20.8% [3]. Since the publication of these studies, awareness of the potential risks of radiation exposure secondary to CT scans has increased [4]. In addition in 2012, the *Choosing Wisely™* campaign kicked off an effort to avoid unnecessary tests or treatments on patients, including head CT [5]. In 2013, the American College of Emergency Physicians joined *Choosing Wisely™* with its collection of evidence-based recommendations, two of which aimed to avoid unnecessary head CTs [5].

We investigated national trends in the use of head CT during injury-related visits to the ED during a 4-year period (2012–2015). We

☆ Summary conflict of interest statement: None.

☆☆ Funding information: None.

☆☆☆ Prior abstract publication/presentation: None.

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hypothesized that the prevalence of head CT use in injury-related ED visits would decrease or plateau. Secondly, we aimed to determine the change in diagnostic yield over the same period, and to examine patient and hospital characteristics associated with increased head CT utilization.

2. Methods

2.1. Study setting and population

This secondary analysis used data collected from the National Hospital Ambulatory Medical Care Survey (NHAMCS) and met criteria for exemption by the Institutional Review Board. NHAMCS is an annual, national probability sample of ambulatory visits to non-federal, general, and short-stay hospitals in the United States (U.S.) [6]. NHAMCS uses a four-stage probability sampling design, collecting a nationally representative sample of ED visits [6]. At each sampled hospital, NHAMCS data are abstracted from patient records by trained hospital staff members monitored by the U.S. Census Bureau's agents during a randomly assigned 4-week reporting period.

2.2. Study protocol

We restricted our analyses to visits from 2012 to 2015 that were related to an injury due to trauma. Variables of interest included patient age (<18, 18–64, and >64 years), region of the country, sex, race, insurance status, and provider type. Insured was defined as having Medicare, Medicaid, worker's compensation, or private insurance; uninsured was defined as charity, self-pay, no charge, other, or unknown. Providers were categorized as having primarily been seen by an attending physician, resident (defined as intern or resident), or advanced practice provider (nurse practitioners and physician assistants).

We calculated diagnostic yield based on the proportion of injury-related visits in which patients receiving a head CT received a significant intracranial injury diagnosis. For the purposes of this study, we operationally defined "significant diagnosis" as International Classification of Diseases, 9th Revision (ICD-9), code: Fracture of the vault of skull (800.xx), fracture of base of skull (801.xx), fracture of face bones (802.xx), other skull fractures (803.xx), multiple fractures involving skull or face with other bones (804.xx), cerebral laceration and contusion (851.xx), subarachnoid, subdural, and extradural hemorrhage following injury (852.xx), other intracranial hemorrhage following injury (853.xx), intracranial injury of other or unspecified nature (854.xx), injury to blood vessels of head and neck (900.xx), crushing injury of face, scalp, and neck (925.xx), injury to optic nerve and pathways (950.xx), and injury to other cranial nerve(s) (951.xx) [2,3].

2.3. Outcome measures

Our primary outcome was the use of head CT during injury-related visits to the ED. As secondary outcomes, we determined diagnostic yield, defined as the proportion of injury-related visits in which patients receiving a head CT received a significant head injury diagnosis, and patient and visit characteristics associated with head CT use.

2.4. Data analysis

We reported frequencies of unweighted raw ED visits and weighted for national representativeness. We reported yearly trends of head CT utilization for injury-related visits. We used survey-weighted chi-square tests to assess for differences in the proportion of visits receiving head CT across categories. In addition, we used a survey-weighted multivariable logistic regression to assess the whether certain patient or visit characteristic variables were independently associated with head CT use.

We incorporated NHAMCS complex survey design features including cluster, strata, and probability weights to produce nationally representative estimates. As recommended, we included only variables where cell sizes were ≥ 30 samples per cell [7]. We did not consider or analyze any items with a nonresponse rate of >10%. A p-value < 0.05 was considered significant. All analyses were conducted using SAS 9.4 (Cary, NC).

3. Results

From 2012 to 2015, the NHAMCS included an unweighted total of 99,135 ED visits, 30,158 of which were injury-related. This represented a weighted sample of 135 million total and 40 million yearly injury-related ED visits. Patient and visit characteristics are reported in Table 1.

3.1. Head CT utilization and yield

Between 2012 and 2015, 12.25% (95% confidence interval [CI] 11.48–13.02%) of injury-related visits received at least one head CT. Overall head CT utilization showed an increased trend during the study period (2012: 11.7%, 2015: 13.23%, $p = 0.09$), but the results were not statistically significant (Fig. 1). These findings held when stratified by age. Among patients <18 years, head CT use went from 7.17% (CI 5.31%–9.03%) in 2012 to 8.20% (CI 6.24%–10.16%) in 2015 ($p = 0.46$). Among patients 18–64 years of age, head CT use went from 10.31% (CI 8.94%–11.68%) in 2012 to 11.64% (CI 9.97%–13.32%) in 2015 ($p = 0.21$). Among patients 65 years and older, head CT use went from 26.90% (CI 22.74%–31.07%) in 2012 to 29.23% (CI 25.53%–32.94%) in 2015 ($p = 0.39$).

The diagnostic yield of head CT for a significant intracranial injury diagnosis over the four-year period was 7.4% and did not significantly change over the study period (2012: 9.68% and 2015: 7.67%, $p = 0.23$) (Fig. 1).

Table 1

Relationship between patient and visit characteristics and head CT use during injury-related Emergency Department (ED) visits

	Unweighted ED visits	Weighted ED visits (Thousands)	Adjusted odds ratio* for likelihood of CT use (95% CI)
Age (years)			
<18	7072	9591	Reference
18–64	18,934	25,187	1.75 (1.46–2.10)
>65	4152	5462	5.19 (4.34–6.20)
Sex			
Male	15,881	20,775	Reference
Female	14,277	19,467	0.95 (0.84–1.07)
Race			
Non-Hispanic White	18,900	25,245	Reference
Non-Hispanic Black	5726	7722	0.97 (0.83–1.12)
Other	5532	7274	0.98 (0.84–1.14)
Insurance			
Uninsured	7759	10,459	Reference
Insured	22,399	29,782	1.03 (0.90–1.17)
Provider			
Attending	20,302	27,433	Reference
Resident/Intern	2619	2990	1.35 (1.08–1.70)
PA/NP	6479	8842	0.72 (0.62–0.85)
Region			
Northeast	6403	7402	Reference
Midwest	7365	9526	1.18 (0.95–1.46)
South	9986	14,244	1.31 (1.09–1.59)
West	6404	9069	1.053 (0.84–1.32)
Total	30,158	40,242	

*Adjusted for age, sex, race, insurance status, provider level, and region.

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