Efficacy of Computed Tomography Utilization in the Assessment of Acute Traumatic Brain Injury in Adult and Pediatric Emergency Department Patients

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ABSTRACT

BACKGROUND: Computed tomography (CT) is commonly used to assess traumatic brain injury (TBI) in the emergency department (ED). Radiologists at a Level 1 trauma center implemented a novel tool, the RADiology CATegorization (RADCAT) system, to communicate injuries to clinicians in real time. Using this categorization system, we aimed to determine the rates of positive head CTs among pediatric and adult ED patients evaluated for TBI.

METHODS: We performed a retrospective analysis of all patients who received a head CT to assess for TBI. We classified head CTs using the RADCAT tool. On a 5-point scale, scores of 3 or less are considered normal or routine. Scores of 4–5 are considered high priority, representing findings such as intracranial bleeding.

RESULTS: Of the 5,341 head CT's obtained during the study period, 992 (18.5%) had high priority results (scores 4–5). A large number of pediatric studies, 30.8%, were positive for high priority results. Among the adult population, 18.0 % contained high priority results.

CONCLUSION: The pediatric population had a higher rate of high priority reads among those undergoing non-contrast head CT for TBI compared to adult patients.

INTRODUCTION

Background

The appropriate use of imaging studies, especially those associated with radiation exposure, is an important consideration for both physicians and patients.[1] It is particularly salient in the pediatric and young adult populations (age < 26 years).[2,3] There is a reported increased cancer incidence, as high as 24%,[3] among those with early radiation exposure compared to those of the same age without radiation exposure from imaging.[1,3,4] When using imaging modalities associated with ionizing radiation, physicians must weigh the theoretical risk of oncogenesis, with the risk of missing a clinically significant injury.[1]

Importance

Radiologists mitigate the risk of radiation exposure by decreasing radiation doses based on age and weight, but the risk is still non-zero. Initiatives such as the Image Gently® campaign, and the American College of Emergency Physicians "Choosing Wisely" campaign[5,6] emphasize the use of judicious imaging. Emergency physicians often use clinical support aids to guide imaging use. These guidelines include validated support tools, such as the Canadian CT Head Rule,[6] NEXUS head CT[7,8], and PECARN[9] clinical decision support aids. However, evidence suggests that head CT use continues to increase without a change in the overall positive predictive value of the study.[10] In some physician groups, the use of head CT imaging may be unchanged or increased despite the use of validated clinical support aids,[11,12] while some groups report a decrease in imaging use with these tools.[13] Some of this increase in imaging use may be attributed to physicians who are unaware of recommended guidelines.[7,13,14] Approximately 70% of physicians overuse imaging studies even when institutional practices encourage the use of clinical decision support aids.[15]

In our study, a Level 1 trauma center implemented a new system of communication between radiologists and clinicians, the RADiology CATegorization (RADCAT) system.[16] In real time, high priority findings such as subdural hemorrhage or skull fractures are given scores of "four" or "five", while normal or incidental findings are scored as "one", "two", or "three". This novel reporting tool enables clinicians to rapidly identify priority radiological findings.

Goals of this Investigation

Assigning the RADCAT designation to studies helps to improve the quality of care provided, by flagging patient findings as urgent or non-urgent on ED head CT imaging. This finding can inform local applicability and efficacy of validated decision support tools. The first step in this process is to identify the prevalence of high priority findings in patients who receive ED head CT imaging. In this study, we assessed the number of high priority head CT findings after the implementation of the RADCAT system.

METHODS

Study Design and Setting

This study was a retrospective quality improvement analysis, where we sought to evaluate the number of positive CT studies in patients presenting to the Emergency Department

acutely for the assessment of TBI. We identified all adult and pediatric patients presenting to the adult and pediatric emergency departments affiliated with a Level 1 trauma center between November 1, 2017, and February 22, 2018, who received a non-contrast head CT to assess head injury. Adult ED visits, those >=18 years old, total approximately 110,000 visits per year while pediatric ED visits, those <18, total approximately 60,000 annual visits. All CT's were initial studies ordered by the emergency medicine provider. We excluded all head injury patients who did not receive a non-contrast CT of the head, as well as patients who received other imaging of the body including the chest, spine, abdomen, and extremities (i.e. "trauma pan-scan"). We collected data on patient age, gender, and RADCAT classification.

Data Analysis

We computed the ratios of the number of positive (RADCAT > 3) vs. negative (RADCAT <= 3) CTs for all patients presenting with head injury. Positive findings include findings such as hemorrhage (epidural, subdural, subarachnoid, intracerebral), diffuse axonal injury, or skull fracture. We stratified the prevalence of positive injury by age and report the counts and percentages.

RESULTS

We found that of the 5,341 head CTs obtained during this period, n=992 (18.5%) had high priority results. Two hundred and fifty (4.7%) of the head CTs were from the children's ED, n=77 (30.8%) of these studies were coded with high priority results. Therefore, for every 3.25 completed non-contrast head CTs in the pediatric population, 1 study yielded high priority findings. Among the 5,091 adult non-contrast head CTs, n=915 (18.0%) yielded high priority results. In this population, for every 5.56 head CTs performed, 1 study yielded a high priority result. **Figure 1** shows the age specific distribution of positive findings as clustered in 9-year intervals.

DISCUSSION

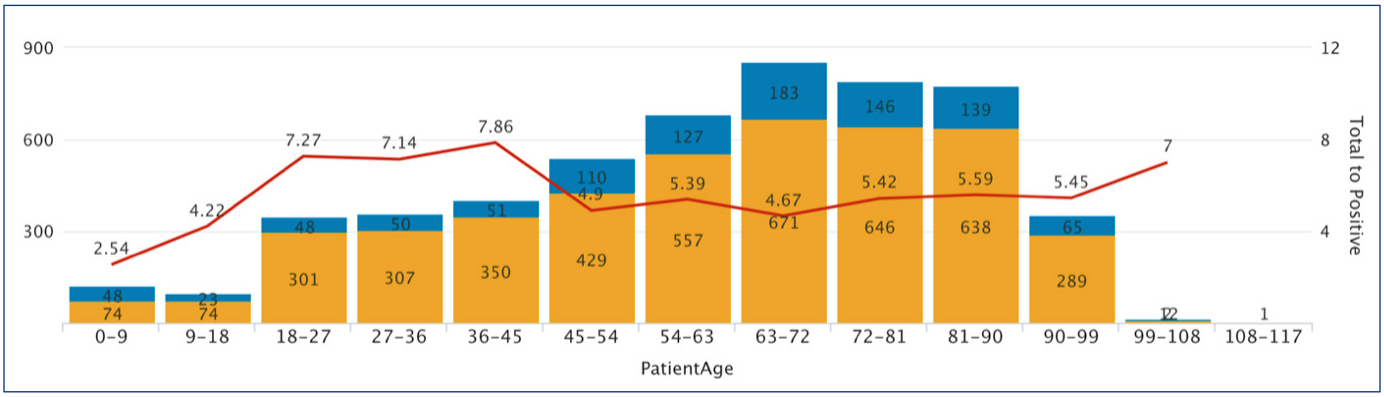
This analysis found a higher proportion of high priority results in the pediatric population than in the adult population. In children, approximately 1 in 3 head CT's were associated with a RADCAT 4/5 designation or *high priority* result compared to approximately 1 in 5 head CTs in the adult population. Patients aged 18–45 had the lowest rates of positive findings: less than 1 in 7. This finding suggests that clinicians may be more selective about ordering head CT's for pediatric patients than they are for adult patients at our institution. Notably, the percentage of positive findings in the pediatric cohort is higher, 30.8%, compared to prior studies reporting a positive CT rate of 1-9% in this age group.[17,18] This discrepancy may be attributed to recent efforts within our pediatric trauma center to reduce CT utilization and perform ancillary imaging studies, or observation in patients of young age.

Clinical decision aids can decrease CT imaging particularly in pediatric patients. Based on the findings presented in this study, support tools may be more frequently applied in pediatric patients with mild traumatic brain injury accounting for the high detection rates using. Previous studies have illustrated that implementing clinical support aids for patients with mild traumatic brain injury can decrease the use of CT imaging as much as 13.4%, when comparing pre-intervention and post-intervention populations.[19] Communication among emergency physicians and radiologists is essential if we are to mitigate the use of unnecessary CT scanning.[20] The novel reporting tool presented in this study will improve communication between radiologists and clinicians. Improved communication has implications for both clinical practice and research and may lead to improved ease of validation for radiology specific clinical support tools.

LIMITATIONS

Our study has several limitations restricting the generalizability of our findings. This report was a retrospective

Figure 1. Number of positive (RADCAT 4/5) CTs for head injury compared to negative



(RADCAT 1/2/3) as distributed across patient age. The red curve is the ratio of all studies to positive, or the "number needed to CT" for each positive study.
CT= computed tomography,
RADCAT = RADiation CATegorization

analysis and was not designed to assess patient outcomes associated with reported high priority results. For example, of the high priority results noted in this cohort, it is unknown which of those resulted in neurosurgical intervention or prolonged hospitalization. It is also unclear if clinical decision support tools were applied to the patients imaged in this study population. Additionally, though the radiologists defined high priority results a priori, there was no verification of the consistency or interrater reliability of the interpretation of these results among radiologists. The study duration was also only five months in the immediate period after the universal implementation of the RADCAT protocol.

CONCLUSIONS

CT scan utilization was more refined in our pediatric trauma population, when assessing for TBI. The pediatric population had a higher rate of positive findings per head CT completed, when compared to the adult patients which may be secondary to higher use of clinical decision tools. Future research should include a prospective analysis of CT imaging and clinical decisions support use among the adult and pediatric patient populations presenting traumatic brain injury at our institution and will include outcome assessment for these patients using the novel radiology tool.

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