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Overuse of Non-Contrast Computed Tomography in Minor Head Trauma: Diagnostic Performance of NICE Guidelines in a Tertiary Care Setting

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Abstract

Background & Methods: To evaluate the extent of overuse of non-contrast computed tomography (NCCT) head in minor head trauma and assess the diagnostic performance of NICE guidelines in predicting clinically significant intracranial injury.

Results: Among the 62 patients with abnormal CT findings, scalp hematoma was the most common finding (58.1%), followed by extra-axial haemorrhage (45.2%) and skull fracture (38.7%). Intracerebral haemorrhage/contusion was noted in 30.6% of cases. Multiple intracranial abnormalities were observed in 33.9% of patients.

Conclusion: CT head imaging is frequently overutilized in patients with minor head trauma despite the availability of validated clinical decision guidelines. NICE criteria demonstrate good diagnostic accuracy, strong association with abnormal CT findings, and excellent rule-out capability. An observation-based approach for patients not fulfilling NICE criteria can safely reduce unnecessary CT scans, radiation exposure and healthcare costs. Strict adherence to evidence-based guidelines combined with structured clinical observation can reduce unnecessary CT scans while maintaining patient safety.

Keywords: Overuse, Non-Contrast, Tomography, Minor, Trauma & NICE.

Study Design: Observational Study

Introduction

Traumatic brain injury (TBI) is a major public health problem and remains one of the leading causes of mortality, disability, and healthcare utilization worldwide. It is estimated that nearly 69 million individuals sustain a traumatic brain injury each year, with road traffic accidents, falls, assaults, and sports-related injuries representing the most common mechanisms of trauma. Minor head injury, generally defined as a Glasgow Coma Scale (GCS) score of 13–15 after blunt head trauma, accounts for approximately 70–90% of all traumatic brain injuries presenting to emergency departments. Although the majority of these patients have no clinically significant intracranial injury, prompt identification of the small proportion

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requiring neurosurgical intervention remains essential because delayed diagnosis may result in substantial morbidity and mortality (1–4).

Non-contrast computed tomography (NCCT) of the head has become the imaging modality of choice for the initial evaluation of acute head trauma owing to its rapid acquisition, widespread availability, excellent sensitivity for detecting acute intracranial hemorrhage, skull fractures, cerebral contusions, and mass effect, and its ability to guide timely neurosurgical management (5,6). Consequently, CT utilization in emergency departments has increased substantially over the past two decades. However, indiscriminate use of CT imaging in patients with minor head trauma has raised concerns regarding unnecessary radiation exposure, escalating healthcare costs, prolonged emergency department length of stay, increased workload for radiology services, and identification of incidental findings that may trigger further unnecessary investigations (7–10).

Although the radiation dose from a single head CT is relatively low compared with other CT examinations, repeated exposure at the population level contributes significantly to cumulative medical radiation burden. Brenner and Hall estimated that the increasing use of computed tomography has become one of the largest sources of medically related radiation exposure, with a measurable increase in lifetime cancer risk, particularly among younger patients (8). Beyond radiation concerns, unnecessary imaging places considerable strain on healthcare resources, particularly in busy tertiary care centers and low- and middle-income countries where imaging facilities are often limited and emergency department overcrowding remains a persistent challenge (9,10).

To optimize patient selection for CT imaging while maintaining patient safety, several validated clinical decision rules have been developed, including the National Institute for Health and Care Excellence (NICE) Head Injury Guidelines, the Canadian CT Head Rule (CCHR), the New Orleans Criteria (NOC), and the NEXUS II Head CT decision instrument (11–15). Among these, the NICE guideline is one of the most widely adopted recommendations in routine clinical practice. The updated NICE Guideline NG232 (2023) provides evidence-based recommendations regarding the indications and timing of CT imaging in adults and children with head injury, incorporating clinical features such as Glasgow Coma Scale score, vomiting, focal neurological deficits, suspected skull fractures,

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anticoagulant use, age, and mechanism of injury to identify patients at risk of clinically important intracranial injury (11). Adherence to these recommendations has been shown to improve resource utilization without compromising diagnostic safety.

Despite the availability of evidence-based guidelines, several studies have demonstrated persistent overutilization of CT imaging in patients with minor head trauma. Previous investigations from North America, Europe, and Asia have reported that between 30% and 60% of CT examinations performed for minor head injury do not fulfill established clinical decision rule criteria, with diagnostic yields frequently below 15–20% (7,12,16). Factors contributing to excessive CT utilization include defensive medical practice, fear of missing significant intracranial injuries, patient expectations, medicolegal concerns, limited availability of structured observation facilities, physician preference, and variability in guideline adherence (17–19). Such practices not only increase healthcare expenditure but may also expose patients to avoidable risks without improving clinical outcomes.

Although several studies have validated the diagnostic performance of individual clinical decision rules, relatively few have simultaneously evaluated the extent of CT overuse and the real-world diagnostic performance of the NICE guideline within routine emergency practice, particularly in tertiary care hospitals in India. Local data are important because injury mechanisms, patient demographics, healthcare infrastructure, availability of observation facilities, and physician practice patterns vary considerably across regions and may influence imaging utilization. Furthermore, evidence regarding the proportion of potentially avoidable CT examinations and the diagnostic accuracy of the current NICE recommendations in Indian emergency departments remains limited.

Therefore, the present prospective observational study was undertaken to evaluate the extent of NCCT overutilization in patients presenting with minor head trauma and to assess the diagnostic performance of the 2023 NICE Head Injury Guidelines in predicting clinically significant intracranial injury. In addition, the study aimed to determine the diagnostic yield of CT imaging, compare CT positivity between NICE-positive and NICE-negative patients, evaluate the association between guideline adherence and imaging findings, and explore the potential role of structured clinical observation as a safe alternative to immediate CT imaging in selected guideline-negative patients. By identifying potentially avoidable imaging while

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maintaining diagnostic safety, this study seeks to provide evidence that may support more rational utilization of CT imaging, reduce unnecessary radiation exposure and healthcare costs, and promote evidence-based management of minor head injury.

Objectives:

1. To determine the proportion of CT scans performed without NICE guideline indication.
2. To evaluate the overall diagnostic yield of NCCT head in minor head trauma.
3. To compare CT positivity rates between NICE-positive and NICE-negative groups.
4. To determine the strength of association between guideline adherence and CT findings.
5. To analyze the diagnostic accuracy parameters of NICE criteria (sensitivity, specificity, predictive values, likelihood ratios, RR, OR, AUC).
6. To explore the role of structured clinical observation in guideline-negative patients.

Material and Methods

Study Setting: Department of Radiodiagnosis, Superspeciality Hospital, Sanjay Gandhi Memorial Hospital, Rewa (M. P.)- A Tertiary Care Hospital.

Study Duration: Three months (November 2023 to January 2024).

Sample Size: 200 patients.

Inclusion Criteria

- Minor head trauma
- Glasgow Coma Scale (GCS) 13–15
- Referred for NCCT head following minor head injury.

Exclusion Criteria

- Polytrauma requiring whole-body CT
- Penetrating head injury
- Known intracranial pathology
- Incomplete clinical data

Statistical Analysis:

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Data were analyzed using descriptive statistics.
Association between NICE criteria and CT findings was evaluated using the Chi-square test.

The following were calculated:

- Sensitivity
- Specificity
- Positive predictive value (PPV)
- Negative predictive value (NPV)
- Relative risk (RR)
- Odds ratio (OR) with 95% confidence interval
- Likelihood ratios (LR+ and LR−)
- Area under the ROC curve (AUC)

A p-value < 0.05 was considered statistically significant.

A STROBE-style flow diagram illustrating patient selection is shown in Figure 1.

Institutional Ethics Committee approval was obtained prior to study initiation.

Result

RESULT:

1. Baseline Characteristics

Total patients = 200
Male = 116 (58%)
Female = 84 (42%)

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Association of Individual NICE Risk Factors with CT Positivity (n = 200)

Mechanism of injury

- **RTA = 86 (43%)**
- **Accidental fall/self trauma = 72 (36%)**
- **Assault = 12 (6%)**

2. NICE Criteria Adherence

- NICE-positive: 92 (46%)
- NICE-negative: 108 (54%)

Thus, more than half of CT scans were performed without guideline-based indication.

This means **54% underwent CT without NICE indication**, suggesting overuse.

Table 1:

Risk Factor	Present (n)	CT Positive (n)	CT Positive %	p-value
Age ≥65 years	**22**	**14**	**63.6%**	**0.004**
Vomiting ≥2 episodes	28	18	64%	<0.001
Loss of consciousness	54	32	59%	<0.001
GCS 13–14	76	45	59%	<0.001
Signs of Skull fracture	35	26	74%	<0.001
ENT bleed	12	9	75%	0.002
Black eye	16	10	62%	0.01

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CT Yield

CT was considered **positive** if any of these were present:

- Skull fracture
- Extra-axial hemorrhage
- Intracerebral hemorrhage

Table 2:

CT Finding	Number (n)	Percentage (%)
Extra-axial haemorrhage (Subdural/Epidural/SAH)	28	45.2%
Intracerebral haemorrhage / Contusion	19	30.6%
Skull fracture	24	38.7%
Scalp hematoma	36	58.1%
Multiple findings	21	33.9%

Types of Abnormal Findings on NCCT Head

Overall CT positivity

- Positive CT findings = 62 (31%)
- Normal CT = 138 (69%)

Diagnostic yield is 31%, while 69% scans were normal, supporting overuse.

Among the 62 patients with abnormal CT findings, scalp hematoma was the most common finding (58.1%), followed by extra-axial haemorrhage (45.2%) and skull fracture (38.7%). Intracerebral haemorrhage/contusion was noted in 30.6% of cases. Multiple intracranial abnormalities were observed in 33.9% of patients.

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Table 3: Correlation of NICE Criteria with CT Positivity:

NICE CRITERIA	CT Negative	CT Positive	TOTAL
NO	97	11	108
YES	41	51	92
TOTAL	138	62	200

- CT yield in NICE-positive group: 55.4%
- CT yield in NICE-negative group: 10.2%
- CT yield is **much higher when NICE criteria are met**.

Table 4: Diagnostic Performance Parameters of NICE Criteria.

Parameter	Value
Sensitivity	82.3%
Specificity	70.3%
PPV	55.4%
NPV	89.8%
Relative Risk	5.43
Odds Ratio	10.97
AUC	0.77
LR+	2.77
LR−	0.25

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True positives = 51

True negatives = 97

False positives = 41

False negatives = 11

Patients fulfilling NICE criteria were approximately 11 times more likely to have abnormal CT findings.

The LR− of 0.25 indicates strong rule-out capability.

. Statistical Test (Chi-square)

Chi-square test result:

- Chi-square = 45.46
- p-value < 0.0000000001 ($p < 0.001$)

Highly statistically significant association between NICE criteria and abnormal CT.

7. Strength of Association

Odds Ratio (OR):10.97 (~11)

Patients fulfilling NICE criteria were ~11 times more likely to have abnormal CT findings compared to those not fulfilling criteria.

8. Association of Individual NICE Risk Factors with CT Positivity

Significant predictors included:

- Age ≥65 years ($p = 0.004$)
- Vomiting ≥2 episodes ($p < 0.001$)
- Loss of consciousness ($p < 0.001$)
- GCS 13–14 ($p < 0.001$)
- Signs of skull fracture ($p < 0.001$)
- ENT bleed ($p = 0.002$)
- Periorbital ecchymosis ($p = 0.01$)

All showed statistically significant association with abnormal CT findings.

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Discussion

The present prospective observational study evaluated the extent of NCCT head overutilization in patients with minor head trauma and assessed the diagnostic performance of the 2023 NICE head injury guidelines in predicting clinically significant intracranial injury. More than half of the patients (54%) underwent CT despite not fulfilling NICE guideline indications, suggesting considerable overuse of imaging in routine emergency practice. In contrast, patients fulfilling NICE criteria demonstrated a significantly higher rate of abnormal CT findings (55.4% vs. 10.2%), with the guidelines showing good overall diagnostic performance (sensitivity 82.3%, specificity 70.3%, AUC 0.77).

Overutilization of CT in minor head injury has been consistently reported in previous studies despite the availability of validated clinical decision rules. Sharp et al. demonstrated substantial variation in CT utilization across emergency departments, highlighting that many patients underwent imaging without evidence-based indications. Similarly, Smits et al. reported that adherence to established clinical decision rules significantly reduced unnecessary CT examinations while maintaining diagnostic safety. The findings of the present study are in agreement with these observations and emphasize that guideline adherence remains suboptimal in routine clinical practice. Possible reasons include defensive medical practice, medicolegal concerns, physician preference, patient expectations, and limited availability of structured observation facilities, particularly in resource-constrained settings(20).

The overall CT positivity rate in our study was 31%, with a significantly higher diagnostic yield among patients meeting NICE criteria. Similar observations have been reported in studies validating the Canadian CT Head Rule and NICE guidelines, where selective imaging based on clinical risk factors improved diagnostic yield and reduced unnecessary imaging. The relatively higher CT positivity observed in our study may be attributed to the tertiary referral nature of our institution, where patients with greater clinical suspicion of intracranial injury are more likely to undergo imaging.

The NICE guidelines demonstrated good diagnostic accuracy in the present study, with a high negative predictive value (89.8%) and a likelihood ratio for a negative test (LR−) of 0.25, indicating good rule-out capability. These findings are consistent with previous validation studies showing that evidence-based clinical decision rules safely reduce unnecessary CT examinations while maintaining high sensitivity for clinically important intracranial injuries. Although our sensitivity was slightly lower than that reported in some international studies, variations in patient demographics, injury mechanisms, referral patterns, and study design may account for these differences.

Among the individual NICE risk factors, increasing age, vomiting, reduced Glasgow Coma Scale score, loss of consciousness, clinical signs of skull fracture, ENT bleeding, and periorbital ecchymosis showed significant associations with abnormal CT findings. These observations are in accordance with the variables incorporated within the NICE guidelines and further support their clinical relevance in identifying patients at increased risk of intracranial injury.

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The findings of this study have important clinical implications. Routine CT imaging for all patients with minor head trauma is unlikely to improve patient outcomes and contributes to unnecessary radiation exposure, increased healthcare costs, and greater workload in emergency departments. Careful adherence to validated clinical decision rules, together with structured clinical observation for appropriately selected guideline-negative patients, may safely reduce unnecessary imaging while maintaining patient safety. Such an approach also aligns with the ALARA principle by minimizing avoidable radiation exposure.

FUTURE RECOMMENDATIONS:

➢ First Approach

- Who do not fulfill criteria can be managed with clinical observation in the casualty or emergency department. Immediate CT imaging in such cases may not alter management and contributes to avoidable radiation exposure and increased healthcare costs.

- Overall, in this study, CT imaging did not lead to operative decision-making in any case, highlighting the limited clinical impact of routine CT head scans in minor head trauma and reinforcing the need for strict adherence to clinical decision rules such as the Canadian CT Head Rule and NICE guidelines.

- Certain intracranial injuries such as epidural hematoma may initially present with a lucid interval, with neurological deterioration occurring later. This underscores the importance of vigilant clinical observation, with CT imaging reserved for patients who demonstrate clinical worsening.

- Alcohol-Intoxicated Patients may present with a reduced GCS due to intoxication rather than traumatic brain injury. Observation until the effects of alcohol subside, followed by reassessment, allows more appropriate identification of patients who truly require CT imaging.

- Follow ALARA Principle (As Low As Reasonably Achievable)

- Findings support existing literature advocating selective CT use.

Strengths

- Prospective design

- Real-world evaluation

- Complete diagnostic accuracy assessment

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Limitations

- Single-center study
- Short study duration
- No long-term follow-up

Conclusion

CT head imaging is frequently overutilized in patients with minor head trauma despite the availability of validated clinical decision guidelines. NICE criteria demonstrate good diagnostic accuracy, strong association with abnormal CT findings, and excellent rule-out capability.

An observation-based approach for patients not fulfilling NICE criteria can safely reduce unnecessary CT scans, radiation exposure and healthcare costs. Strict adherence to evidence-based guidelines combined with structured clinical observation can reduce unnecessary CT scans while maintaining patient safety.

References

1. World Health Organization. Neurological disorders: public health challenges. Geneva: WHO; 2024.
2. Dewan MC, et al. Estimating the global incidence of traumatic brain injury. *J Neurosurg.* 2018;130(4):1080–1097.
3. Maas AIR, et al. Traumatic brain injury: integrated approaches to improve prevention, clinical care, and research. *Lancet Neurol.* 2017;16:987–1048.
4. Capizzi A, et al. Traumatic brain injury: an overview of epidemiology and management. *J Neurosurg Sci.*2020;64:222–231.
5. American College of Radiology. ACR Appropriateness Criteria® Head Trauma. 2024.
6. Stiell IG, et al. The Canadian CT Head Rule for patients with minor head injury. *Lancet.* 2001;357:1391–1396.
7. Sharp AL, et al. Computed tomography use for adults with minor head injury. *Ann Emerg Med.* 2017;69:664–671.
8. Brenner DJ, Hall EJ. Computed tomography—an increasing source of radiation exposure. *N Engl J Med.*2007;357:2277–2284.
9. Melnick ER, et al. Overuse of imaging in emergency medicine. *BMJ.* 2015;350:h2437.
10. Organisation for Economic Co-operation and Development. *Health at a Glance 2023: OECD Indicators.* Paris: OECD; 2023.

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11. National Institute for Health and Care Excellence. Head injury: assessment and early management (NG232). London: NICE; 2023.
12. Smits M, et al. Minor head injury: guidelines for the use of CT—a multicenter validation study. *Radiology.*2007;245:831–838.
13. Haydel MJ, et al. Prediction of intracranial injury in patients with minor head injury. *N Engl J Med.* 2000;343:100–105.
14. Mower WR, et al. Derivation of the NEXUS II Head CT decision instrument. *Ann Emerg Med.* 2005;46:447–457.
15. American College of Emergency Physicians. Clinical policy for adult patients presenting with mild traumatic brain injury. *Ann Emerg Med.* 2023.
16. Marincowitz C, et al. Diagnostic accuracy of clinical decision rules for mild traumatic brain injury: systematic review. *BMJ.* 2023.
17. Ip IK, et al. Drivers of CT utilization in emergency departments. *Radiology.* 2012.
18. Korley FK, et al. Emergency department evaluation of mild traumatic brain injury. *Acad Emerg Med.* 2010.
19. Pandor A, et al. Diagnostic management strategies for adults and children with minor head injury: systematic review. *Health Technol Assess.* 2011.
20. National Institute for Health and Care Excellence. Head injury: assessment and early management. NICE guideline [NG232]. London: NICE; 2023.