

# Audit of Computed Tomography (Brain) Referrals from the Accident and Emergency Department in a Tertiary Care Hospital

RAVINDER SAHDEV<sup>1</sup>, YASHASVI SHUKLA<sup>2</sup>, AKHILESH RAO<sup>3</sup>

## ABSTRACT

**Introduction:** Non-Contrast Computed Tomography (NCCT) brain is a common referral made from the Accident and Emergency (A&E) Department both for traumatic and non-traumatic causes.

**Aim:** To evaluate the veracity of the referrals made by the Accident and Emergency Department clinicians for NCCT Head.

**Materials and Methods:** This was the Retrospective evaluation of diagnostic yield of head Computed Tomography (CT) referrals made from A&E Department of a tertiary care hospital located in northern-central India over three year period between January 2015 to December 2017. CT reports were first grouped into two major group's trauma and non trauma referrals with further subdivision into positive and negative scan on the basis of presence of abnormality. Subsequently, the positive trauma reports were classified into major findings (three subgroups extra-axial haemorrhage, brain contusions and depressed skull fractures) and minor findings like undisplaced fractures of the skull or facial bones with or without subgaleal haematoma.

Distribution of trauma cases as per National Institute for Health and Care Excellence (NICE) guidelines was then tabulated. Non trauma reports were also further classified into the two major clinically important findings of haemorrhage and infarct as well as non-specific minor findings.

**Results:** Of the total data of 2185 head CT (980 trauma cases and 1205 in non trauma cases) referrals done by A&E Department during the study period. Out of total, 144 (58.5%) of trauma cases and 328 (27.2%) of non trauma cases were with major findings. Trauma 788 cases and non trauma 965 cases were referred by Medical Officer (MO)/ Resident as revealed from the audit. Positivity percentages for traumatic and non traumatic causes were 25.1% and 27.2%, respectively.

**Conclusion:** Due to non adherence to existing guidelines or due to poor clinical knowledge, there is poor diagnostic yield of CT referrals made from A&E Department. Thus clinical audit is essential at Department of Radiodiagnosis to streamline the referring protocols and improves the overall efficiency of the healthcare system.

**Keywords:** Clinical audit, Glasgow coma scale, Head Injury, Non-contrast computed tomography, National institute for health and care excellence guidelines

## INTRODUCTION

The Computed Tomography (CT) brain is one of the most common referral in any Radiology Department of a secondary or a tertiary care hospital. Reason for this is very high sensitivity and specificity of CT scan in diagnosing intracranial abnormalities as compared to skull x-ray which has poor sensitivity (about 38%) and relatively lower specificity (about 95%) even for diagnosing condition like skull fractures [1].

In our hospital, the number of referrals for CT Brain from A&E Department was found to be on the rise over past 3 years. Unfortunately, the numbers of positive cases were found to be very few resulting in a low diagnostic yield, increasing costs and an overall increase in exposure of patients and healthcare providers to avoidable radiation. Above observation warranted a clinical audit on CT Brain referrals from the A&E Department.

The aim of this audit is to retrospectively evaluate the diagnostic yield of urgent Non Contrast Computed Tomography (NCCT) brain scans done in previous 3 years in the hospital's Radiology Department including both traumatic and non traumatic head scans, most of which are referrals from the Accident and Emergency Department at a tertiary care hospital. The study also aimed to evaluate the referral patterns vis-a-vis the existing national/international guidelines based on the requisition or requirement for urgent imaging of head in both trauma and non trauma cases.

## MATERIALS AND METHODS

This study was a retrospective evaluation of diagnostic yield of head CT referrals made from A&E Department of a tertiary care hospital

located in northern-central India over three year period between January 2015 to December 2017 and was done by retrieving and systematically collating data from the CT report archives of the CT scan centre of the Radiology Department. Since, it was a retrospective study based purely on patient data hence ethical approval was not necessary.

**Inclusion criteria:** All the data of trauma and non trauma cases referred to the Radiology Department for Computed Tomography scan brain from Accident and Emergency Department between January 2015 to December 2017 was included in the study

**Exclusion criteria:** To avoid a false high positive result follow-up scans with significant positive findings at first scan were excluded from the study.

Based on the diagnosis, the reports were first grouped into two major group's trauma and non trauma referrals with further subdivision into positive and negative scan on the basis of presence of abnormality. Subsequently, the positive trauma reports were classified into major findings (three subgroups extra-axial haemorrhage, brain contusions and depressed skull fractures) and minor findings like undisplaced fractures of the skull or facial bones with or without subgaleal haematoma. The distinction was made only to separate out the more severe from the less severe findings; however no further classification was done on the basis of other parameters like presence or absence of cerebral oedema, midline shift or subfalcine or uncal herniation, as the results would have made the statistics complex and difficult to comment upon.

Further positivity and negativity rate of trauma referral cases was calculated depending upon their fulfilment of National Institute of Health and Care Excellence (NICE) guidelines for CT head in patients of head injury [2].

Non trauma reports were also further classified in the two major clinically important findings of haemorrhage and infarct. Minor findings like cerebral atrophy, non-specific white matter changes, sinusitis and mastoiditis were also recorded separately.

## STATISTICAL ANALYSIS

Results were expressed in terms of frequency and percentages and analysis was done in Microsoft Excel.

## RESULTS

The audit in total collected 2185 traumatic and non traumatic referrals for NCCT head. Out of 2185, a total of 980 referrals for trauma were separated out from the rest of, other non traumatic causes [Table/Fig-1].

Trauma referrals {980 (44.9%)}		Non trauma {1205 (55.1%)}	
Positive	Negative	Positive	Negative
246 (25.1%)	734 (74.9%)	328 (27.2%)	877 (72.8%)

[Table/Fig-1]: Distribution of total head CT cases.

The result of the audit revealed, the out of 980 trauma cases that were sent for an urgent NCCT head scan; only 246 were having major positive findings as per the major criteria for trauma cases. Broadly, these were further classified into 3 subgroups-extra-axial haemorrhage (106), brain contusions (35) and depressed fractures (3) [Table/Fig-2]. Another 102 cases had only minor positive findings for trauma.

Trauma cases	Major findings {144 (58.5%)}			Minor findings {102 (41.5%)}
	Extra-axial haemorrhage	Brain contusion	Depressed skull fracture	
Total number of positive trauma cases (246)	106 (73.6%)	35 (24.3%)	3 (2.1%)	

[Table/Fig-2]: Distribution of positive trauma cases.

Out of the total 980 cases, only about 378 cases met the NICE criteria [2] for CT referral in head injury either directly or indirectly, out of these 378 cases, positive scans were 241 [Table/Fig-3]. The Glasgow Coma Scale (GCS) which is used as a quick examination tool in case of head injury or in cases of altered mental status was mentioned in bare 267 referral forms. An account of referring physician/surgeon was also made which brought out that a majority of the traumatic referrals were made by medical officers or surgery residents on call posted in the A&E Department (788 out of 980 trauma cases) [Table/Fig-4].

Total number of trauma cases (980)			
NICE criteria met*		NICE criteria not met	
378 (38.6%)		602 (61.4)	
Positive*	Negative	Positive	Negative
241 (24.6%)	137 (14%)	5 (0.5%)	597 (60.9%)
Positivity rate when NICE criteria met 63.7%. (Percentage of positive cases meeting NICE criteria among total positive case 97.96%)		Positivity rate when NICE criteria not met 0.83%	

[Table/Fig-3]: Distribution of trauma cases as per NICE criteria.

\*Please refer [Table/Fig-1] for indications for a head CT in a case of head injury as per NICE criteria. Total number of trauma cases= 980; Total number of positive scans=246; \*Positive cases as per major and minor criteria in trauma cases described in materials and methods

A total of 1205 number of referrals were grouped in to the major category of non traumatic referrals and 328 were found to be positive suggesting non traumatic patients had a slightly higher positive yield. A total of 817 cases were of recently developed weakness, slurring of speech, altered mental status suggestive of suspected

Total number of trauma cases (980)			
Referral by MO/Resident		Referral by surgeons/ neurosurgeons	
788 (80.4%)		192 (19.6)	
Positive	Negative	Positive	Negative
137 (17.4%)	651 (82.6%)	109 (56.8%)	83 (43.2%)

[Table/Fig-4]: Distribution of trauma cases as per referring doctor.  
Total number of trauma cases=980; Total number of positive scans=246; MO: Medical Officers

stroke followed by headache which is another common presenting complaint in the Emergency Department. Yet again it was found that the number of referrals mentioning GCS in the referring note, were abysmally low, some of them with clinical notes of only the provisional diagnosis like altered mental status or moderate to severe headache. The incidental findings like non-specific demyelinating changes, sinusitis, and age related cerebral atrophy were also recorded which were presented in the vast majority of the patients (533 out of total 1205 non trauma cases) [Table/Fig-5].

Total number of non trauma cases (1205)		
Major findings	Minor findings	No findings (normal scan)
328 (27.2%)	533 (44.2%)	344 (28.5%)
Infarct	Haemorrhage	
241 (73.5%)	87 (26.5%)	

[Table/Fig-5]: Distribution of non trauma cases.  
Total number of non trauma cases=1205

As observed in trauma referrals, most of non trauma referrals were also by the A&E medical officers or medical residents (965 out of 1205). Referrals by physicians or neurosurgeons are relatively less (240 out of 1205). The cases referred for CT by medical officers or medical residents had poor yield as compare to specialist referrals [Table/Fig-6].

Total number of non trauma cases (1205)			
Referral by MO/Resident		Referral by surgeons/neurosurgeons	
965 (80.1%)		240 (19.9)	
Positive	Negative	Positive	Negative
187 (19.4%)	778 (80.6%)	141 (58.8%)	99 (41.2%)

[Table/Fig-6]: Distribution of non trauma cases as per referring doctor.  
Total number of non trauma cases=1205; Total number of positive scans= 328; MO: Medical Officer

Just to avoid a false high positive result, about 217 cases (in past 3 years) were not included in the study which were follow-up scans and were already with clinically significant findings. Annual workload data of CT scan head showed that there was a nearly 15% increase in referrals over the past 3 years. The increase was primarily because of over-suspicion of stroke where the initial clinical work-up was lacking the details of a neurological examination.

## DISCUSSION

The National Institute for Health and Care Excellence (NICE) has produced guidelines entitled 'Head Injury in Infants, Children and Adults: Triage, Assessment, Investigation and Early Management' [2] for early management of head injury. These guidelines include recommendation for initial assessment in A&E Department with indications for CT scan. As discussed by Hentel KD et al., due to various factors described, evidence-based guidelines and imaging criteria were not followed at A&E while referring patients for head CT leading to its inappropriate use and they have advocated greater scrutiny of imaging performed at A&E level [3]. A study done by Nawaz M et al., revealed that neuroimaging especially an urgent NCCT brain have a limited diagnostic role in conditions like headaches [4]. In present study, positive diagnostic yield for trauma and non trauma head scans were 25.1% and 27.2%, respectively, which were relatively lower as compared to similar earlier studies

where positive results were ranging from 29% to 65.8% in trauma and 10% to 70.3% in non trauma [5-9].

In the present study the most common major positive finding was extra-axial haemorrhage (73.6%) followed by brain contusion (24.3%). Study by Waganekar A et al., also showed similar results with extra-axial haemorrhage being most common (68%) followed by brain contusion (32.9%). Similar results were also seen in other studies [9,10].

The present study demonstrated that the cases where NICE guidelines was followed, it led to a high diagnostic yield of 63.7% with percentage of positive cases meeting NICE criteria among total positive case is 97.96%. Similar findings were observed in other studies [2,11].

In this study, most of the scans were ordered by residents or medical officer from Emergency Department with poor diagnostic yield with positivity rate in trauma cases 17.4% and non trauma cases 19.4% as compared to specialist referral where positivity rate of scan was 56.8% and 58.8%, respectively. There are no known studies where comparisons of diagnostic yield out of referrals between a specialist/consultant and resident were done. However, Prevedello LM et al., suggested that experience is not related to ordering of head CTs [13]. As per Puri S et al., providers with more clinical experience are likely to consider previous imaging and discuss risks and benefits of imaging [14]. The attendance of a senior physician decreases the tendency for referral for imaging [15].

The exercise carried out by the Radiology Department of our hospital brought out that diagnostic yield of emergency head CT scans referred from A&E Department of our hospital is relatively low. On close scrutiny, it was found that the medical officers or the residents on call were more or less having partial knowledge of the good practice guidelines as mentioned above. Most of the normal reports that were generated were part of the documentation that was required to discharge the patient from the Emergency Department rather than a tool to evaluate and correlate the clinical findings with imaging. After analysing the results, following points were drawn behind the reason for low positive results in the urgent referrals:

- The staff that handles the A&E has inadequate knowledge of any existing national and international guidelines or recommendations based on their requirement of imaging in both traumatic and non traumatic causes.
- Most of the referrals were either by the duty medical officers or by the medicine/surgery residents on call who at a time are responsible for both emergency as well as various wards allotted to them, hence due to shortage of time, imaging of head comes up as a better and apt alternative as compared to a thorough history or clinical examination.
- The common misconception that Radiodiagnosis being a non-clinical branch, the clinical notes endorsed in the referral form is of no use to the radiologist concerned.
- Lack of awareness regarding the importance of clinical examination or calculating GCS in a patient of head injury or stroke.
- Unawareness regarding the shortcomings of NCCT head as an investigative tool in cases of acute stroke which can be normal even in cases of hyperacute/acute on going insult to brain. The over-reliance on imaging has positively contributed to the trend of increasing number of requisitions.
- In the background of the increasing number of patients adopting legal re-course, imaging is more and more being used as documentary evidence where the normal report is used as a defence against any possible adverse outcome arising in the case.

Hence in view of the above observations, an audit Committee within the Department of Radiology is pivotal for a proper clinical audit and should be widely supplemented with participation of the departmental and managerial staff as well as referring physician's and patients. Overuse of CT scan is a growing concern because of the financial implications and avoidable risks (radiation exposure) to the patient. Increase in the number of scans had actually increased the number of unnecessary scans to 15-30% which indirectly translates to an increase in the number of avoidable referrals as per our audit. Two major reasons that can be pin pointed are lack of adherence to the guidelines by the clinicians or practice of "defensive medicine" which is increasingly being done due to large scale corporatisation and increasing number of litigations in healthcare system [2,4].

As indicated by Baloescu C that to resolve issue of over imaging, an integrated approach at the level of health policy, government mandate, hospital administration, physician associations, research, and education are needed [16].

Hence, in view of above authors have following recommendations:

- Referral for NCCT Head from the A&E Department should be targeted to reduce overutilisation, wastage of precious radiological resources and decrease costs. Guidelines could be formulated either as per the existing NICE guidelines or European Society of Radiology (ESR) [17].
- Educate residents and general practitioners regarding referrals, improve clinical knowledge, in particular neurology assessment.
- Improve supervision by senior specialists.
- Encourage discussion with the Radiologists.
- Re-audit in every 6 months.

### Limitation(s)

Small sample size and single centre study were the limitations. Another limitation was its retrospective nature as data was studied for limited time period.

### CONCLUSION(S)

Clinical audit is an essential process which any healthcare organisation can use to enhance and ensure the quality of the service it provides. The process in essence means sampling of performance and comparing the results with a pre-selected standard of good practice. If the standard is not upto the expected level, reasons for this are sought, changes implemented and a re-audit carried out to ensure improvement.

### REFERENCES

- [1] Hofman PA, Nelemans P, Kemerink GJ, Wilmink JT. Value of radiological diagnosis of skull fracture in the management of mild head injury: meta-analysis. *J Neurol Neurosurg Psychiatry*. 2000;68:416-22. doi: 10.1136/jnnp.68.4.416.
- [2] National Institute for Clinical Excellence Triage, assessment Investigation and early management of head injury in infants, children and adults Clinical Guidelines 4 NICE, 2003, CG 56 September 2007 and CG 176 (Partial update of NICE CG56) January 2014.
- [3] Hentel KD, Sharma R, Wladyka C, Min RJ. Appropriate use of CT in the emergency department. *Emergency Medicine*. 2011;43(7):06-13
- [4] Nawaz M, Amin A, Qureshi AN, Jehanzeb M. Audit of appropriateness and outcome of computed tomography brain scanning for headaches in pediatric age group. *J Ayub Med Coll Abbottabad*. 2009;21(1):91-93.
- [5] Swartzberg K, Goldstein LN. High positive computed tomography yields in the emergency department might not be a positive finding. *S Afr Med J*. 2018;108(3):230-34. doi: 0.7196/SAMJ.2018.v108i3.12635.
- [6] Sinclair DE, Kovacs G, Hillis M. Cranial CT scans-emergency department utilisation. *J Emerg Med*. 1993;11(5):643-46. [https://doi.org/10.1016/0736-4679\(93\)90325-2](https://doi.org/10.1016/0736-4679(93)90325-2).
- [7] Kelly AM, Kerr D. Are too many head CT scans ordered in emergency departments? *Emerg Med*. 2000;12(1):50-54. <https://doi.org/10.1046/j.1442-2026.2000.00083.x> 23.
- [8] Ismail MS, Fathil SM, Hong SB, Azhar AA, Bener A. Emergency head CT scan ordering and yield. *J Emerg Med Trauma Acute Care*. 2008;8(3):151-55.

- [9] Waganekar A, Sadasivan J, Prabhu AS, Harichandrakumar KT. Computed tomography profile and its utilisation in head injury patients in emergency department: A prospective observational study. *J Emerg Trauma Shock*. 2018;11(1):25-30. doi:10.4103/JETS.JETS\_112\_17
- [10] Maharjan S, Chhetry S, Ahmed N, Sherpa P. CT head findings in suspected cases of head injury. *Asian Journal of Medical Sciences*. 2017;8(2):76-81. <https://doi.org/10.3126/ajms.v8i2.16205>.
- [11] Lolli V, Pezzullo M, Delpierre I, Sadeghi N. MDCT imaging of traumatic brain injury. *Br J Radiol*. 2016;89(1061):20150849. doi:10.1259/bjr.20150849
- [12] Mohsin SN. By adhering to NICE guidelines, could it be possible to avoid CT scan brain in patients presenting with head injury safely? *J Trauma Crit Care*. 2018;2(2):03-06.
- [13] Prevedello LM, Raja AS, Zane RD. Variation in use of head computedtomography by emergency physicians. *Am J Med*. 2012;125(4):356-64.
- [14] Puri S, Hu R, Quazi RR, Darcy MD, Picus DD, Menias CO. Physicians' and midlevel providers' awareness of lifetime radiation-attributable cancer risk associated with commonly performed CT studies: Relationship to practice behavior. *AJR Am J Roentgenol*. 2012;199(6):1328-36.
- [15] Lee Cl, Ponce NA, Ettner SL, Kahn KL, Bassett LW, Forman HP. Ordering of CT by emergency department provider type: Analysis of a nationally representative sample. *AJR Am J Roentgenol*. 2012;199(5):1054-59.
- [16] Baloesco C. Diagnostic imaging in emergency medicine: How much is too much? *Annals of Emergency Medicine*. 2018;72(6):637-43.
- [17] Remedios D, Hierath M, Ashford N, Bezzi M, Cavanagh P, Chateil JF, et al. Imaging referral guidelines in Europe: Eow and in the future-EC Referral Guidelines Workshop Proceedings. *Insights Imaging*. 2014;5(1):09-13. doi:10.1007/s13244-013-0299-8

**PARTICULARS OF CONTRIBUTORS:**

1. Associate Professor, Department of Radiodiagnosis, MH Secund Erabad, Hyderabad, Telangana, India.
2. Senior Resident, Department of Radiodiagnosis, TSM Medical College, Lucknow, Uttar Pradesh, India.
3. Professor, Department of Radiodiagnosis, CHAF, Bangalore, Karnataka, India.

**NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:**

Yashasvi Shukla,  
901, D1, Akash Enclave, Vrindavan Yojna, Lucknow, Uttar Pradesh, India.  
E-mail: shukla\_yashasvi@yahoo.in

**AUTHOR DECLARATION:**

- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? NA
- Was informed consent obtained from the subjects involved in the study? NA
- For any images presented appropriate consent has been obtained from the subjects. NA

**PLAGIARISM CHECKING METHODS:** [Jain H et al.]

- Plagiarism X-checker: Aug 08, 2020
- Manual Googling: Mar 25, 2021
- iThenticate Software: Apr 19, 2021 (3%)

**ETYMOLOGY:** Author OriginDate of Submission: **Aug 01, 2020**Date of Peer Review: **Oct 29, 2020**Date of Acceptance: **Mar 30, 2021**Date of Publishing: **Jun 01, 2021**