ORIGINAL ARTICLE

ANNALS OF PUNJAB MEDICAL COLLEGE

CT Brain Profile and its Utilization in Patients presenting in Emergency and its Impact on Health and Economy: A Descriptive Cross-Sectional Study

Zafar Ali Choudry[1], Mohammad Adil[2], Hira Bukhari[3], Sara Gill[4], Anjum Mehdi[5]

1 ***Vice Chancellor, Professor of Surgery, Faisalabad Medical University, Faisalabad Pakistan***
Manuscript writing, Supervision, Proof reading

2 ***House Officer, DHQ Hospital, Sargodha Pakistan***
Data collection, Manuscript writing

3 ***House Officer, Allied Hospital, Faisalabad Pakistan***
Data collection, Manuscript writing

4 ***Women Medical Officer, Department of Radiology, DHQ Hospital, Chiniot Pakistan***
Data collection, Results preparation, Manuscript writing

5 ***Associate Professor, Department of Radiology, Wapda Hospital, Faisalabad Pakistan***
Manuscript writing, Data analysis

CORRESPONDING AUTHOR
Dr. Anjum Mehdi
Associate Professor, Department of Radiology, Wapda Hospital, Faisalabad Pakistan
Email: dranjumehdi@gmail.com

Submitted for Publication: 02-07-2020
Accepted for Publication 27-03-2021

How to Cite: Choudry ZA, Adil M, Bukhari H, Gill S, Mehdi A. CT Brain Profile and Its Utilization in Patients Presenting in Emergency and Its Impact on Health and Economy: A Descriptive Cross-Sectional Study. APMC 2021;15(4):216-220. **DOI: 10.29054/APMC/2021.958**

ABSTRACT

Background: Struggling healthcare systems of developing countries like Pakistan have to balance the patient load with financial burden in maximum benefit of patient. Unnecessary CT brain although relatively economical and less time taking should be avoided owing to its negative impact on health and economy. This study is based on data obtained from CT request form of Allied Hospital Faisalabad, Pakistan and analyzed in terms of proportionate wastage of financial resources of unnecessary scans. **Objective:** To study proportionate morbidity on CT findings and Comparison of CT scan request with clear indication and without clear indication and to calculate proportional wastage of resources. **Study Design:** Descriptive cross sectional. **Settings:** Emergency CT section, Allied Hospital, Faisalabad Pakistan. **Duration:** 2 Months i.e., 1st July to 31st Aug 2019. **Methods:** In this study, CT brain referral forms of all the patients that were referred for CT brain during 2 months period were reviewed via non probability consecutive sampling in Allied hospital Faisalabad then their CT brain findings were reviewed. Referral forms were reviewed for pattern of request they made or any CT brain indication they followed. All the patients referred were included in the study except those whose CT brain showed too many motion artifacts. **Results:** There were total 500 patients in this study, out of which 463 (92.6%) were having CT request slips without clinical history and 37(7.4%) were having request slip with clinical history. 164 patients had positive CT findings, whereas 336 patients had negative CT findings. Proportionate wastage of financial resources was 52% i.e., 4,70,400/rupees which is our margin of saving revenue. **Conclusion:** Most of the request forms are without proper clinical history and findings with many having normal CT brain, some of these scans could have been avoided, provided proper history, examination, GCS, time lapse mentioned and patient triaged accordingly, will avoid radiation and financial burden it had put on patient, hospital and state.

Keywords: *CT Brain, CT health hazards, CT financial burden, Glasgow coma scale.*

INTRODUCTION

Our emergencies are crowded with patients[1] having a number of problems, a major cause being altered sensorium resulting from head injuries, neurological deficits, requiring early decision making for diagnosis and appropriate management. With significantly reduced doctor to patient ratio[2] and less resources as we are a developing country, we can't afford to have delayed patient stay and unnecessary tests.[3]

CT (computerized tomography) brain is a very economical, less time taking, easily available radiological modality that can rule out a number of emergency and non-emergency pathologies,[4] correlating it with history of the patient and clinical examination aids treating clinician to reach a decision regarding patient management. Emergency CT brain is advised in most hospital settings for patients presenting in emergency for conditions like road traffic accidents, sudden unconsciousness, ruling out stroke either infective or hemorrhagic, to rule out

other causes of altered sensorium, seizures and severe headache and in making surgical decisions in sudden raised intracranial pressure[5] Although modern CT scanners are delivering relatively less radiation still radiation induced hazards are something clinician must take into account. Unnecessary CT where possible should be avoided in favor of reducing radiation and cost.[6]

This study is intended to give an overview of how emergency CT scan brain are done with the protocol being followed for scans in Allied hospital Faisalabad. As in our opinion no standard protocol is being followed in our system and no such study has been conducted in our setup regarding this so this study is intended to give awareness to our clinicians, the need for importance of following a standard protocol.

OBJECTIVES

1. Study of proportionate morbidity on CT findings.

2. Comparison of CT scan request with clear indication and without clear indication.

3. To calculate proportional wastage of resources.

METHODS

This was descriptive cross-sectional study conducted in Emergency CT scan section, Allied hospital Faisalabad Pakistan. The duration of the study was two months from July 01, 2019 to August 31, 2019.

The sample size was 500 patients by using non-probability consecutive sampling in this study.

Patients of all ages and both sex who were referred from emergency departments both medical and surgical during this period for need of emergency CT brain were included for the study.

We had to exclude around 15 patients whose CT brain showed too many motion artifacts making them difficult to read so we were left with a sample size of 500 patients.

CT request forms of all these patients were reviewed for the request made by emergency clinicians, i.e., if they mentioned indication for scan, if they mentioned patient's history and examination, salient features that could give an idea about emergency CT brain indication in each case. Referral ward and patient's payment status were also noted. Then we reviewed their CT finding. We also estimated cost of each scan and inferred total radiation dose given to patients.

RESULTS

Table 1 shows that 7.4% of all referral forms had clinical history mentioned on them and 92.6% have no clinical history mentioned.

Table 1: Clinical screening and requisition with clinical diagnosis

	Number	Percentage
CT advised with clinical history mentioned	37	7.4%
CT advised without clinical history mentioned	463	92.6%
Total	500	100.0%

Table 2 shows relationship of CT positive patients and CT negative patients. 67.2% (336 out of 500) of the patients had normal CT scan (CT negative patients) while 32.8% were CT positive.

Table 2: Proportionate CT scan morbidity

Morbidity Status	Number	Percentage
Morbidity Detected on CT scan	164	32.8%
Normal Scan	336	67.2%
Total	500	100.0%

Table 3 shows clinical suspicion profile showing 83.7 % of suspicion mentioned slips had CVA mentioned, 8.1% had RTA and SAH mentioned each.

Table 3: Clinical suspicion profile

Finding	Number	Percentage
CVA	31	83.78%
RTA	3	8.11%
SAH	3	8.11%
Total	37	100.0%

Table 4 shows 31.7% (52/164) had infarct. The descriptive of the data further showed that 22.5% (37/164) and 5.48% (9/164) had intracranial bleed (ICB) and subarachnoid bleed respectively.

Subdural hemorrhage (SDH) having 12% (12/164), extradural hemorrhage (EDH) having 3.04% (5/164), gliosis had 5% (5/164) on the CT scan findings. 13.41% (22/164) showed atrophic changes. Intracranial masses had 3% (5/164) representation. Others include soft tissue swelling, pneumocephalus, edema and fractures having 11.5% (19/164) representation.

Table 4: Radiological findings by CT scan

Radiological findings		Frequency	Percentage
Bleed	ICB	37	22.5%
	SAB	9	5.48%
	SDH	12	7.31%
	EDH	5	3.04%
Infarct		52	31.70%
Mass/Tumor		3	1.82%
Atrophy		22	13.41%
Gliosis		5	3.04%
Others		19	11.5%
Total		164	100%

*Proportionate scan positivity rate: 164/500*100 = 32 %*
Cost on positive scan = 164 x 1400 = 2,29,600
Cost on negative scan = 336 x 1400 = 4,70,400
Total CT cost = 500 x 1400 = 7,00,000

DISCUSSION

Irrational use of healthcare services resulted in wastage of approximately 750 billion dollars on non-beneficial treatments in US.[7] Approximately 26 million CT scans are being done annually in US only in emergency.[7] This injudicious use of CT is reasoned via its easy availability in most setups, less time taking, no interference with metal objects placed within the body, suitability for unwell patient, in diagnosing early signs of progressive hemorrhagic injury[8] and its ability to decide when not to use thombolytics.[9] Decision is also influenced by many other factors such as fear to miss some special diagnosis on clinical examination only, unable to reassure patient of symptoms not needing radiological interference, on the other hand factors like fear of increasing inpatient hospital stay, keeping overly safe approach for radiation induced side effects may miss a justified CT. So, a balanced approach is required following international and local guidelines in order to limit excess CT exposure reducing radiation hazards and on the other hand not wasting hospital resources on unnecessary scans and utilizing them where they are actually necessary.

As we know a single CT scan brain gives 2mSv of radiation dose to patient so it should be justified. In our study 67% (336/500) patients had normal CT brain, giving approx. 672mSv of radiation in normal scans, some of which could have been avoided if we had properly triaged patient with proper request.

A plain CT brain costs 1400 rupees so approximately 4,70,400 rupees were spent on these normal scans. This is consistent with the US study[7] mentioned above in sense of financial burden; however, they are strictly following standardized international protocols for emergency CT brain., however if we use the standardized protocols this state burden would have definitely reduced. According to a study most of the negative results were owing to not following proper clinical indication for imaging due to lack of adequate clinical information probably due to overcrowded emergencies. It is mandatory to know indications for emergency CT brain in each clinical situation to avoid overuse of imaging techniques, minimize radiation risk and economic cost.[10]

A proper request should be in accordance to international CT protocol guidelines, such as for trauma patient one of the internationally used criteria is NEXUS II criteria; National Emergency X-Ray Utilization Study (NEXUS II) is one of the validated criteria for emergency computed tomography in head trauma patients.[11]

Nexus II criteria[12] is as follows:
CT head not indicated if all of the following are absent
1. Evidence of significant skull fracture
2. Scalp hematoma
3. Neurologic deficit
4. Altered level of consciousness
5. Abnormal behavior
6. Coagulopathy
7. Recurrent or forceful vomiting

In the same way for stroke and altered sensorium patients at least GCS score, side of weakness should be mandatory to be assessed and written on imaging request forms. For developed countries, stroke incidence in childhood was estimated to be varying from approximately 2.3 to 13 per 100,000 children annually.[13] Mutch CA *et al*[14] also stated in his study that in order to assess a patient's conscious level GCS has been used and accepted worldwide for its easy, rapid and accurate stratification[5], he also added that it should be written in sub scores. In our study no request form mentioned GCS and only 5 request slip mentioned side of weakness.

Mair G *et al* stated in his study that in an emergency situation radiation hazard is not our primary concern but all stroke patients don't fall in this category.[9] Radiation dose delivered to a patient during a plain CT scan brain is estimated to be 2 mSv, which is very less when compared to CT brain done with full stroke protocol which is approximately 14 mSv, that is, equivalent to an additional 5 years of normal background radiation over non-contrast CT alone. 0.05% patients over the age of 60 years can develop cancer due to radiation who undergo CT head with full stroke protocol, the frequency of inducing cancer at this dose is two to three times higher in young patients.[9] In our emergency setup we are using protocol of CT brain with radiation of 2mSv.

Ikpeme AA *et al*[15] in his study stated that for stroke patient CT should be advised first in order to rule out cause of stroke however early CT may miss findings in ischemic strokes needing help of MRI or late CT. This could justify a small proportion of normal CTs in suspected stroke patients.

A meta-analysis was done by Dubosh NM *et al*[16] and his colleagues stating that if subarachnoid hemorrhage is not seen in CT brain in first 6 hours of symptoms, then it can be easily excluded from differentials in following conditions:

1. Thunderclap headache
2. Neurologically symptomless patient
3. Clear time of onset.[16]

Overall sensitivity of CT for ruling out subarachnoid hemorrhage after meta-analysis was estimated to be 95% with only 0.14% being false positive.[16]

In 2012, an initiative was introduced by The American Board of Internal Medicine Foundation, called "Choosing Wisely" whose principal aim was to set better medical practice and decisions in order to avoid unnecessary procedures and medical test which result in waste of money. One of the proposals was; in cases of minor head injuries CT head should be avoided to maximum extent, which according to established criterias are not at high risk. Due to lack of data. it couldn't be assessed that to what degree these guidelines were being followed[7]. Our aim behind study is to cause awareness to have such criteria applied in our setup.

In US, hospitalization expenses of traumatic brain injury are approximately estimated to be 52 billion dollars.[17] John DeAngelis, in his study said that streamlined assessment of patients presenting with minor head injury to identify those who require imaging, in order to further risk stratify the need for neurosurgical management could result in a significant reduction in healthcare expenditure and he concluded that emergency department(ED) providers appropriately applied the Choosing Wisely criteria for 75.5% of patients, obtaining head CTs when indicated by the NEXUS II rule (41.5%), and not obtaining head CTs when the NEXUS II criteria were not met (34.0%). However, ED providers obtained non-indicated CTs in 23.1% of patients. Less than 2% of the sample did not receive a head CT when imaging was indicated by NEXUS II.[7] Our results are probably a lot worse than this as out of our 336 requests that were without any clinical history/ clinical finding, 322 patients were normal so percentage of non-indicated scans seem higher. Another similar study done in Ghana South Africa that showed that 60% patients with head injury had normal CT finding necessitating need for proper guidelines to be implemented at their setup.[18]

Waganekar A. and colleagues in their study concluded that CT positivity is strongly related to these five factors: Loss of consciousness more than 5min, vomiting, fits, ear and nose bleed in head injury patients. In his study positive CTs were approximately 50.9% overall with 38% being positive CTs in minor head injury category.[19] Most of such patients can be discharged without need of hospital stay approximately (78%) according to a study.[20] As our study includes emergency patients having medical and surgical/trauma patients so in this case we can't compare our data with this as they are only considering head injury.

In our study 473 out of 500 patients underwent CT free of cost and only 27 patients paid for the scan but hospital has to bear the cost of free CT and also wear and tear of machine is also paid by hospital. Allied hospital Faisalabad is paying approximately 1 crore rupees for CT maintenance annually. So, concluding point is that if emergency department and radiology department collaborate and follow a pre-set protocol for emergency CT as discussed above, a lot of unjustified scans can be omitted in favor of both patient and hospital staff and reduce unnecessary expenditure.

CONCLUSION

As CT has its radiation hazards and again has a financial burden so we can avoid unnecessary scans saving hospital and state resources, patient health and his financial burden.

LIMITATIONS

As in our study most of the requests were blind i.e., without history and clinical examination, so we couldn't assess adherence to international protocols of emergency CT in different conditions.

SUGGESTIONS / RECOMMENDATIONS

All patients presenting in emergency should be thoroughly evaluated with proper history clinical examination, GCS which should be mentioned properly and then the patient should be triaged carefully for radiological imaging or referral or discharge. These things should also be properly documented on request forms to radiology department so they can have an idea what to expect and for clinical correlation.

CONFLICT OF INTEREST / DISCLOSURE

None.

ACKNOWLEDGEMENTS

The authors are very grateful to the Prof. Dr. Muhammad Ashraf Majrooh for his helpful and constructive comments and suggestions.

REFERENCES

1. Khan AS, Sattar A, Ghauri SK, Hasnain H, Khan HM. Validating the National Early Warning Score (NEWS) in Emergency Department of a tertiary care hospital in Pakistan. South Asian J Emerg Medi. 2019;2(2):8-13.
2. Junaid A, Rafi MS. Communication Barriers between Doctors, Nurses and Patients in Medical Consultations at Hospitals of Lahore Pakistan. Pak Armed Forces Med J. 2019;69(3):560-65.
3. Razzak JA, Kellermann AL. Emergency medical care in developing countries: is it worthwhile? Bull World Health Organ. 2002;80(11):900-5.
4. Talebian MT, Kavandi E, Farahmand S, Shahlafar N, Arbab M, Seyedhosseini-Davarani S, et al. Comparing the brain CT scan interpretation of emergency medicine team with radiologists' report and its impact on patients' outcome. Emerg Radiol. 2015;22(3):261-8.
5. Singhal V. Clinical Approach to Acute Decline in Sensorium. Indian J Crit Care Med. 2019;23(2):120–3.
6. Vedin T, Svensson S, Edelhamre M, Karlsson M, Bergenheim M, Larsson PA. Management of mild traumatic brain injury-trauma energy level and medical history as possible predictors for intracranial hemorrhage. Eur J Trauma Emerg Surg. 2019;45(5):901-7.
7. DeAngelis J, Lou V, Li T, Tran H, Bremjit P, McCann M, et al. Head CT for minor head injury presenting to the emergency department in the era of choosing wisely. West J Emerg Med. 2017;18(5):821–9.
8. Tong WS, Zheng P, Xu JF, Guo YJ, Zeng JS, Yang WJ, Li GY, He B, Yu H. Early CT signs of progressive hemorrhagic injury following acute traumatic brain injury. Neuroradiology. 2011;53(5):305-9.
9. Mair G, Wardlaw JM. Imaging of acute stroke prior to treatment: current practice and evolving techniques. Br J Radiol. 2014;87(1040):20140216.
10. Aguilar LZ, Gómez MF, Pineda FG, & Maldonado JFM. Emergency head CT scan. Is it indicated? European Congress of Radiology 2017:1-17. https://epos.myesr.org/poster/esr/ecr2017/C-1887
11. Babl FE, Oakley E, Dalziel SR, et al. Accuracy of NEXUS II head injury decision rule in children: a prospective PREDICT cohort study. Emerg Med J. 2019;36(1):4-11.
12. Mower WR, Hoffman JR, Herbert M, Wolfson AB, Pollack CV Jr, Zucker MI; NEXUS II Investigators. Developing a decision instrument to guide computed tomographic imaging of blunt head injury patients. J Trauma. 2005;59(4):954-9.
13. Mirsky DM, Beslow LA, Amlie-Lefond C, Krishnan P, Laughlin S, Lee S, et al. International Paediatric Stroke Study Neuroimaging Consortium and the Paediatric Stroke Neuroimaging Consortium. Pathways for Neuroimaging of Childhood Stroke. Pediatr Neurol. 2017;69:11-23.
14. Mutch CA, Talbott JF, Gean A. Imaging Evaluation of Acute Traumatic Brain Injury. Neurosurg Clin N Am. 2016;27(4):409-39.
15. Ikpeme AA, Bassey DE, Oku A O & Ephraim PE. Computerized tomography findings of cerebrovascular disease in adults in Calabar, Nigeria. West African J Radiology. 2014;21(1):12-6
16. Dubosh NM, Bellolio MF, Rabinstein AA, Edlow JA. Sensitivity of Early Brain Computed Tomography to Exclude Aneurysmal Subarachnoid Hemorrhage: A Systematic Review and Meta-Analysis. Stroke. 2016;47(3):750-5.
17. Andrew N. Wilner, MDTraumatic Brain Injury with a Normal CT ScanApril 4, 2019. Available at https://www.neurologytimes.com/tbi/traumatic-brain-injury-normal-ct-scan
18. Asare HK, Abdulai AB, Akorli E, Aweligiba S, Akorli P. Computed Tomography Findings of Traumatic Brain Injury in Patients with Head Trauma Presenting at the Tamale Teaching Hospital. J Radio & Clin Imaging. 2019;2(1):24-32.
19. Waganekar A, Sadasivan J, Prabhu AS, Harichandrakumar KT. Computed Tomography Profile and its Utilization in Head Injury Patients in Emergency Department: A Prospective Observational Study. J Emerg Trauma Shock. 2018;11(1):25-30.
20. Alfageeh M, Bahran M, Albargi S, Althomali I, Alzahrani A, Al-Buqaisi, A et al. CT Scan importance in the first eight hours of head injury. Int J Advances in Med. 2018;5(4):766.