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Clinical Predictors of Abnormal Findings in Head CT among Non-Trauma Patients who were Visiting Emergency Department of King Fahd Armed Forces Hospital in Jeddah City, Saudi Arabia, 2019

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Abstract

Objective: Although there has been huge development in utilizing the computed tomography as a diagnostic tool, yet there are dose-related risks of developing cancer and mutation. The high cost of CT scan and its heath impact lead us to raise the possibility of creation an evidence based clinical guideline that might guide the ER physicians for ordering head CT scan especially for non-trauma patients. Study aimed to identify predictor factors of abnormal head CT findings among non-trauma patients.

Methods: Through a retrospective cross-sectional study design, patients who visited Emergency Department during the months of October, November and December of 2018 and underwent head CT (n = 724) were enrolled in the study.

Results: 724 patients were included in the study; majority of the patients 68% on age group of (18 to 70 years) with 1:1 male to female ratio. Greater number of patients who were visiting ED had focal neurological deficit symptoms and signs and Majorities of patients with symptoms and signs of focal neurological deficient had infarction features on CT. In multivariate analysis, neurological symptoms of Non-trauma patients were statistically significance and independent predictors for CT findings on CT image.

Conclusion: Abnormal radiological findings on head CT image is significantly associated with neurological symptoms of Non-trauma patients. Those with the focal neurological deficient symptoms and signs with known case of hypertension will have about three-fold risk of getting abnormal finding on CT image.

Keywords: *Head Ct; Non-Trauma Patients; Clinical Predictors; Abnormal Findings; Neurological Symptoms*

Introduction

CT scans stand to computed/computerized tomography (tomos-meaning section, graphy-picture in Greek) and consist of special X-ray tests that produce cross-sectional images of the body using X-rays and a computer [1]. First clinical brain scanner was in Mayo Clinic at 1973 [2]. A British engineer named Sir Godfrey Hounsfield and Dr. Alan Cormack developed CT independently and they were shared the 1979 Nobel Prize for their development of CT [3].

Regarding the medical practice, utilizing the computed tomography (CT) scanning is increasing annually and reached up to 70 million CT examinations per year in United States [4,5]. CT scan has become a central component for diagnosing medical diseases and provides a highly detailed look at many different parts of the body. CT is noninvasive, quick and well tolerated, thus make it preferred for physicians and patients [1].

In general, imaging modality is associated with exposure to radiation doses. Although, the large benefits of these radiological investigations, there are dose-related risks of developing cancer and mutation. Radiation dose from CT procedures varies and depends on the size of the body part examined, the type of procedure, and the type of CT equipment and its operation [6]. However, for protection purposes and for assessing the risk of cancer detriment from a CT procedure; scientists used the effective dose [7]. Effective dose used to assess the potential for long-term effects that might occur in the future in units of millisieverts (mSv). The effective doses from diagnostic CT procedures are typically estimated to be in the range of 1 to 10 mSv [6]. This range is not less than the lowest doses of 5 to 20 mSv that was expected to receive by some of the Japanese survivors of the atomic bombs [6]. Saudi National program of radiation protection follows the international basic safety standards that stated the annual effective dose of radiation must be on limit of 50 mSv (5 rem) [8].

Furthermore, from economic perspective, CT scan costs range from $270 on the very low end to nearly $5,000 on the high end [9]. The cost varies depends on anatomical location, hospital and other factors such as whether you pay in cash or by insurance provider. Decision makers has concerned about the increase in both costs and health risk of exposure that occurs during CT procedure.

In Saudi Arabia, several regional and referral hospitals have CT scans. However, the cost of each unit is around 5,000,000 Saudi Riyals (US $1,300,000) in addition to the maintenance costs of about 500,000 Saudi Riyals (US $133,298) annually [10]. Furthermore, the number of Saudi health institutions that have CT expected to be more than 20 which considered costly and this added to the harm effects that come from both carcinogenesis and genetic injury [10].

Health Report from United States showed that one of every seven patients undergoes CT scanning in emergency department (ED), which accounts for 25% of all CT scans that usually performed in different medical departments other than ED [11]. In Saudi Arabia, one research study address that doctors serving in an emergency department had low level of knowledge about the radiation doses that might be received by their patients, and had poor knowledge about the risks of radiation exposure [12].

National Hospital Ambulatory Medical Care Survey for 2016 found that headache was 2.2% of all ED visits and the percentage of the patients who had imaging was 12%, 5.5% of them only had a pathologic diagnosis [13]. Emergency physicians should decide who needs CT neuroimaging in the ED and who can be evaluated in the outpatient setting.

The high cost of this equipment and its heath impact on other conventional investigative radiology leads us to the question of proper utilization and possibility to build up a well-organized clinical guideline with specific indications and eligible criteria that might guide the ER physicians for ordering the CT scan especially for non-trauma patients.

From above disclosure and attributable to gap of knowledge that may identify predictor factors of abnormal head CT findings among non-trauma patients who were visiting ER. The objective of this study was to identify clinical predictors of abnormal imaging findings among patients in the ED with no history of trauma who underwent head CT.

Methodology

Rationale

Performing head CT scan for many patients in emergency department with no historyof head injury would be time consuming and costly in addition to the radiation hazards. Based on literature review, previous studies suggested that almost all non-trauma patients with abnormal head CT findings, they may had previously specific characteristics like age for example and justified neurological symptoms that can be utilized as predictor indicators and aid in forming clinical decision guidelines to support physicians' decisions to order head CT for these patients.

Objective

To measure the association between patients' characteristics (age, gender and neurological symptoms) and presence of abnormal findings on non-enhanced CT scanamong Non-trauma Patients who were visiting Emergency Department of King Fahd Armed Forces Hospital in Jeddah city, Saudi Arabia.

Study design

The research design was cross sectional retrospective study.

Study setting

King Fahd Armed Forces Hospital in Jeddah city, Saudi Arabia.

Population

The study had recruited patients with no history of trauma patients who were visitingEmergency Department during the months of October, November and December of 2018 and underwent head CT. The selected patients for this research had filtered by applying inclusion and exclusion criteria.

Inclusion criteria

- Patients who had non-enhanced CT images that requested by ER physicianand carried out during the same time and date of ED visiting.
- Patients who had no history of trauma.

On the other hand, the exclusion criteria were as the following:

- Patients who had non-enhanced CT images that not requested from ED.
- Patients who had age less than 18 years.
- Patients who had head trauma.
- Patients with known case of intracranial pathology.

Sample size

Patients who visited Emergency Department of King Fahd Armed Forces Hospital in Jeddah city, Saudi Arabia during the months of October, November and December 2018 (n = 724) and met the inclusion and exclusion criteria, had recruited in our studyafter reviewing hospital database.

Data collection

Questionnaire

The questionnaire of this study was consisted of two sections:

- First section included the following information: Age and gender.
- Second section included:
  1. Non-Trauma caused of Neurological symptoms in ED.
  2. Non-enhanced CT readings, which included the following information:radiological findings of infarction, mass lesion and hemorrhage.

Operation definition

- **Non-trauma caused of neurological symptoms:** Are symptoms that usuallythe ER physicians request Non enhanced CT scan for non-trauma patients andincluded the following:
  1. Headache
  2. Altered mental status (loss of concentration/confusion).

3. Posterior fossa syndrome: is a group of neurological symptoms that occurdue to the presence of mass lesion in the areas of the cerebellum and brainstem, without evidence of a stroke or injury to the brain tissue. These symptoms include mutism, weakness in one side of the body, ataxia (unsteadiness/poor balance) emotional liability, poor muscle tone, facial paralysis on one side and incontinence [14].
4. Focal neurological deficient: is a set of symptoms or signs in which causation can be localized to an anatomic site in the central nervous system. Focal neurologic deficits may develop suddenly or may evolve slowly. These symptoms include cranial nerves abnormality, dysarthria and aphasia. The sudden development of a focal neurologic deficit suggests a vascular ischemicevent such as an infarction [15].
5. Abnormal blood pressure: patient who on anti-hypertensive medications ora physician diagnosed him as patient with hypertension.
6. Nausea and vomiting
7. Known case of seizure disorder.

CT readings

To ensure the reliability, an expert panel of radiologists revisedfindings; the abnormal findings on a head CT image, defined by one or more of the following: hemorrhage, acute or sub-acute infarction, mass lesion.

Study plan

- Fulfill the selection criteria of patients who were visiting Emergency Department during the months of October, November and December of 2018.
- Medical data of the patients are present in Database of King Fahd Armed Forces Hospital.
- Data collection had started after getting the permission from ethical and scientific committee in King Fahd Armed Forces Hospital department.
- All patients in the study had approached by mobile calls and verbal consent was taken from them. The patient confidentiality was also under keen observation and the data was kept highly confidential along the course of theresearch.

Data management and statistical analysis

For the Data entry and statistical analysis SPSS 20.0 statistical software package wasused. Quality control was done at the stages of coding and data entry. Data were presented using descriptive statistics in the form of frequencies and percentages for qualitative variables, and means and standard deviations, medians and inert-quartile range for quantitative variables.

Chi-square test and fisher exact test were used to record the statistical significantbetween patients' characteristics (age, gender and neurological symptoms) and presence of abnormal findings on non-enhanced CT scan.

Multiple Logistic regression analyses were conducted with presence of abnormal findings on non-enhanced CT scan (yes or no) as the dependent variable. The independent variables were only entered in the logistic regression model if they had astatistically significant association with presence of abnormal findings on non- enhanced CT scan.

Result

Characteristics of the study subjects

According to the study design, 724 patients were included in the study; majority ofthe patients 68% on age group of (18 to 70 years) with 1:1 male to female ratio (Table 1). On (Figure 1); greater number of patients who were visiting ED had focal neurological deficit symptoms and signs (18.9%) followed by headache (16%), altered mental status (14.9%) and posterior fossa syndrome (11.25). 86% of

the patients had normal findings on non-enhanced head CT scan and 9.7% of the patients had radiological features of acute or sub-acute infarction (Figure 2).

Demographic characteristics	Frequency	Percent
Age		
18 to 70 years	497	68.6
More than 70 years	227	31.4
Gender		
Male	374	51.7
Female	350	48.3

Table 1*: General characteristics of the patients (n = 724).*

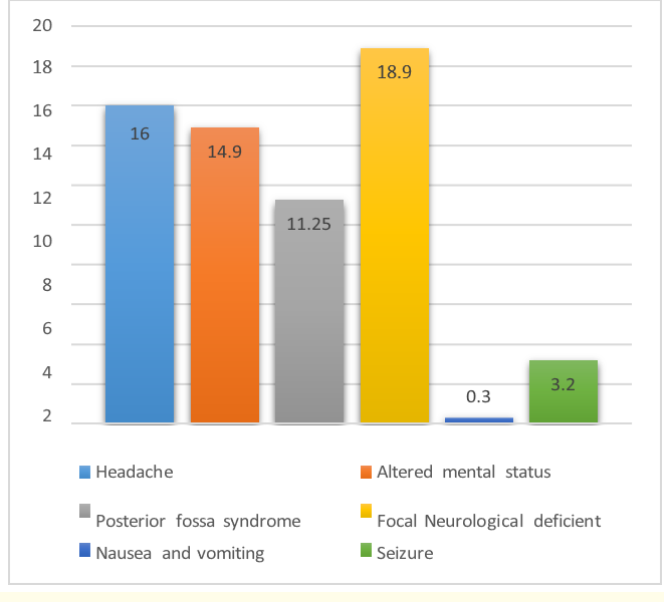

Figure 1: *Percentages of neurological symptoms of non-trauma patients (n = 724).*

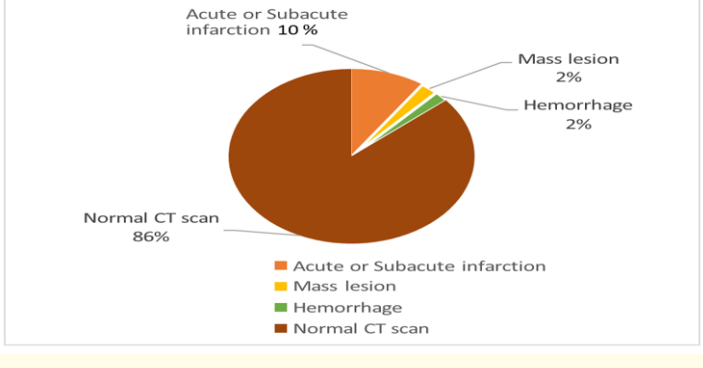

Figure 2: *Percentages of non-enhanced CT readings among patients CT image (n = 724).*

Relation between patients' CT finding (radiological findings of infarction, mass lesion and hemorrhage) and their demographic characteristics (age and gender)

Bivariate analysis on table 2 demonstrates no statistical association between agegroups of patients and radiological findings. Although there were high number ofmale patients with infarction findings on CT image but the association could not reach statistical significance.

	Radiological findings on CT scan					
	Normal	**infarction**	**Mass lesion**	**Hemorrhage**	**Chi-squaretest value**	**p- value**
Age						
18 to 70	430	14	12	8	1.001	0.8
> 70	193	23	5	6		
Gender						
Male	314	42	5	8	5.54	0.136
Female	304	28	12	6		

Table 2: *Relation between patients' CT finding (radiological findings of infarction, mass lesion and hemorrhage) and their characteristics (age and gender).*

Relation between patients' CT finding (radiological findings of infarction, mass lesion and hemorrhage) and neurological symptoms of non-trauma

On bivariate analysis, table 3 displays that there was association between Neurological symptoms of Non-trauma and CT findings, majorities of patients with symptoms and signs of focal neurological deficient had infarction features onCT.

	Radiological findings on CT scan				
	Normal	**Infarction**	**Mass lesion**	**Hemorrhage**	**P-value of Fisher exact test**
CNS symptoms/signs					
Headache	105	65	2	1	0.002*
Altered mentalstatus	69	37	2	3	
Posterior fossa syndrome	88	3	1	0	
Focal neurological deficient	112	54	3	6	
Nausea and vomiting	2	0	0	1	
Seizure	22	1	0	0	

Table 3: *Relation between patients' CT finding (radiological findings of infarction, masslesion and hemorrhage) and neurological symptoms of non-trauma.*

** Statistically significant at $p < 0.05$.*

Multiple logistic regression models for prediction of PFS severity

In multivariate analysis (Table 4), neurological symptoms of Non-trauma is the only factor was predicting radiological finding on CT scan. The model indicates that this factor was statistically significant independent predictors. Thus, presenceof focal neurological deficient symptoms and signs compared with headache as reference variable is associated with abnormal finding on CT image by one and half-fold risk. Meanwhile, those with the focal neurological deficient symptoms and signs with known case of hypertension will have about three-fold risk of getting abnormal finding on CT image.

	B	SE	Wald	Df	P	OR	95.0% CI for OR	
							Upper	Lower
Constant	0.21	0.340	0.055	1	0.81			
Focal neurological deficit	1.54	0.475	4.458	1	0.02	1.5	0.9	5.4
Focal neurological deficit and abnormal blood pressure	0.15	0.982	2.232	1	0.03	2.7	1.3	7.2
(References: Headache and Abnormal finding on CT scan)								

Table 4*: Multiple logistic regression models for prediction of radiological findings on CTscan.*

Discussion

Performing head computed tomography (CT) for every patients without supportive indicators would be time consuming and costly in addition to the radiation hazards. Inthis retrospective study of ED patients without a history of trauma who underwent head CT, we identified independent clinical predictors of abnormal CT findings that may assist in forming clinical guidelines to support physicians' decisions to order head CT for these patients.

Almost 32% of patients in presents study consisted of age group more than 70 years,which means that most of ED visitors are in age group than less 70 years. This is come line with previous studies that showed the mean age of ED visitors in age 64 ± 18 [5]. Furthermore, the one to one male and female ratio of the study sample is in itself an advantage for the study given that it is a known risk factor for abnormal readings in head CT that related to cardiovascular disease and stroke [16]. Hence, its role as a possible selection bias is eliminated in this study given that the whole sampleconsisted of equal distribution of gender.

According to the present findings, the prevalence of patients with focal neurological deficient was high (18.9%) followed by headache (16%). The rates are lower [13] compared with US report of National Hospital Ambulatory Medical Care Survey andcome in line with other study that justified this by increase prevalence of cardiovascular diseases among population [5].

However, majority of the patients in present study had normal findings on non- enhanced head CT scan and this is support aim of study to build up high selective criteria to order head CT for non-trauma patients in ED. Furthermore, only 9.7% ofthe patients had radiological features of acute or sub-acute infarction that actually reflects the high prevalence cardiovascular disease and related neurological features.

Through the literature review, many researches [17,18] and medical reports have debated about most sensitive and accurate potential indicators that may use to reducethe number of unjustified CT scan of the head among patients with minor head trauma. Canadian Assessment of Tomography for Childhood Head injury (CATCH) [17] and Canadian computed tomography head rule (CCHR) [18] are examples of assessment tools, which had been developed to help physicians determine which minor head injury patients need head CT imaging. Comparatively few studies examine non-trauma patients, who are in fact more likely to have more unjustified head CT scan.

Moreover, potential independent indicators for radiological findings on head CT scan of non-trauma patients showed that the neurological signs and symptoms are the common indicators among different studies; present study revealed that presence of focal neurological deficient symptoms and signs compared with headache as referencevariable is associated with abnormal finding on CT image by (adjusted OR 1.5) one and half-fold risk. Meanwhile, those with the focal neurological deficient symptoms and signs with known case of hypertension will have about three-fold risk (adjusted OR 2.7) of getting abnormal finding on CT image. Previous study [19] of 279 patients determined that only 15% had positive findings on CT and among them 95% had positive neurologic examination findings. Furthermore, other study [5] of 29, 469 patients showed that 13.8% had abnormal head CT and this study was able to identify Six independent clinical predictors of important abnormal findings on head CT: age (adjusted OR per 10-year increase: 1.17) focal neurologic deficit (adjusted OR:

5.39), altered mental status (adjusted OR: 2.32) history of malignancy (adjusted OR: 4.11), nausea and/or vomiting (adjusted OR: 2.22), and derangements in coagulation profile (adjusted OR: 1.91).

Conclusion

Abnormal radiological findings on head CT image is significantly associated with neurological symptoms of Non-trauma patients. Those with the focal neurological deficient symptoms and signs with known case of hypertension will have about three-fold risk of getting abnormal finding on CT image.

Limitations of study

Limitations of study can be summarized into

- This study is cross-sectional design according to literature review a cohort study design would be with better value by identifying potentialindependent indicators for radiological findings on head CT scan of non-trauma patients.
- Study carried out in single- institute and multicenter approach mayincrease the sample size.

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Conflict of Interest

We have no conflict of interest to declare.

Authors' Contributions

Authors testify that: All persons designated as authors qualify for authorship and have checked the article for plagiarism. If plagiarism is detected, all authors will be held equally responsible and will bear the resulting sanctions imposed by the journal thereafter.

Shada conceived and designed the study, conducted research, provided research materials, and collected and organized data. Ashjan analyzed and interpreted data. Faisal wrote initial and final draft of article, and provided logistic support. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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