



St. Paul Hospital Millennium Medical College

Emergency and Critical Care Medicine Department

**Assessment of Accuracy of Emergency and
Critical Care Medicine Residents in Head
Computed Tomography Scan Reading and
Associated Factors**

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Assessment of Accuracy of Emergency and Critical Care Medicine Residents in Head Computed Tomography Scan Reading and Associated Factors at Teaching Institutions in Addis Ababa, Ethiopia; Multicenter Cross Section Study

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**St. Paul Hospital Millennium Medical
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**Emergency and Critical Care Medicine
Department**

Research Project Submission Template

Name of investigator	Dr. Fraol Alemayehu
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Summary

Background: Computed tomography (CT) interpretation in the emergency department is one of the vital issues that should be carried out rapidly and accurately. Very little is known whether current curriculum of emergency medicine is guarantees higher accuracy of in the interpretation of emergency cranial CT scans.

Objectives: Aim the study was to assess the accuracy of Head CT interpretations by Emergency and critical care residents and associated factors at three teaching institutions with ECCM residency in Addis Ababa, Ethiopia.

Methods: Institution based Cross-sectional study used to assess the accuracy of Head CT interpretations by Emergency and critical care residents and associated factors radiologist as gold standard at three teaching institutions with ECCM residency in Addis Ababa, Ethiopia. Data was collected with semi-structured questioner by using google form from August 1 2025 to September 30 2025. ECCM resident will presented with YouTube video link of most common head CT finding at ED to interpret in the google form.

Result: 55 residents participated in the research, 24 from AAU, 25 from SPHMMC, 6 from Yekatit 12 Hospital MC. Overall accuracy rate of Head CT scan interpretation is 68.0% which is mean of 10.2 correct interpretation out of 15 of CT scans (SD = 2.4). Most residents (65.5%) scored between 10-13 correct answers, while only 34.5% (n=19) achieved high performer status ($\geq 80\%$ accuracy). Year Three residents had 13 times higher odds of being high performers (OR = 13.01, 95% CI [1.48, 114.29], $p = 0.022$) compared to year two residents. The analysis of individual CT scan interpretations revealed substantial variation in diagnostic accuracy across different pathological findings. Performance ranged from excellent (96.4%) for common hemorrhages to very poor (10.9%) for advanced radiological signs like CVT and Meningeal enhancements.

Conclusion: Emergency and critical care residents CT interpretation accuracy is suboptimal. There are variation in CTs interpretation for significant hemorrhages to subtle pathologies. Further formal training and radiology support are necessary to provide better standard of care.

Keywords: Accuracy; Head computed tomography; Emergency and critical care medicine resident

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Acronyms and Abbreviations

AaBET: Addis Ababa Burn, Emergency and Trauma Center

AAU: Addis Ababa University

AAUSOM: Addis Ababa University School of Medicine

BDU: Bahirdar University

CI: Confidence interval

CT: Computed Tomography

CVT; Cerebral Venous Thrombosis

DAI: Diffuse axonal injury

DICOM: Digital Imaging and Communications in Medicine

DSF: Depressed skull fracture

ECCM/EMCC: Emergency and critical care medicine

EDH: Epidural Hematoma

EM: Emergency Medicine

EMTF: Emergency Medicine Task Force

EP: Emergency Physician

ESEP: Ethiopian society for emergency professionals

ICH; Intracerebral Hemorrhage

IVH; Intraventricular hemorrhage

KKUH: King Khalid University Hospital

NCCT: Non-Contrast CT

NPV: Negative Predictive Value

PGY: post-graduation year

PPV: Positive Predictive Value

SAH: Subarachnoid hemorrhage

SD: Standard deviation

SDH: Subdural hematoma

SPHMMC: St. Paul's Hospital Millennium Medical College

SPSS: Statistical Package for Social Science

TASH: Tikur Anbessa Specialized Hospital

UoG: University of Gondar

List of Table and Figures

TABLES

Table 1: Proportion of residents from calculated sample size

Table 2: ECCM residents' characteristics and CT scan related training/class

Table 3: Distribution of Total Interpretation Scores

Table 4: High Performer Rates by Demographic and Training Factors

Table 5: Bivariate Associations with CT Interpretation Accuracy with continuous score

Table 6: Combined Multivariate Regression Analyses of Factors Associated with Head CT Interpretation Performance

Table 7: Diagnostic accuracy by pathology type

Table 8: Performance Gaps by Residency Year and pathology type

Table 9: Diagnostic Performance of Emergency and Critical Care Medicine Residents in Head CT Interpretation for Various Pathological Findings

FIGURES

Figure 1: Distribution of Head CT Interpretation score

Contents

Research Project Submission Template	1
Summary	2
Acknowledgements.....	3
Acronyms and Abbreviations	4
List of Table and Figures	5
Chapter 1 Introduction	8
1.1. Background	8
1.2. Statement of the problem	9
1.3. Rationale of the study.....	9
Chapter 2 Literature Review	11
2.1. Comparison between Emergency Residents and Radiologist.....	11
2.2. Comparison between Emergency Physician and Radiologist	12
2.3. Common and clinically significant Head CT finding at Emergency department.....	13
Chapter 3 Objectives.....	15
3.1. General Objective	15
3.2. Specific Objectives	15
Chapter 4 Methods	16
4.1. Study setting	16
4.2. Study Design.....	16
4.3. Source Population	16
4.4. Study population.....	16
4.5. Inclusion & exclusion criteria	16
Inclusion criteria.....	16
Exclusion criteria	16
4.6. Sample Size and Sampling Procedures	16
4.8. Study period.....	17
4.9. Data Collection Procedures.....	17
4.10. Data Management	17
4.11. Data Analysis Procedures.....	17
4.12. Variables.....	18
Dependent variable	18
Independent variable	18

4.13. Operational Definitions.....	18
4.14. Ethical Consideration	18
4.15. Dissemination of Results.....	18
Chapter 5 Results	19
5.1. Sociodemographic and Training Characteristics.....	19
5.2. Overall Accuracy in Head CT Scan Interpretation	20
5.3. Performance Distribution by Key Variables.....	21
5.4. Bivariate Associations with CT Interpretation Accuracy.....	22
5.4.1. Analysis with Continuous Score	22
5.4.2. Analysis with High Performer Status ($\geq 80\%$ Accuracy)	23
5.5. Multivariate Regression Analyses	23
5.5.1. Linear Regression (Continuous Outcome)	23
5.5.2. Logistic Regression (High Performer Status).....	23
5.6. Diagnostic Accuracy by Pathology Type.....	24
5.6.1. Hemorrhage Recognition Patterns	25
5.6.2. Performance varied significantly for other critical findings.....	25
5.6.3. Advanced and Challenging Findings.....	25
5.6.4. Performance Gaps by Residency Year and pathology type	26
5.6.4. Most Common Diagnostic Errors	26
Chapter 6 Discussion.....	28
6.1. Overall Accuracy	28
6.2. Sociodemographic Factors.....	28
6.3. Specific Pathology Recognition pattern.....	29
Chapter 7 Limitation and Strength	30
Chapter 8 Conclusion and Recommendation	30
Chapter 9 Reference	31
Chapter 10 Annex: Questioner(10)	33

Chapter 1 Introduction

1.1. Background

Computed Tomography (CT) scans possess a broad spectrum of clinical applications, depending on specific organs under investigation. These scans are integral to both inpatient and outpatient medical care. Furthermore, in emergency scenarios, CT scans play a vital role in the expeditious exclusion of critical medical conditions (1). The most common CT scan done in an emergency department is CT head, which falls under two categories i.e. post traumatic and non-traumatic CT head. A segment of CT scan in emergency department is done for medico-legal purposes requiring evidence based clinical practice (2).

CT scans are crucial for assessing the extent of injuries in patients with head trauma. They can identify intracranial bleeding, brain swelling, skull fractures, and other critical injuries that may not be apparent on physical examination(3). CT scans can quickly identify ischemic stroke and differentiate it from hemorrhagic stroke, guiding immediate treatment decisions(4). In cases of severe or persistent headaches, CT scans can help rule out serious underlying causes like brain tumors, aneurysms, or infections. CT scans can help identify structural abnormalities in the brain that may be causing seizures, such as tumors or malformations. If a patient presents with confusion, disorientation, or decreased responsiveness, a CT scan can help identify potential causes like brain injury, stroke, or infection(5).

Even though head CT plays such a critical role in patient diagnosis and management at emergency departments, numerous previous studies have revealed a deficiency in the ability of emergency physicians and residents to interpret head CTs(6–10). While the accuracy of interpretation of brain CT scan by emergency physicians is of crucial importance, many EM residency programs do not allocate enough time to brain CT scan interpretation training(6,11).

In Ethiopia, emergency and critical care residence program was started in 2010. Since then growing fast in the past decade. Currently, there are 8 institutions with emergency and critical care specialty program (Addis Ababa University (AAU), St. Paul Hospital Millennium Medical College (SPHMMC), Jimma University, Haromaya University, Hawassa University, University of Gondor(UoG), Bahirdar University(BDU) and Yekatit 12 Hospital Medical College). Three-year program curriculum was developed by the formation of an emergency medicine task force (EMTF) with core group physicians in Addis Ababa University, School of Medicine (AAUSOM) along with the University of Wisconsin and the University of Toronto. In this curriculum there is 1-month emergency radiology attachment for year one residents (11). Very little is known whether current curriculum of emergency and critical care medicine is guarantees higher accuracy in the interpretation of emergency cranial CT scans.(10)

1.2. Statement of the problem

Computed tomography (CT) interpretation in the emergency department is one of the vital issues that should be carried out rapidly and accurately.(10,12) Emergency physicians and residents, as the initial point of contact within the hospital, encounter a diverse and high volume of cases. Working around-the-clock, they often lack immediate access to attending radiologists. This necessitates their independent evaluation of diagnostic images, including cranial CT scans, to establish diagnoses and initiate appropriate treatment. However, this responsibility carries the inherent risk of diagnostic errors, such as misinterpretations, missed findings, or even the identification of nonexistent conditions. Accurate assessment of cranial CT scans by emergency physicians and residents is crucial to mitigate these risks and prevent adverse patient outcomes.(10,13)

In Ethiopia, emergency medicine is young field of study. Very little is known whether current curriculum of emergency medicine is guarantees higher accuracy of in the interpretation of emergency cranial CT scans. There is only one study published data in this regard in Ethiopia. The study done 5 years back in 2019 back when there were only two institutions with emergency medicine program. The study showed lower accuracy (57.6%) in the interpretation of emergency cranial CT scans by emergency and critical care residents when compared to accuracy of emergency residents in other part of the world (78% to 82.3%) (2,6,10). Subsequently there no study done to show any changes in this regard and also accuracy of residents at newer institutions never been assessed. Further research is necessary to assess the effectiveness of the current emergency medicine curriculum to improve resident training and patient outcomes(6,10).

1.3. Rationale of the study

Head CT scans are a critical diagnostic tool in emergency medicine, particularly in the evaluation of acute neurological conditions. Accurate and timely interpretation of these scans is essential for prompt diagnosis and initiation of appropriate treatment. However, the interpretation of head CT scans can be complex, requiring expertise in neuroanatomy, neuroimaging, and clinical correlation.(6,9,10,14–16)

The rationale for this study is to:

1. Evaluate the diagnostic accuracy of emergency and critical care residents (ECCMRs) in interpreting head CT scans. This will help assess the level of expertise and knowledge of ECCMRs in interpreting these critical images.
2. Identify potential areas of discrepancy between the interpretations of ECCMRs and radiology specialists. This will help pinpoint knowledge gaps and areas where additional training or support may be needed.
3. Determine if there are any factors that influence the accuracy of head CT interpretations by ECCMRs. These factors may include years of training, exposure to neuroimaging, or the complexity of the cases.

4. Inform the development of educational programs and quality improvement initiatives to enhance the diagnostic accuracy of ECCMRs in interpreting head CT scans. This may involve targeted training programs, the use of standardized reporting templates, or the implementation of tele-radiology consultations.

By addressing these research questions, this study will contribute to improving the quality of emergency care in Ethiopia by ensuring accurate and timely interpretation of head CT scans.

Chapter 2 Literature Review

The discrepancies between emergency staff and radiologists have been the subject of investigation by various researchers (8).

2.1. Comparison between Emergency Residents and Radiologist

Ethiopian residents

In May 2019 a prospective cross-sectional study to assess the accuracy of emergency medicine residents in interpreting cranial CT scans compared to neuroradiologists. For this study 42 residents from two medical colleges in Addis Ababa (AAU and SPHMMC) participated. 15 cranial CT scans were interpreted by both residents and neuroradiologists. Residents wrote their findings on blank paper. Results of the study shows overall accuracy of resident interpretations was 57.6%. Sensitivity for normal scans was 62.6%, specificity was 96%. Residents performed well in identifying hemorrhage and hydrocephalus. Herniation and meningeal enhancement were often missed. Limitations of the study includes, no patient clinical data was provided and clinical significance was not studied, and the study was also done while the residents working hours which they might not devote their full attention in reading the scans. In essence, the study found that while residents showed some accuracy in interpreting cranial CT scans, their performance could be improved, particularly in identifying certain critical findings.(10)

Rest of the world

A Multicenter Study to Improve Emergency Medicine Residents' Recognition of Intracranial Emergencies on Computed Tomography was done at 5 centers with emergency program 3 states of USA (Delaware, South Carolina, North Carolina, Virginia). The objective of this study was to quantify the initial ability of emergency medicine residents to interpret cranial CT scans and to assess the efficacy of a novel approach to cranial CT interpretation specifically designed for emergency physician trainees. In this study, standardized pretest was administered to assess baseline ability to interpret CT scans, then 3 months after a novel method of cranial CT interpretation course given standardized posttest was administered. Each test consisted of 12 CT scans with a short accompanying history. A total of 83 residents were tested at the 5 sites over a 6-month period. As a result, the mean percentage correct CT interpretation before the course was 60% (95% CI) on the standardized pretest. At retesting 3 months after the course, the accuracy rate increased to 78% ($P < 0.001$). The strength of this study was they were able to demonstrate how a novel educational course significantly improve ability of the residents to interpret CT. However, the clinical relevance and subsequent management errors arising from misinterpretation could not be ascertained from this study.(6)

A single center study was conducted in Dr Lutfi Kirdar Kartal Training and Research Hospital Department of Emergency Medicine, Istanbul, this study aimed to evaluate the competence of emergency medicine residents in interpreting cranial CT scans. 525 CT scans from patients

presenting to the emergency department were assessed by both residents and radiologists. Findings were residents and radiologists agreed on 82.3% of interpretations. Residents detected abnormal findings in 20.8% of scans, while radiologists found them in 17.9%. Sensitivity, specificity, positive predictive value, and negative predictive value were high. The conclusion of the study was Emergency medicine residents can accurately interpret cranial CT scans, demonstrating consistency with radiologists. The limitations of the study was that the study was conducted at a single center, and resident seniority was not considered.(9)

2.2. Comparison between Emergency Physician and Radiologist

A retrospective cohort study done at Princess Margaret Hospital at Hong Kong, reviewing all ED patients presented with head injuries from 2008 to 2010 requiring CT brain. A total of 1716 cases were included. The study sought to determine whether emergency department staff could accurately distinguish CT scans requiring neurosurgical intervention from those indicating safe patient discharge. As result the primary outcome, when compared to radiologist reading emergency staff able to interpreted abnormal brain CT with sensitivity and specificity of 0.66 (95% CI 0.60-0.71) and 0.96 (95% CI 0.95-0.97), respectively. As secondary outcome this study also able to assess association between CT interpretation accuracy and year of working experience. According to this study sensitivity increased from 0.63 (95% CI 0.54-0.72) in ED staff with 0-3 years of working experience, to 0.71 (95% CI 0.59-0.84) with 4-6 years of experience and 0.75 (95% CI 0.63-0.86) with 7-10 years of experience, then it dropped to 0.59 (95% CI 0.47-0.71) with more than 10 years of experience.(16)

Another study done was a four-month prospective cohort study at emergency department of King Khalid University Hospital (KKUH), Riyadh, Saudi Arabia. During this four month starting 1st March till 30th June 2009 a total of 255 patient had Non-contrast CT(NCCT) according to emergency physician discretion, from which 241 was eligible for the study. The Emergency physician will read the NCCT then document their finding on the form in patient chart. Radiologist report was collected from electronic system within a week. The result shows Emergency physician and radiologists agreed on 210 (87.14 %) of the case, of which 185 normal cases and 25 abnormal cases. Discordance was there in 31 cases (12.86 %), of which 15 cases were normal by the EP & abnormal by the radiologist, 7 cases were abnormal by the EP & normal by the radiologist, and 9 cases were with mismatching abnormalities. In general, the study demonstrate that EPs were able to interpret NCCT brain with a high degree of accuracy of 90.5% when compared with radiologists. A negative predictive value of 78.12% and a positive predictive value of 92.50%, and he false negative rate of EPs was 3.6%. Unlike most of studies reviewed here this study result showed high concordance between EP and radiologist with the limitation the study being EP knew the clinical scenario.(8)

At academic teaching medical center in Tehran, Iran, a prospective cross sectional study conducted from March to May 2009 to compare the findings reported in the interpretation of head CTs by emergency physicians and compare to radiologists as the gold standard. During this period a total

544 patients with head CTs as part of their work up, were registered in this study. Every head CT scan study was interpreted at quiet room outside the emergency department with as much time by an emergency physician and a senior emergency medicine resident (who had finished a one-month rotation in the diagnostic imaging unit). Another copy of the CT scan was sent for interpretation by a radiologist as the diagnostic gold standard. According to this study when compared to radiologist as gold standard EPs had 88 (16.2%, 95% CI) difference in interpretation out of 544 scanned patients. There were 35 (6.44%, 95% CI) false negative and 53 (9.73%, 95% CI) false positive cases which was statistically significant ($P < 0.0001$). These findings revealed a sensitivity and specificity of 86.5 % and 81.4% respectively for the interpretations done by the EPs. PPV of 86.9%, NPV of 86.9%, PLR of 4.6 and NLR of 0.16. The reports from senior residents were different from those of the radiologist for 86 (15.8%, 95%CI) cases. There were 12 (2.21%, 95%CI) false positive cases while false negative cases accounted for 74 (13.6%, 95%CI) of the discordances and the difference was statistically significant ($P < 0.0001$). Senior residents had a sensitivity of 71.4%, specificity of 95.8%, PPV of 93.9% and NPV of 78.7%. The PLR and NLR were calculated to be 17 and 0.29 respectively. Emergency physicians demonstrated superior sensitivity in their CT interpretations (86.5% vs. 71.4%), while residents exhibited higher specificity (91.8% vs. 81.4%). It's important to note that the interpretations in this study were conducted in a controlled environment, not the hectic conditions of an emergency room.(14)

A prospective cohort study was done at county hospital emergency medicine residency program in USA by Dr. Dennis Alfaro et al to determine the concordance of emergency physicians and radiologists in interpreting cranial computed tomography (CT) scans. Total of 555 patients undergoing CT scanning during emergency department evaluation. Of those 46.1% (256) of the CT scans interpreted as abnormal by radiologist. Discordance between radiologists and emergency physicians was found in 38.7% (206) of the cases. Potentially clinically significant misinterpretations were found in 24.1% (131) of the total sample. These misinterpretations included 62 missed major findings (11.4% of total sample): 25 new infarcts, 10 mass lesions, 8 cases of cerebral edema, 8 parenchymal hemorrhages, 5 contusions, 4 subarachnoid hemorrhages, 1 epidural hematoma, and 1 subdural hematoma. However, review of patient chart indicated that only 3cases (0.6%) were managed sub optimally. Importantly, no patient experienced adverse consequences as a result of this. This study was able to assess clinical significance of misinterpretations; it was the strength of this study. (16)

2.3. Common and clinically significant Head CT finding at Emergency department

A cross-sectional study was conducted on 76 cases of traumatic head injury to asses CT imaging findings in head injury victims of conflict in Northern Ethiopia treated at the University of Gondar comprehensive specialized hospital. This study examined CT scan patterns of traumatic head injuries among war victims in Northern Ethiopia, specifically during the 2020-2021 armed conflict. Conducted at the University of Gondar Comprehensive Specialized Hospital, the research found that the vast majority of patients (96.1%) were young males (≤ 29 years old). Bullet injuries

were the leading cause of trauma (50%), followed by blunt trauma and blasts. Abnormal CT findings were present in nearly 79% of cases, with skull fractures (64.5%), metallic foreign bodies (36%), and cerebral contusions (33%) being the most common. Certain conditions like scalp and brain hematoma, metallic foreign bodies, and pneumocephalus were significantly linked to bullet injuries.(17)

Studies show most Head CT scan from emergency mostly has no finding reported normal (2,9,15,18). A retrospective observational study conducted in Radiology Department of Medical Teaching Institute Lady Reading Hospital (MTI-LRH), Peshawar, Pakistan, over period of 3 months out of 3893 CT scan head done in ED, 2581 cases were reported normal (66.29%), while 1312 cases had positive findings (33.7%), including post traumatic and non-traumatic.(2) Also from study conducted at Dr Lutfi Kirdar Kartal Education and Research Hospital Department of Emergency Medicine, Istanbul, over period of 6 months out of 525 cases, 82.1% (n = 431) of scans reported normal CT findings and 17.9% (n = 94) radiology specialists reported abnormal CT findings.(9)

From head CT scan reported abnormal there some most common finding by most studies (2,9,15). For example, from study done in Pakistan; in non-trauma positive CT scans most common reports are, Intracranial hemorrhage, Cerebral infarcts, Hydrocephalus, and Brain atrophy; in Post trauma positive CT scans most common reports are, Subarachnoid hemorrhage, Subdural hemorrhage, Extradural Hemorrhage, Intraventricular hemorrhage, Skull bone fracture and Pneumocephalus.(2) From study done Dr. Dennis Alfaro et al, most frequent reported abnormalities were scalp hematoma, infarction, calcification, contusion, parenchymal hemorrhage, and mass.(15)

Other studies reported some head CT scan findings as clinically significant(9,15). In study done by Dr. Dennis Alfaro these CT findings are reported as being clinically significant; new infarcts, mass lesions, cerebral edema, parenchymal hemorrhages, contusions, subarachnoid hemorrhages, epidural hematoma, and subdural hematoma.(15) Also from other studies including study conducted at Istanbul, subarachnoid hemorrhage, intracerebral hemorrhage, intracranial mass, edema, hydrocephaly, and cerebral vein thrombosis are assessments identified as potential or significant pathologies.(9,19)

Chapter 3 Objectives

3.1. General Objective

The objectives of this study is to assess the accuracy of Head CT interpretations by Emergency and critical care residents and associated factors at three teaching institutions with ECCM residency in Addis Ababa, Ethiopia.

3.2. Specific Objectives

To determine ECCM residents level of consistency with radiologists in Head CT interpretations

To identify factors associated with ability to read Head CT scans of ECCM residents

Chapter 4 Methods

4.1. Study setting

The study was conducted in 3 different institutions with ECCM residency program in Addis Ababa. These includes, Addis Ababa University (AAU), St. Paul Hospital Millennium Medical College (SPHMMC) and Yekatit 12 Hospital Medical College. AAU emergency department found in the campus of College of health sciences Tikur Anbessa Spatialized hospital (CHS-TASH). It was established in 2010 and it has been teaching emergency medicine since then. Currently there 15 second year and 17 third year three active residents at the department. The second is SPHMMC including its affiliate trauma, emergency and burn center, AaBET Hospital. The emergency department started teaching residency program in 2016, and currently there are 13 second year and 18 third year residents actively on academic activity. The third, Yekatit 12 Hospital Medical College started residency program in year 2024, currently there are 7 second year residents.(11)

4.2. Study Design

Institution based Cross-sectional study was used assess the accuracy of Head CT interpretations by Emergency and critical care residents, radiologist as gold standard.

4.3. Source Population

The study was conducted among all Emergency and Critical care medicine residents at three institutions in Addis Ababa, Ethiopia. Namely, Addis Ababa University, St. Paul Hospital Millennium Medical College, Yekatit 12 Hospital Medical College.

4.4. Study population

All Emergency and Critical care medicine residents at all three institutions who met the inclusion criteria and agreed to participate in the study.

4.5. Inclusion & exclusion criteria

Inclusion criteria

- Any Emergency and Critical care medicine residents who consent and willing to participate in the study who stayed more than 6 months on residency program

Exclusion criteria

- Those residents who refused to consent for participation
- The principal investigator
- Residents who stayed less than 6 months in the residency program.

4.6. Sample Size and Sampling Procedures

No sample size determination nor sampling technique used, all Emergency and Critical care medicine residents at three institutions who met inclusion & exclusion criteria will participate.

Table 1: Number of residents according to data obtained from department of respective institution

SN	Name of the institution	Residents who stayed > 6months in the program		
		R2	R3	Total
1	Addis Ababa University	15	17	32
2	SPHMMC	13	18	31
3	Yekatit 12 Hospital MC	7		7
	Total	35	35	70

4.8. Study period

The study was conducted from July to October 2025.

4.9. Data Collection Procedures

Data was collected by using google form from August 1 2025 to September 30 2025. Data collection was moderated by six residents trained by principal investigator from each institution. Self-administered standardized questionnaire was used to collect the personal and other information from the residents. In the form, most commonly reported abnormal head CT scan and normal head CT scan were inserted after full slices of axial view of the scans converted to video form by using Radiant desktop app. The residents wrote down their interpretation of the CT scan on the form just below each video. All the scan will also be interpreted by radiologist who is randomly selected by radiology department at SPHMMC. Most commonly reported abnormal head CT scan are selected according to data from previous studies. These abnormal finding included are, Subarachnoid hemorrhage (SAH), Subdural hemorrhage (SDH), Epidural Hemorrhage(EDH), Intraventricular hemorrhage (IVH), Skull bone fracture, Pneumocephalus, intracerebral hemorrhage, intracranial mass, edema, hydrocephaly, cerebral vein thrombosis, contusion, infarction, and meningeal Enhancement. (2,9,15)

4.10. Data Management

Google Forms data management features such as a response summary to show the number, status, and trend of responses; individual responses to view, edit, or delete specific responses; email notifications to alert when someone fills out of form; response validation to prevent or warn respondents from entering invalid or incomplete data.

4.11. Data Analysis Procedures

Collected data transferred, compiled, organized, and analyzed using SPSS Version 31. Statistical significance will be set at P-value of 0.05. Both descriptive and analytical statistics was used for

the variables. The accuracy, the specificity, sensitivity, PPV & NPV was calculated. Correlational and Regression Analyses used to assess the association between the dependent and independent variables.

4.12. Variables

Dependent variable: Accurate interpreting of common emergency head CT scans

Independent variable:

- Year of residency (R1, R2 or R3)
- Prior radiology Training
- Head CT scan pathologies
- Institutions of the residency
- Number of CTs interpreted per week
- Age
- Sex
- Confidence level

4.13. Operational Definitions

- Accurate interpreting of CT scans: defining normal anatomy and pathological views in a radiological manner. For this study, any resident with 80% or greater concordance with radiologist considered high performer, any resident with concordance below 80% considered low performer(9,10,19)
- Normal CT scans: failure to detect any pathology and detection of senile atrophy
- Abnormal CT scan: any CT scan with; Subarachnoid hemorrhage (SAH), Subdural hemorrhage (SDH), Epidural Hemorrhage(EDH), Intraventricular hemorrhage (IVH), Skull bone fracture, Pneumocephalus, intracerebral hemorrhage, intracranial mass, edema, hydrocephaly, cerebral vein thrombosis, contusion, infarction, herniation, and meningeal Enhancement
- Concordance: the agreement between the emergency residents and radiologist
- Discordance: the disagreement between the emergency residents and radiologist

4.14. Ethical Consideration

The final proposal of the research was presented to IRB of the college for approval of the research and approval was obtained. Information obtained from individual participants was kept secured and confidential. Names and other identifying data of respondents eliminated throughout the study process to maintain confidentiality.

4.15. Dissemination of Results

The finding of this study will be share with department Emergency and critical care Medicine of each institution and Ethiopian society for emergency professionals (ESEP).

Chapter 5 Results

5.1. Sociodemographic and Training Characteristics

The study included 55 emergency and critical care residents, most of whom were male, and slightly more participants were in their second year of residency than in their third year. Only a minority had received formal instruction on cranial CT interpretation during their undergraduate training, although just over half reported receiving such teaching during residency. Despite this, nearly all respondents felt that the training provided was insufficient. A large proportion indicated that cranial CT interpretation was challenging, and while the majority described themselves as moderately confident, only a small number reported being very confident. Most residents encountered more than 10 cranial CT scans per month, yet they frequently sought assistance with interpretation, usually on an occasional rather than regular basis. Self-directed learning was common, with many using additional resources beyond formal teaching, though reading textbooks occurred infrequently for most respondents. Overall, these findings suggest that while residents are exposed to cranial CT imaging in their clinical practice, gaps in formal training may contribute to limited confidence and a perceived need for supplementary learning support.

Table 2: Sociodemographic and Training Characteristics of Emergency and Critical Care Medicine Residents (N = 55)

Variable	Category	n	%
School of Residency	Addis Ababa University	24	43.6
	SPHMMC	25	45.5
	Yekatit 12 Hospital MC	6	10.9
Sex	Male	46	83.6
	Female	9	16.4
Year of residency	Year Two	30	54.5
	Year Three	25	45.5
Had undergraduate cranial CT reading class	Yes	15	27.3
	No	40	72.7
Had CT reading class during residency	Yes	29	52.7
	No	26	47.3
CT class during residency was sufficient*	Yes	2	3.6
	No	53	96.4
CT interpretation included in residency exam	Yes	44	80.0
	No	11	20.0
Perceives cranial CT interpretation as difficult	Yes	36	65.5
	No	19	34.5
Self-rated confidence in CT interpretation	Very confident	5	9.1
	Moderately confident	45	81.8
	Not confident	5	9.1

Monthly exposure to cranial CT scans	<5 scans	2	3.6
	5–10 scans	16	29.1
	>10 scans	37	67.3
Frequency of seeking help for CT interpretation	Always	4	7.3
	Sometimes	47	85.5
	Rarely	4	7.3
Use of self-learning resources	Yes	52	94.5
	No	3	5.5
Frequency of reading CT interpretation books	Always	3	5.5
	Sometimes	40	72.7
	Rarely	11	20.0
	Not at all	1	1.8

*Only respondents who received residency-level CT teaching answered this item

5.2. Overall Accuracy in Head CT Scan Interpretation

No single resident correctly identified the all 15 emergency cranial CT scan. The mean of correctly answered CT reading was 10.2 (SD = 2.4), the maximum score was 14 from 15 emergency cranial CT scans and the minimum was 0 (Table 4). The mean score was 10.2 is corresponding to an accuracy rate of 68.0% (SD = 15.9%). Score distribution showed that most residents (65.5%) scored between 10-13 correct answers, while only 34.5% (n=19) achieved high performer status ($\geq 80\%$ accuracy) (Figure 1).

Table 3: Distribution of Total Interpretation Scores (N=55)

	Minimum	Maximum	Mean	Std. Deviation
Total Score	0	14	10.20	2.384
Accuracy Percentage (%)	0	93	68.00	15.891

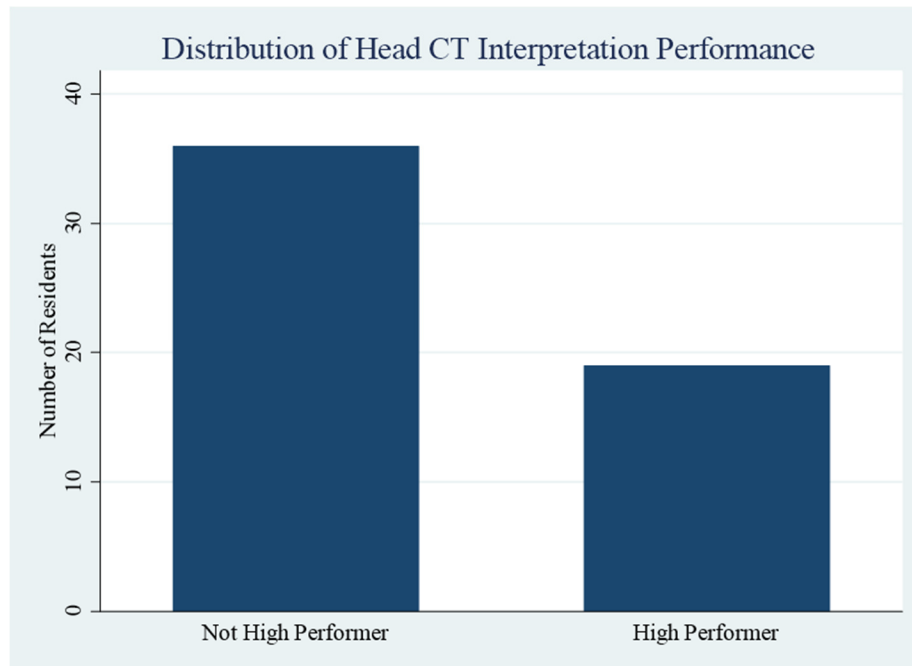


Figure 1: Distribution of Head CT Interpretation score

5.3. Performance Distribution by Key Variables

When we consider demographic and training factors, overall interpretation suggests that being in Year Three of residency, being Female, and having participated in the Residency CT Class are all associated with a higher rate of classifying as a High Performer. High Performer rates were highest among the Moderately Confident group at 37.8% (17 out of 45), substantially exceeding the identical 20.0% rate (1 out of 5) found in both the "Very Confident" and "No Confidence" extreme categories.

Table 4: High Performer Rates by Demographic and Training Factors

Characteristic	Category	High Performers (n)	High Performer Rate (%)
Residency Year	Year Two	8/30	26.7
	Year Three	11/25	44.0
Sex	Female	4/9	44.4
	Male	15/46	32.6
School of Residency	SPHMMC	10/25	40.0

	Addis Ababa University	7/24	29.2
	Yekatit 12 Hospital MC	2/6	33.3
Residency CT Class	No	7/26	26.9
	Yes	12/29	41.4
Self-Reported Level of confidence	Very Confident	1/5	20
	Moderately Confident	17/45	37.8
	No confidence	1/5	20

5.4. Bivariate Associations with CT Interpretation Accuracy

5.4.1. Analysis with Continuous Score

Independent samples t-test demonstrated statistically significant differences in scores based on year of residency ($t(53)=-2.50$, $p = 0.016$), with Year Three residents (Mean = 11.04, SD = 1.57) scoring significantly higher than Year Two residents (Mean = 9.5, SD = 2.73). On One-way ANOVA Confidence levels also showed significant association with performance ($F(2,52) = 3.64$, $p = 0.033$), with "Moderately Confident" residents achieving the highest scores (Mean = 10.56, SD = 1.82).

One-way ANOVA demonstrated no statistically significant difference in scores between institutions ($F(2,52) = 2.24$, $p = 0.117$), though SPHMMC residents showed the highest mean scores (Mean = 10.92, SD = 1.53) compared to Addis Ababa University (Mean = 9.67, SD = 2.79) and Yekatit 12 Hospital Medical College (Mean = 9.33, SD = 3.08).

Table 5: Bivariate Associations with CT Interpretation Accuracy with continuous score

Variable	Category	n	Mean $\pm$ SD	Statistical test	p-value
Sex	Male	46	10.10 $\pm$ 2.50	Independent samples t-test	0.525
	Female	9	10.67 $\pm$ 1.73		
Year of residency	Year Two	30	9.5 $\pm$ 2.73	Independent samples t-test	0.016
	Year Three	25	11.04 $\pm$ 1.57		
School of residency	AAU	25	9.67 $\pm$ 2.79	One-way ANOVA	0.117
	SPHMMC	24	10.92 $\pm$ 1.52		
	Y12 hospital	6	9.33 $\pm$ 3.07		
CT reading Residency class	No	26	9.77 $\pm$ 2.64	Independent samples t-test	0.207
	Yes	29	10.59 $\pm$ 2.10		
Self-rated confidence in CT interpretation	Very confident	5	9.4 $\pm$ 3.13	One-way ANOVA	0.033
	Moderately confident	45	10.55 $\pm$ 1.82		
	Not confident	5	7.8 $\pm$ 4.60		

Monthly exposure to cranial CT scans	< 5 scans	2	7.5 ± 0.71	One-way ANOVA	0.267
	5–10 scans	16	10.25 ± 1.73		
	> 10 scans	37	10.32 ± 2.61		

5.4.2. Analysis with High Performer Status ($\geq 80\%$ Accuracy)

Using the 80% competency threshold, 19 residents (34.5%) were classified as high performers. Chi-square tests revealed notable though non-significant patterns: Year Three residents showed higher high performer rates (44.0%, $n=11$) compared to Year Two residents (26.7%, $n=8$; $\chi^2(1) = 1.81$, $p = 0.178$). Female residents demonstrated higher high performer rates (44.4%, $n=4$) compared to males (32.6%, $n=15$; $\chi^2(1) = 0.47$, $p = 0.495$).

An independent samples t-test indicated that high performers were younger (Mean = 30.6 years, SD = 1.9) than non-high performers (Mean = 32.0 years, SD = 2.9), with this difference approaching statistical significance ($t(53) = 1.81$, $p = 0.076$).

5.5. Multivariate Regression Analyses

To identify independent predictors of interpretation accuracy, both linear and logistic regression models were constructed, with results presented in Table 6.

5.5.1. Linear Regression (Continuous Outcome)

The linear regression model explained 27.7% of the variance and revealed that Year Three residents scored approximately 2.1 points higher than Year Two residents ($p = 0.006$), males scored 1.97 points lower than females ($p = 0.034$), and each year increase in age decreased scores by 0.27 points ($p = 0.031$).

5.5.2. Logistic Regression (High Performer Status)

The logistic regression model showed that Year Three residents had 13 times higher odds of being high performers (OR = 13.01, 95% CI [1.48, 114.29], $p = 0.022$). Residents reporting 5-10 CT scans per month had significantly lower odds of high performer status compared to those seeing fewer than 5 scans (OR = 0.10, 95% CI [0.01, 0.84], $p = 0.034$).

Table 6: Combined Multivariate Regression Analyses of Factors Associated with Head CT Interpretation Performance

Predictor Variable	Linear Regression	Logistic Regression (High Performer)
	β (SE)	OR [95% CI]
Residency Year 3	2.077 (0.718) **	13.01 [1.48, 114.29] *

Sex Male	-1.972 (0.897) *	0.18 [0.03, 0.96]
Age (in Years)	-0.271 (0.122) *	0.81 [0.56, 1.17]
CT Frequency (Ref: <5)		
5 to 10	-0.128 (1.768)	0.10 [0.01, 0.84] *
> 10	1.533 (1.663)	(omitted)
Residency CT Class	0.758 (0.693)	3.98 [0.69, 22.96]
Moderately Confident	2.090 (1.155) †	1.20 [0.08, 18.52]
Observations	55	50
R-squared / Pseudo R-squared	0.464	0.263

*Note: † $p < 0.1$, * $p < 0.05$, ** $p < 0.01$; SE = Standard Error; OR = Odds Ratio; CI = Confidence Interval*

5.6. Diagnostic Accuracy by Pathology Type

The analysis of individual CT scan interpretations revealed substantial variation in diagnostic accuracy across different pathological findings (Table 5). Performance ranged from excellent (96.4%) for common hemorrhages to very poor (10.9%) for advanced radiological signs.

Table 7: Diagnostic accuracy by pathology type

Primary Pathology	Accuracy (%)	Performance Category]
Subdural Hemorrhage (SDH)	96.4	Excellent
Epidural Hemorrhage (EDH)	96.4	Excellent
Intracerebral Hemorrhage (ICH)	96.4	Excellent
Cerebral Edema, Herniation	94.5	Excellent
Intraventricular Hemorrhage (IVH)	89.1	Very Good
Skull/Facial Fracture	80.0	Very Good
Pneumocephalus	87.3	Very Good
Infarction	80.0	Very Good
Normal/Unremarkable	81.8	Very Good
Subarachnoid Hemorrhage (SAH)	72.7	Moderate
Hydrocephalus	74.5	Moderate
Cerebral Venous Thrombosis (CVT)	38.2	Poor
Intracranial Mass, Cerebral Edema	23.6	Very Poor

Hemorrhagic Contusion	10.9	Very Poor
Meningeal Enhancement	10.9	Very Poor

5.6.1. Hemorrhage Recognition Patterns

Residents demonstrated excellent recognition of most intracranial hemorrhages:

- SDH Recognition: 96.4% - Only 2 residents missed this; one called it "Pneumocephalus" and one responded "I Don't Know"
- EDH Recognition: 96.4% - Only 2 errors; one "I Don't Know" and one misidentified as "ICH"
- ICH Recognition: 96.4% - Only 2 errors; one "I Don't Know" and one misidentified as "SAH"
- IVH Recognition: 89.1% - Common errors included "Hemorrhagic contusion" (33%), "Infarction" (17%), and "Aortic Dissection" (17%)

However, SAH recognition was notably lower at 72.7%. The 15 residents who missed SAH most commonly:

- Misidentified as "Intracerebral Hemorrhage" (33%)
- Called "Normal/Unremarkable" (27%)
- Identified as "Intracranial mass" (20%)
- Critical Non-Hemorrhagic Findings

5.6.2. Performance varied significantly for other critical findings

- Fracture Recognition: 80.0% - Common errors included "I don't know" (36%) and "Normal" (36%)
- Pneumocephalus: 87.3% - Errors included misidentification as "SDH" (29%) and "Normal" (29%)
- Hydrocephalus: 74.5% - Frequently mistaken for "Infarction" (14%) or called "Normal" (21%)
- Infarction: 80.0% - common errors include "Normal/unremarkable" (45%) or I don't know (18%)

5.6.3. Advanced and Challenging Findings

- Cerebral Venous Thrombosis (CVT): 38.2% - The 34 incorrect responses showed remarkable variability, with 24 different wrong answers, most commonly "Intracerebral Hemorrhage" (15%) and various contusion/edema combinations
- Meningeal Enhancement: 10.9% - Overwhelmingly misidentified as "Normal" (41%) or "Subarachnoid Hemorrhage" (27%)
- Intracranial Mass with Edema: 23.6% - 83% of residents misidentified this as "Infarction," indicating a fundamental confusion between mass effect and ischemic changes

5.6.4. Performance Gaps by Residency Year and pathology type

Year Three residents consistently outperformed Year Two residents across most videos, with statistically significant differences in:

Table 8: Performance Gaps by Residency Year and pathology type

Case Diagnosis	Year 3 Accuracy	Year 2 Accuracy	P-value	Notes/Significance
Hydrocephalus	88.0%	63.3%	0.037	Statistically Significant
Pneumocephalus	96.0%	80.0%	0.076	Approaching Significance
SDH, EDH, ICH with Edema	100%	93%	0.188	Non-significant trend (Year 3 achieved 100% accuracy)
Mass/Edema	32%	17%	0.183	Both groups struggled; Year 3 performed better
Cerebral Venous Thrombosis (CVT)	44%	33%	0.418	Modest improvement for Year 3

The progression from Year 2 to Year 3 shows that experience improves recognition of most findings, but some challenging diagnoses (CVT, meningeal enhancement) remain difficult even for senior residents, indicating the need for structured, repeated training on these specific topics

5.6.4. Most Common Diagnostic Errors

The analysis revealed systematic patterns in misdiagnosis

1. Overcalling Normal: Residents frequently labeled abnormal scans as normal, particularly for SAH (27%), Hydrocephalus (21%), and Infarction (28%)
2. Hemorrhage Confusion: Mixing different hemorrhage types, especially SAH vs ICH
3. Mass vs Infarction: Fundamental confusion between mass effect and ischemic changes (83% error rate)
4. Advanced Sign Blindness: Missing subtle signs like meningeal enhancement (89% error rate)

Table 9: Diagnostic Performance of Emergency and Critical Care Medicine Residents in Head CT Interpretation for Various Pathological Findings (N=825 Observations)

Pathology	ED Findings	True positive	False Positive	False Negative	True Negative	Sensitivity	Specificity	PPV	NPV	Accuracy
SDH	54	53	1	2	769	96.4%	99.9%	98.1%	99.7%	99.6%
EDH	53	53	0	2	770	96.4%	100.0%	100.0%	99.7%	99.8%
SAH	67	40	27	15	743	72.7%	96.5%	59.7%	98.0%	95.0%
ICH	89	53	36	2	734	96.4%	95.3%	59.6%	99.7%	95.4%
IVH	23	21	2	34	768	38.2%	99.7%	91.3%	95.8%	95.6%
Hydrocephalus	47	41	6	14	764	74.5%	99.2%	87.2%	98.2%	97.6%
Fractures	44	44	0	11	770	80.0%	100.0%	100.0%	98.6%	98.7%
Pneumocephalus	57	48	9	7	761	87.3%	98.8%	84.2%	99.1%	98.1%
Infarction	99	44	55	11	715	80.0%	92.9%	44.4%	98.5%	92.0%
CVT	3	2	1	33	789	5.7%	99.9%	66.7%	96.0%	95.9%
Meningeal Enhancement	1	1	0	49	775	2.0%	100.0%	100.0%	94.1%	94.1%
Normal	45	45	0	10	770	81.8%	100.0%	100.0%	98.7%	98.8%

Chapter 6 Discussion

Several studies regarding competency of emergency physician's skill in reading radiological studies have been undertaken; however, most of these studies has been centered upon conventional plain radiography rather than encompassing computed tomography (CT) scans and few of those studies were centered around residents (10,14,20).

6.1. Overall Accuracy

This study is one of the few studies that assess brain CT scan interpretation by emergency medicine and critical care residents. In Ethiopia the only study done in this regard shows lower accuracy (57.6%) in the interpretation of emergency cranial CT scans by emergency and critical care residents when compared to accuracy of emergency residents in developed part of the world (78% to 82.3%) (6,9,10). In this study, shows an accuracy rate of 68.0% (SD = 15.9%), which is higher than the previous study in the country but still lower as compare to the studies from other parts of the world. The higher accuracy rate in our study compared to in Ethiopia may be explained by the fact that the only residents were involved in this study is senior residents (year two and year) unlike the previous one which includes junior residents(year one).

6.2. Sociodemographic Factors

The most important finding of this study is the powerful and consistent association between residency year and interpretation accuracy. Year Three residents scored significantly higher on average and had substantially greater odds of being in high performers. This translates to a clinically meaningful difference, with Year three residents being over six times more likely to achieve the 80% competency threshold. The current finding is inconsistent with a previous Ethiopian study that reported no statistical difference based on the year of residency(10). However, it does align with the educational model of "see one, do one, teach one," highlighting that frequent clinical experience is crucial for building pattern recognition in neuroradiology(21). The results imply that increased clinical experience during residency leads to a more effective practical approach for reading complex images.

A more surprising and odd finding was the significant negative correlation between age and performance. This association persisted even after controlling for residency year, suggesting a cohort effect. Although similar pattern to found at study done in Hong Kong, the age where accuracy start to decline was 65years not 1 years difference in our case(16). This may reflect evolution in medical school curricula, with more recent graduates benefited from integrated radiology teaching or superior digital literacy. Alternatively, it could indicate a selection bias.

The consistent underperformance of male residents compared to their female counterparts, a finding that reached statistical significance in the multivariate models. Similar pattern were also found in the previous study in Ethiopia which statistically significant difference has been demonstrated that females scans interpreted emergency cranial CT scans cases more accurately with OR of 1.03 (95% CI, P: 0.037) (10). Studies have suggested that female physicians may

demonstrate superior communication and adherence to clinical guidelines which could extend to more meticulous and systematic image interpretation(22). This finding warrants further investigation to understand the underlying cognitive or behavioral mechanisms.

Other Variables like school where the residents attending their residency, their level of confidence, the frequency of CT they read per month, whether they took CT reading class in the residency, perception of difficulty of CT reading and also reading books regarding CT scan interpretation were analyzed but there is no statistically significant association found with accuracy on interpretation.

6.3. Specific Pathology Recognition pattern

The near-perfect sensitivity and specificity for significant intracranial hemorrhages like Subdural hematoma (SDH), Epidural (EDH) Hematoma and Intracerebral hemorrhage(ICH), are reassuring and consistent with other studies in Ethiopia and USA, indicating that residents are well-trained to recognize these life-threatening, neurosurgical emergencies(10,15). The high negative predictive values (NPV > 99%) for these and other common hemorrhages mean that when a resident rules them out, clinicians can be highly confident in that assessment. However, significant challenges were identified in several key areas. The moderate sensitivity (72.7%) and poor positive predictive value (PPV 59.7%) for subarachnoid hemorrhage (SAH) are concerning, as SAH is a time-sensitive diagnosis where missed cases can be catastrophic. The high rate of overcalling suggests difficulty in distinguishing true SAH from mimics like calcifications and contrast enhancements.

In a consistent pattern with previous studies, the most profound deficits were observed in the recognition of cerebral venous thrombosis (CVT) and meningeal enhancement, with sensitivities of 5.7% and 2.0%, respectively. These findings are likely due to their rarity and subtle imaging appearances(23).

The interpretation of ischemic stroke represented another major challenge, characterized by both a high false-negative rate (low sensitivity, Sensitivity= 80%) and an exceptionally high false-positive rate (low PPV, PPV=44.4%). The PPV of 44.4% for infarction means that more than half the time a resident diagnosed a stroke they were incorrect. The result from previous study in Ethiopia had even lower sensitivity and PPV (71.4%, 2.74% respectively)(10). Study in Saudi Arabia has slightly lower sensitivity but significantly higher PPV (sensitivity =60.0%, PPV= 81.82) compared to our study(19). This often manifested as a fundamental confusion between mass effect and ischemic change.

Chapter 7 Limitation and Strength

LIMITATIONS

The study was conducted in limited academic center, which may limit the generalizability of the findings. The use of video clips rather than full DICOM datasets on clinical workstations may not fully replicate the real-world interpretation environment. The absence of clinical information during interpretation is a deviation from actual practice, though it helps isolate pure image interpretation skills. Finally, the cross-sectional design identifies associations but cannot prove causation.

STRENGTH

Firstly, the multi-centered nature of the research enhances the generalizability and external validity of the findings. By drawing data and participants from diverse institutional settings, the results are less susceptible to the biases inherent in single-site studies, ensuring that the identified patterns in interpretation competency are representative of a broader spectrum of residency training environments. Secondly, the employed dataset demonstrates high clinical fidelity through the inclusion of the most commonly encountered

Chapter 8 Conclusion and Recommendation

Emergency and critical care residents CT interpretation accuracy is suboptimal. There are variation in CTs interpretation for significant hemorrhages to subtle pathologies. Although around half of the resident took CT interpretation result during the program almost all think it is insufficient. Further formal training and radiology support are necessary to provide better standard of care.

For future research, we strongly recommend implementing a quasi-experimental study design that incorporates targeted training programs. This methodology would require both pre-test and post-test assessments to rigorously evaluate the causal effect of the training intervention on reducing misinterpretation. Furthermore, transitioning the research to a clinical setting is crucial. Conducting the study within a real-world clinical environment will enhance the ecological validity of the findings, allowing researchers to accurately assess the practical significance of misinterpretation and determine the influence of diverse, real-time patient-specific clinical data on the interpretation process.

Chapter 9 Reference

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Chapter 10 Annex: Questioner(10)

Part – I: Personal and Head CT related

1. School of residency.....
2. Age.....
3. Sex: A. Male B. Female
4. Year of residency training program A. PGY1 B. PGY2 C. PGY3
5. Did you had any Cranial CT scan reading class in your under graduate study? A. Yes B. No
6. Did you have any Cranial CT scan reading class in your residency training? A. Yes B. No
7. If “yes” to no 6, do you think the Cranial CT scan class was enough? A. Yes B. No
8. Did you took Cranial CT scan interpretation as part of your residency exam? A. Yes B. No
9. Do you think cranial CT scan reading is difficult? A. Yes B. No
10. How confident you are on interpretation of Cranial CT scan? A. Very confident C. Moderately Confident C. Not confident
11. How frequently Cranial CT scan do you see per month? A. <5 B. 5-10 C. > 10 times D. Not at all
12. Where do you go to get help in difficulty of cranial CT scan readings? (more than one answer possible) A. Radiologist B. Emergency physician C. Emergency senior residents D. my peers. E. References F. other.....
13. How frequently did you ask for help for interpretation of Cranial CT scan? A. Rarely B. Sometimes C. Always D. Not at all
14. Did you use any self-learning methods for Cranial CT scan interpretations other than training and regular class? A. Yes B. No
15. How often do you read books regarding cranial CT scan interpretation? A. Rarely B. Sometimes C. Always D. Not at all

Part II: Head CT scans are confirmed by radiologists of SPHMMC copied in Radiant viewer then all the slices axial view of the scan converted to video form. The participants will describe

what they see and finally write the conclusion of each scan on blank space left just below each CT scan. YouTube link of Video of the head CT scan Attached below in order.

1. Subarachnoid hemorrhage (SAH), Intracerebral hemorrhage(ICH)

<https://youtube.com/shorts/VblWKTrDtc?feature=share>

2. Subdural hemorrhage (SDH)

<https://youtube.com/shorts/R3PbmF5FJDw?feature=share>

3. Epidural Hemorrhage(EDH)

<https://youtube.com/shorts/3IxT68CJ75k>

4. Intraventricular hemorrhage (IVH)

<https://youtube.com/shorts/ZqSUxqsihbo?feature=share>

5. Skull bone fracture, Facial bone fracture

<https://youtube.com/shorts/NLgBuFgIkhI>

6. Pneumocephalus

<https://youtube.com/shorts/sjmo4T3cNi4?feature=share>

7. Intracerebral hemorrhage(ICH)

<https://youtu.be/jQf3JcjDHFU>

8. Intracranial mass

<https://youtube.com/shorts/nC-0obj2N2c?feature=share>

9. Intracerebral hemorrhage (ICH), Cerebral edema, Herniation

<https://youtube.com/shorts/k13aNAoDIFk?feature=share>

10. Hydrocephaly

<https://youtube.com/shorts/ZyB4YIBkaY8?feature=share>

11. Cerebral vein thrombosis(CVT), Intraventricular hemorrhage (IVH)

<https://youtube.com/shorts/T9y0xr9vV6M?feature=share>

12. Hemorrhagic Contusion

<https://youtube.com/shorts/-auIGCAf8as?feature=share>

13. Infarction

<https://youtube.com/shorts/m1mxYEX--L8?feature=share>

14. Meningeal Enhancement

<https://youtube.com/shorts/2EVMoxO10SQ?feature=share>

15. Normal/Unremarkable

<https://youtube.com/shorts/VEyqHccxbC8?feature=share>

Google form link:

<https://docs.google.com/forms/d/e/1FAIpQLSf23AnNUOzku3EPojh7BE6dkDXSDnPSjwPG2tqiLuMfLyw22Q/viewform?usp=header>