

ASSESSMENT OF CT SCAN INTERPRETATION SKILLS AMONG SURGICAL RESIDENTS OF CIVIL HOSPITAL KARACHI IN TRAUMA CASES

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Abstract: Trauma care relies heavily on accurate imaging, particularly CT scans, for effective clinical decision-making. Surgical residents often face challenges in interpreting CT scans, impacting patient outcomes. This study evaluates the CT scan interpretation skills of surgical residents in trauma cases and identifies areas requiring improvement to enhance diagnostic accuracy and clinical efficacy. **Methods:** A cross-sectional study was conducted with 16 surgical residents that were divided into two groups as senior residents (SR- Year 4) and junior residents (JR- Year 3). Participants analyzed CT scans depicting liver, spleen, kidney injuries, and pneumoperitoneum. Their interpretations were compared with expert radiologists' diagnoses. Data was analyzed using SPSS version 21 to assess accuracy, confidence, and misclassification trends. **Results:** Overall diagnostic accuracy was highest for pneumoperitoneum (85%), followed by liver injuries (81.25%), splenic injuries (75%), and renal trauma (68.75%). Senior residents outperformed junior residents, especially in diagnosing complex injuries. Challenges included identifying subtle abnormalities and correlating radiological findings with clinical scenarios. Most residents reported a need for further training in trauma imaging. **Conclusion:** CT scan interpretation skills among surgical residents at Civil Hospital Karachi vary significantly with experience. Enhanced, structured training in trauma-related radiology is recommended to improve diagnostic accuracy and patient outcomes.

Keywords: CT scan Interpretation, Trauma Care, Surgical Residents, Diagnostic Accuracy, Radiology Training, Civil Hospital Karachi

Introduction

Trauma care is critical to emergency medicine, and accurate diagnosis is paramount for ensuring optimal patient outcomes (1). In this context, computed tomography (CT) scans are invaluable, providing detailed anatomical information for effective clinical decision-making (2). Particularly in cases of trauma, timely and accurate interpretation of CT scans can significantly influence patient management and treatment strategies. However, the ability to interpret CT scans accurately is a skill that requires continuous refinement and proficiency, especially among surgical residents who are often at the forefront of trauma care delivery (3).

Civil Hospital Karachi (CHK) is a pivotal healthcare institution in the region, catering to a large and diverse population with a significant burden of trauma cases. As such, the competence of its surgical residents in interpreting CT scans, particularly in the context of trauma, holds substantial clinical significance. Despite the pivotal role played by surgical residents in trauma care, there exists a gap in understanding the extent of their proficiency in interpreting CT scans and the challenges they encounter.

The interpretation of CT scans demands a sound understanding of anatomy and pathology, the ability to correlate imaging findings with clinical presentations, and the formulation of appropriate management plans (4). However, the complexity and variability of trauma cases and time constraints inherent in emergency settings can pose

significant challenges to surgical residents in effectively interpreting CT scans (5). These challenges may range from difficulties in recognizing subtle abnormalities to time pressures and inadequate exposure to diverse trauma cases (6). Addressing these challenges requires a comprehensive understanding of the current CT scan interpretation skills among surgical residents at CHK. Targeted interventions can be developed to enhance their skills and ensure optimal trauma care delivery by assessing their proficiency, identifying areas for improvement, and understanding their barriers. Therefore, this research proposal seeks to investigate the CT scan interpretation skills among surgical residents at CHK, explicitly focusing on trauma cases, aiming to improve patient outcomes and enhance the quality of trauma care provided at the institution. Overall, this research aims to contribute to the enhancement of trauma care delivery by addressing knowledge gaps and refining the training of surgical residents at Civil Hospital Karachi.

While trauma remains a leading cause of mortality worldwide, accurate and prompt diagnosis is essential to improving patient outcomes. Imaging modalities, mainly CT scans, play an integral role in identifying internal injuries in trauma cases. Among abdominal injuries, liver, spleen, and kidney damage, as well as pneumoperitoneum, present significant diagnostic challenges, which, if misinterpreted, could lead to delayed or inappropriate treatment. These injuries demand precise interpretation of CT images to inform critical clinical decisions.

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CT scans offer high-resolution imaging that facilitates the identification of trauma-related injuries in internal organs. Liver injuries, for instance, may range from minor contusions to life-threatening lacerations or ruptures, with the degree of damage significantly influencing the treatment approach. Similarly, splenic injuries often require urgent attention due to the risk of hemorrhage. Renal trauma, although less common, can be life-threatening and necessitates prompt diagnosis and intervention. Additionally, pneumoperitoneum—an abnormal presence of gas within the peritoneal cavity—requires immediate surgical consultation to address potential bowel perforation or other significant abdominal injuries.

Despite their importance, interpreting CT scans in trauma settings is often challenging for surgical residents, given the complexity of the images and the time-sensitive nature of emergency care. This study aims to assess the proficiency of surgical residents at Civil Hospital Karachi in interpreting CT scans for trauma cases, focusing on liver, spleen, and kidney injuries, as well as pneumoperitoneum. The study seeks to enhance diagnostic accuracy and patient outcomes by identifying areas for improvement.

Methodology

The current research has been offered as a cross-sectional study to evaluate surgical residents' diagnostic performance in analyzing CT scan images of abdominal trauma patients. The main focus has been the performance assessment of surgical residents in determining the presence of abdominal injuries from CT scans against interpretations of experienced radiologists considered in the reference group. The study has been conducted to establish the current level of competency and confidence of surgical residents regarding trauma diagnosis and to use it as a reference point to train surgical residents.

The current research has been conducted at Civil Hospital Karachi (CHK), one of the leading and biggest teaching hospitals in Karachi, Pakistan. The CHK surgery department receives many patients, particularly trauma cases, which indicates that the chosen center is appropriate for this study.

This research was carried out over six months per the ethical committee's approval from December 2023 to May 2024. During this period, the data collection process was accomplished, all participants were recruited, and their interpretations were evaluated according to the set time frame. At the beginning of the study, ethical clearance was sought to warrant compliance with the required ethical measures in all undertakings.

The study's sample size has been estimated and determined statistically. A sample size of 16 per group was estimated following a power analysis calculation, assuming the standard alpha level and power. This sample size has given enough data to evaluate surgical residents' diagnostic capabilities and compare them to those of expert radiologists.

In the present study, the subjects were recruited using the non-probability consecutive sampling method. This process included recruiting the surgical residents working at the Surgery Department at the Civil Hospital Karachi. All residents who met the inclusion criteria and who consented to volunteer were used in the study. This sampling method was adopted because it would reduce the possibility of

comparing the interpretations of participants with significantly varying exposure to trauma care and diagnostic challenges.

Participants in the study had to be selected based on some criteria that have been set down as inclusion criteria. For the present study, only those surgical residents participating in the surgical training program at Civil Hospital Karachi have been included who are in year 3 and 4 of their residency? Further, all groups of participants' required valid informed consent to be enrolled in the study. They also had to be present during data collection to ensure that all the data was collected uniformly and before the data collection time elapsed.

Those patients and residents of the study sites who did not meet the inclusion criteria have been removed from the study. This includes people who were not in the surgical resident's program at the time of the study and surgical residents who could not contribute to the study because they were on leave or were not at their workplace during data collection were also deemed ineligible.

Information gathering has been designed to give a clear intention on the kind of information to be retrieved, and the methods of collecting the information facilitate achieving accurate results. First, surgical residents were directly approached through their offices within the hospital, and all surgical residents were invited to participate in the study. After obtaining the participants' informed consent to participate in the study, they were randomly presented with CT scan images of patients who had undergone management of their abdominal trauma at Civil Hospital Karachi. These CT images depicted usual, typical, or even not-so-uncommon pathologies that may be encountered in abdominal trauma cases; thus, it can be said that the cases offered were within the scope of interest of the participants. Every subject was asked to analyze the CT scan images and their findings for specific injuries and diagnostic conclusions. The suspicions made by the surgical residents were then checked against the final diagnoses of the expert radiologists in the hospital's radiology department. This comparative process made it possible to assess the reliability of the residents' interpretations. Descriptive analysis of the collected data was done using the Statistical Package for Social Sciences (SPSS) version 21. The primary objective of data analysis undertaken in this study has been to determine the degree of concordance of surgical residents' ability to interpret CT scans with those of a gold-standard measure, which in this case are radiologists. In the analysis, descriptive statistics were often employed to summarize some relevant data characteristics, like the number of correct and wrong interpretations made by the residents. Detailed analysis was performed to compare the results of the diagnosis made by the residents with the final expert radiological diagnosis, based both on the correct and missed injuries. The study was carried out in compliance with the seven principles of ethical research practices, and approval from the IRB of Dow University of health sciences was sought before the research was implemented. The participants read and signed informed consent, which gave them adequate information and consent to participate in the study. Participants were also told that they could quit the study at any one time, which was very important as it informed the participants that the study was voluntary.

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Results

The subject of this study was 16 surgical residents from the surgical residency program at Civil Hospital, Karachi. Participants were divided into two groups based on their residency year: We surveyed 10 JR (R-3) and 6 SR (R-4). The participants' mean age was 28.5 years (± 3.1), and the age distribution was 25- 32 years. The gender distribution was somewhat skewed male, with 62.5% (10) of participants identifying as male while 37.5% (6) identified as female. Each participant was concurrently working in the Department of General Surgery (16) to ensure adequate interaction with traumatology cases, which was the primary focus of the study.

The participants described the variability in the trauma caseload they encountered due to the nature and type of clinical rotations as well as the role they performed. Half of the respondents (50%, n = 8) confirmed attending to trauma cases daily. Another 31.25% (n = 5) said they treated trauma patients weekly, usually during their shift's scheduled, organized drafts, or on-call. Third, a considerably lesser number of respondents, 18.75% (n = 3), said they handle trauma only once a month because of department rotation or work schedule. No participant claimed to ever come across cases involving trauma, which makes the skill important in their training. The validity of the generic image scoring among the residents was compared with that of expert radiologists in which 81.25% (n = 13) of the participants correctly diagnosed liver trauma presence. We identified contusions as the most often described subtype of liver injuries, with lacerations as the second most often described. That said, regarding more severe injuries comprising the parenchymal disruption (Grade IV) and vascular injury, accuracy was inconsistent. While some senior residents seemed to better differentiate between liver injuries, assigning an accurate grade of injury proved to be a problem for many junior residents, especially if the findings needed to be more transparent on the radiographic films.

The same trends were also noted when evaluating splenic and renal injuries. Overall, appreciable performance was observed in detecting splenic injuries; 75% (n = 12 residents) could correctly identify the injuries on a CT scan. The most significant level of accuracy involved the accurate classification of Subcapsular hematoma and minor lacerations (Grades 1&2). Nevertheless, defining higher-grade injuries such as hilar vessel disruption or complete splenic rupture was difficult. In renal trauma cases, the response accuracy levels attained by the participants as per equation 1 were 68.75% (n = 11) for injury identification. Contusions and lacerations were the most confusing for junior residents as for senior residents, their accuracy was more on the higher side, especially in diagnosing vascular injuries or collecting system injuries. This study revealed that 85% of residents correctly identified findings of pneumoperitoneum on CT scan; however, it was difficult to ascertain the exact cause. A minor difference in

interpretation between senior and junior residents was noted, with an 80% accuracy rate for junior residents and 90% for senior residents.

Respondents were also asked to self-estimate their confidence level while interpreting CT scans in traumatic cases. Self-reported confidence levels were "very confident" by 25% (n = 4) and "somewhat confident" by 43.75% (n = 7). The remaining participants were ambivalent (18.75%, n = 3) or slightly nonconfident (12.5%, n = 2). Some of the problems reported by the participants included the inability to distinguish between minor and significant injuries and the failure to appreciate clinical correlations of radiological appearances. Some proposed that the logical step would be one or two more training sessions on trauma-related imaging. The time it took junior and senior residents to interpret each CT scan was compared. R-4 students needed about 8 minutes per scan, while the R-3 students needed about 12 minutes per scan. This difference was expected due to the effect of experience and confidence when analyzing images.

An examination of misclassification trends showed that I-grade SPLS could be infrequently misidentified as usual by junior residents, mainly involving subcapsular splenic hematomas. Likewise, accidental rupture of low-grade renal contusions (Contusion Grade I) with minor lacerations (Contusion Grade II) was frequently misidentified in 25% of the cases. On the other hand, missed pneumoperitoneum was underdetected in 20% of cases across all levels of residency training as a common

Feedback on the study methodology and personal performance was also obtained, and 87.5% (n = 14) expressed that the study helped them identify areas they could improve. In comparison, 93.75% (n=15) of participants wished to enhance their performance by having more discussions besides participative learning activities like case discussions and practical demonstrations with professionals such as radiologists

Tables 1: Demographics and Training Characteristics

Variable	Frequency (n = 16)	(%)
Gender		
Male	10	62.5
Female	6	37.5
Residency Year		
R-3 (Junior)	10	62.5
R-4 (Senior)	6	37.5

Tables 2: Frequency of Trauma Case Encounters

Frequency of Exposure	Frequency (n = 16)	(%)
Daily	8	50.0
Weekly	5	31.25
Monthly	3	18.75
Rarely/Never	0	0.0

Tables 3: Accuracy in CT scan Interpretation

Type of Injury	Accuracy Rate (%)	Junior Residents (%)	Senior Residents (%)
Liver Injuries	81.25	70.0	95.0
Splenic Injuries	75.0	65.0	90.0
Renal Injuries	68.75	60.0	85.0
Pneumoperitoneum	85.0	80.0	90.0

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Tables 4: Confidence in CT scan Interpretation

Confidence Level	Frequency (n = 16)	Percentage (%)
Very Confident	4	25.0
Somewhat Confident	7	43.75
Neutral	3	18.75
Somewhat Unconfident	2	12.5
Very Unconfident	0	0.0

Tables 5: Summary of Results on CT scan Interpretation Skills, Training Impact, and Participant Feedback

Category	Subcategory/Feedback Topic	Number of Residents	Percentage (%)	Other Metrics
Time Taken for Interpretation	R-3 (Junior Residents)	-	-	Avg. Time: 12.0 min, Range: 10–15 min
	R-4 (Senior Residents)	-	-	Avg. Time: 8.0 min, Range: 6–10 min
Misclassification Trends	Splenic Hematoma (Grade I)	-	15	Common Misclassification: Normal finding
	Renal Contusion (Grade I)	-	25	Common Misclassification: Minor laceration (Grade II)
	Subtle Pneumoperitoneum	-	20	Common Misclassification: Missed diagnosis
Participant Feedback	The study helped identify weak areas	14	87.5	-
	The desire for more interactive training	15	93.75	-

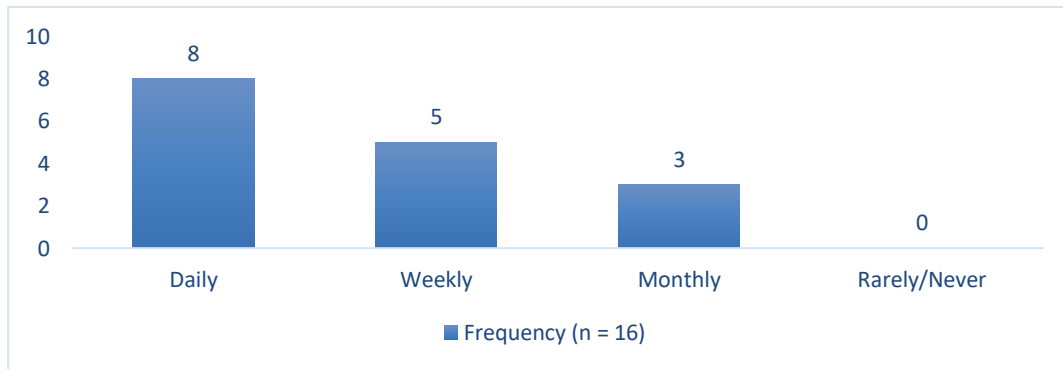


Figure 1 Frequency of Trauma Case Encounters

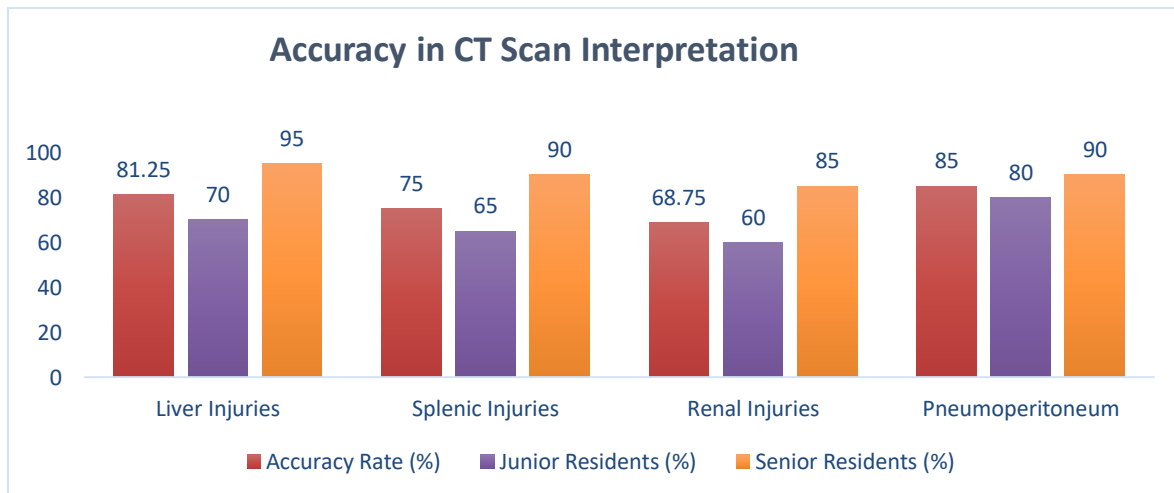


Figure 2: Accuracy in CT scan Interpretation

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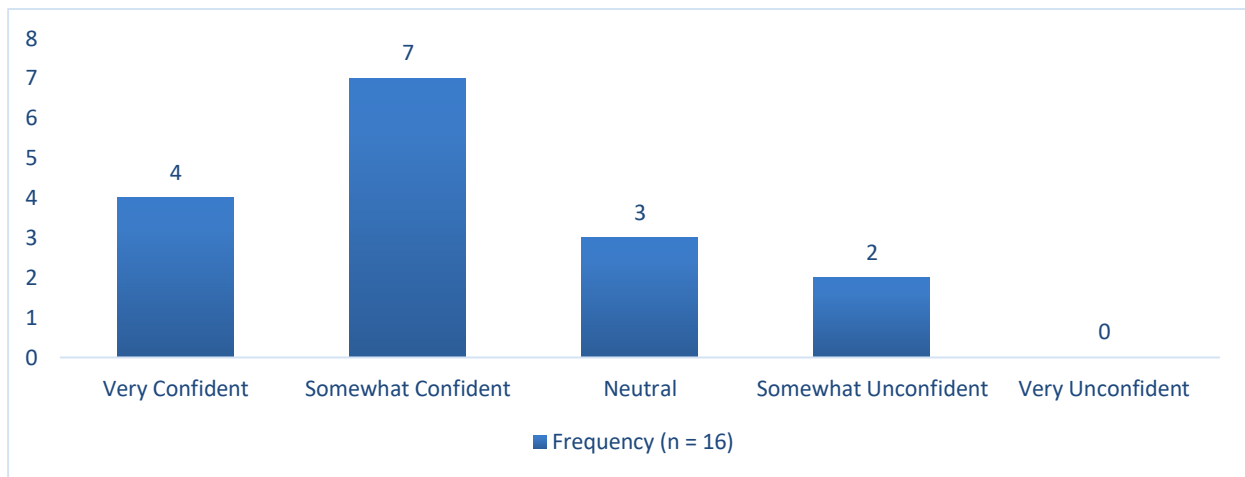


Figure 3 Confidence in CT scan Interpretation

Discussion

This study shows the level of competence among surgical residents in interpreting CT scans in a trauma environment. These results imply that while diagnostic competencies can be learned informally (7). Perhaps through mentorship or clinical preceptorship, the advanced differential diagnosis of traumatic injuries using radiological imaging can only be attained following the formal education or hands-on training that is encased in Fellow of the Royal College (FRC) training.

One of the findings is the difference in diagnostic accuracy between junior and senior residents, with the latter being more accurate in their diagnosis with significant improvements in the diagnosis of complicated intra-abdominal injuries such as liver, spleen, and kidney injuries. This implies that concentrated training and actuating familiarization with traumatic situations throughout residency are required to build interpretative ability (8). It is also evident from the study that the senior residents gave a more accurate grading of injuries and could identify minor findings such as pneumoperitoneum compared to the junior residents. This shows that learning is an ongoing process.

The study also provides insight into the difficulties observed by surgical residents in analyzing computed tomography scans. The challenges attributed to interpretation included transitions between trivial and serious injuries and associating radiological findings with clinical expression. These challenges raise the importance of developing relevant educational solutions that fill the gaps in knowledge concerning image interpretation and the approaches used to integrate radiological findings with clinical practice (The Evidence-Based Radiology Working Group, 2001).

The study also depicted the pattern of usual misdiagnosis as reported; for instance, subcutaneous emphysema was underdiagnosed to have pneumoperitoneum and splenic hematomas mistaken for renal contusions. Such patterns can give insights into specific approaches that need to be taken to enhance students' accuracy of diagnosis and design educational interventions for areas of weakness (9).

The implications of this study for the design and implementation of trauma-focused training programs for surgical residents are discussed (10). Explicitly dedicated

training in formal CT scan image interpretation with models to mimic real-life case scenarios and correct pitfalls usually noted in CT/MRI image interpretation would go a long way towards ensuring that the errors we have demonstrated regarding missed traumatic injuries are reduced (12). In addition, through the participants' feedback drawn on the study's usefulness in revealing areas of work, the need to integrate such an educational activity as a part of the surgical residency training curriculum is strongly emphasized. Promoting learning organizations and self-reflectiveness enables residents to participate in their personal and professional growth and seek excellent practice in trauma care (11).

However, there are several limitations in the study that will have to be taken into account when interpreting the results. First, the study sample included only 16 surgical residents, which reduces its generalisability to other workflow environments or other populations. Moreover, it is also a limitation that all the procedures of this study were performed in Civil Hospital Karachi and did not include the other hospitals and regions where the different levels of proficiency among the residents could be observed. Limitations of the study are that the study was based on certain injuries like liver, spleen, kidney, and pneumoperitoneum, which may have excluded other important trauma findings that the residents meet in practice. Furthermore, differences in diagnostic skills between junior and senior residents tend not to capture the learning curve or prior experiences dealing with a similar trauma case. However, the self-estimated confidence levels potentially do not correspond to the real capabilities of the residents in emergency situations. Moreover, while the study established time-sensitive scenarios, it did not accurately capture the pressure that goes with real trauma care situations. Finally, a few modifications with regard to the feedback of the participants were made, but the effect of the post-intervention diagnostic accuracy-enhancing specific trainings was not examined. Organisation of such studies in the future with these limitations could give a clearer picture of CT scan interpretation skills and training requirements of surgical residents.

Conclusion

In conclusion, this study emphasizes the importance of practical courses and training for improving the competencies of surgical residents in CT scan interpretation for traumatic situations. Healthcare institutions should address the challenges discussed here and the knowledge gained from this study to enhance trainees' preparedness in managing traumas that lead to adverse patient effects.

Declarations

Data Availability statement

All data generated or analyzed during the study are included in the manuscript.

Ethics approval and consent to participate

Approved by the department Concerned. (IRBEC-CHMK-09912/23)

Consent for publication

Approved

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Conflict of interest

The authors declared absence of conflict of interest.

Author Contribution

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Coordination of collaborative efforts.

Study Design, Review of Literature.

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Conception of Study, Development of Research Methodology Design, Study Design, Review of manuscript, final approval of manuscript.

Conception of Study, Final approval of manuscript.

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Data entry and Data analysis, drafting article.

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Coordination of collaborative efforts.

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