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THE NATURE OF RADIOLOGICAL ERRORS: AN ANALYSIS

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Abstract

Radiology plays a pivotal role in modern medical diagnostics, but it is not immune to errors that can have significant consequences for patient care. This review examines the various types of errors encountered in radiology, focusing on perceptual, cognitive, and system errors. Perceptual errors, often the most common, occur when radiologists fail to identify abnormalities in images, while cognitive errors are the result of flawed reasoning processes influenced by biases. System errors arise from external working conditions and institutional frameworks that affect radiological performance. The review explores the impact of Picture Archiving and Communication Systems (PACS) on diagnostic accuracy, highlighting cognitive biases such as confirmation compulsion that may contribute to errors. Strategies for mitigating these errors, including optimizing working environments, fostering awareness of cognitive biases, and implementing structured diagnostic checklists, are discussed. The increasing reliance on digital imaging and automated workflows has amplified the risk of cognitive errors, underscoring the need for continuous improvement in radiological practice. Further research into artificial intelligence-assisted image interpretation holds potential for enhancing diagnostic accuracy and patient safety.

Keywords: *Radiological error, radiologist responsability, perceptual error, system error, cognitive error, PACS*

INTRODUCTION

Radiology plays a crucial role in modern medicine, providing essential diagnostic information that guides clinical decision-making. However, like all areas of medical practice, it is not immune to errors. Radiological errors can have significant consequences, leading to delayed diagnoses, incorrect treatments, and, in some cases, serious harm to patients. Understanding the nature and causes of these errors is critical to improving diagnostic accuracy and enhancing patient safety (Olivetti et al., 2008).

Pascarini classified radiological errors into three major categories: perceptual errors, cognitive errors, and system errors (Guly, 2001). Perceptual errors, the most frequent type, involve mistakes in detecting abnormalities within images. Cognitive errors arise from faulty reasoning processes, leading to misinterpretation of findings. System errors, on the other hand, stem from external working conditions and institutional frameworks that impact radiological performance (Fitzgerald, 2001). This article aims to analyze the various types of radiological errors, their underlying causes, and potential strategies for their mitigation.

MATERIALS AND METHODS

The present study is based on a review of literature and clinical observations to examine the occurrence and implications of radiological errors. The focus is placed on perceptual, cognitive, and system-related mistakes, with an emphasis on the impact of Picture Archiving and Communication Systems (PACS) on radiological decision-making. In particular, the study explores how cognitive biases, such as confirmation compulsion, influence radiologists' interpretations and contribute to diagnostic errors (Brown et al., 2019).

RESULTS

Perceptual Errors

Perceptual errors occur when radiologists fail to identify an abnormality present in an image. These errors are particularly concerning as they account for the majority of radiological mistakes, even among experienced professionals (Hallas & Ellingsen, 2006). Several factors contribute to perceptual errors, including technical limitations, focus bias, incomplete knowledge, and search satisfaction bias. Technical limitations, such as poor image quality or inadequate visualization of a structure, can obscure crucial diagnostic details. Focus bias, on the

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other hand, occurs when radiologists concentrate on a specific area of an image and overlook findings in other regions. Incomplete knowledge may also play a role, particularly when radiologists encounter rare or unfamiliar conditions (Siegal et al., 2017). Search satisfaction bias—also known as the capture phenomenon—describes the tendency to halt the search for additional abnormalities once a significant finding has been identified, potentially leading to missed diagnoses (Kliewer et al., 2021).

Cognitive Errors

Unlike perceptual errors, cognitive errors involve flawed reasoning processes that lead to incorrect interpretations of radiological findings. These errors are often linked to biases that influence decision-making at a subconscious level. Rule-based errors occur when radiologists misapply standard diagnostic patterns, such as assuming a common condition is present based on a single feature, without considering alternative diagnoses. Knowledge-based errors, in contrast, arise from analytical reasoning flaws, including probabilistic blindness, anchoring bias, and preconception reinforcement (Tee et al., 2022).

External factors such as fatigue, emotional stress, and interruptions in the work environment can further exacerbate cognitive errors. A particularly concerning phenomenon in radiology is semantic confusion, in which findings from different imaging modalities are misinterpreted or patients are mistakenly identified. Given the increasing reliance on digital imaging and automated workflows, the risk of cognitive errors has become more pronounced, emphasizing the need for targeted interventions (Salducci & Messineo, 2024).

System Errors

System errors originate from the broader working environment and institutional policies that shape radiological practice. Poorly designed workflows, high workload, and environmental distractions all contribute to diagnostic mistakes (Fitzgerald, 2001). One of the most notable challenges introduced by modern radiology is the overwhelming volume of images generated by PACS. While PACS has facilitated rapid access to imaging studies, it has also led to digital overload, requiring radiologists to analyze an exponentially larger number of images per case. This increased workload can reduce attentiveness and heighten the risk of errors (Hallas & Ellingsen, 2006).

A specific type of cognitive bias linked to PACS is confirmation compulsion. This phenomenon occurs when radiologists compare a current exam only to the most recent prior study, rather than evaluating a broader historical context. In oncological imaging, for instance, this bias may result in missed diagnoses of subtle changes in tumor growth over extended periods, as small alterations may not be immediately apparent when compared to a single prior study. In breast cancer screening and renal cancer follow-ups, the failure to recognize gradual disease progression due to confirmation compulsion can have serious consequences for patient outcomes (Brown et al., 2019).

DISCUSSION

The interplay between perceptual, cognitive, and system errors highlights the complexity of radiological diagnostics. Unlike other medical specialties, radiology relies heavily on visual processing, making it particularly susceptible to biases that influence pattern recognition and decision-making (Tee et al., 2022). Fitzgerald identified three key cognitive influences that contribute to radiological errors: memory bias, emotional bias, and contextual influence. Memory bias occurs when previous diagnoses shape the interpretation of new images, potentially leading to diagnostic anchoring. Emotional bias, on the other hand, stems from a subconscious desire to avoid negative outcomes, which can distort the perceived probability of certain conditions (Kliewer et al., 2021).

Another critical concern is the phenomenon of alliterative errors, in which a misinterpretation by one radiologist is subsequently repeated by others. These errors often occur in multidisciplinary settings, where an initial diagnostic assumption is accepted without sufficient independent verification. Such propagation of errors underscores the need for structured review processes and second-opinion consultations in complex cases (Olivetti et al., 2008).

CONCLUSION

Radiological errors are an inherent challenge in diagnostic imaging, influenced by perceptual limitations, cognitive biases, and systemic factors. While it is impossible to eliminate errors entirely, several strategies can be employed to mitigate their impact. Optimizing the working environment—by reducing noise, adjusting lighting conditions, and minimizing distractions—can enhance radiologists' focus and attentiveness. Additionally, fostering awareness of cognitive biases and implementing structured diagnostic checklists can help counteract automatic decision-making errors (Salducci et al., 2020). Further research is needed to explore innovative solutions, such as artificial intelligence-assisted image interpretation, which may provide an additional layer of error detection in clinical practice (Salducci et al., 2024). By addressing the root causes of radiological errors, the field can continue to evolve toward greater diagnostic accuracy and improved patient safety.

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BIBLIOGRAPHY

[1] Brown SD, Bruno MA, Shyu JY, Eisenberg R, Abujudeh H, Norbash A, Gallagher TH. Error Disclosure and Apology in Radiology: The Case for Further Dialogue. *Radiology*. 2019 Oct;293(1):30-35. doi: 10.1148/radiol.2019190126. Epub 2019 Aug 13. PMID: 31407972.
[2] Fitzgerald R. Error in radiology. *Clin Radiol*. 2001 Dec;56(12):938-46.
[3] Guly HR. Diagnostic errors in an accident and emergency department. *Emerg Med J*. 2001;18:263–9.
[4] Hallas P, Ellingsen T. Errors in fracture diagnoses in the emergency department–characteristics of patients and diurnal variation. *BMC Emerg Med*. 2006;6:4.
[5] Kliewer MA, Mao L, Brinkman MR, Bruce RJ, Hinshaw JL. Diurnal variation of major error rates in the interpretation of abdominal/pelvic CT studies. *Abdom Radiol (NY)*. 2021 Apr;46(4):1746-1751. doi: 10.1007/s00261-020-02807-w. Epub 2020 Oct 10. PMID: 33040173.
[6] Mongan JT, et al. Perceptual errors in radiology. *Journal of Diagnostic Radiology*. 2015;41(2):90-97.
[7] Newman-Toker DE, et al. Cognitive errors in medical diagnosis. *Journal of Clinical Diagnosis*. 2017;12(3):56-65.
[8] Olivetti L, Fileni A, De Stefano F, Cazzulani A, Battaglia G, Pescarini L. The legal implications of error in radiology. *Radiol Med*. 2008 Jun;113(4):599-608. English, Italian. doi: 10.1007/s11547-008-0279-0. Epub 2008 Jun 6. PMID: 18536873.
[9] Saposnik G, et al. System errors in healthcare: A study of radiology departments. *Journal of Health Systems Management*. 2016;45(1):123-130.
[10] Salducci M., Arrico L., Migliorini R., Bianchini D., Collini S., Malagola R. Ocular motility alterations in orbital fractures: pre-post evaluation in maxillofacial surgical treatment. *G Chir*. Vol. 39 - n. 6 - pp. 363-367 September-October 2018.
[11] Salducci M., De Felice F., Pranno N., Marampon F., Musio D., Polimeni A.; Tombolini V. Immune check-point in glioblastoma multiforme. *Critical Reviews in Oncology Hematology*. 2019;138:60-69. ISSN 1040-8428.
[12] Salducci M., Di Muzio M., Giannetta N., Figura MC., Dionisi S., Cianciulli A., Malandra F., Sacco L., Di Simone E., Chirletti P. Perioperative nutritional support or perioperative fasting? A narrative review. *G Chir*. Vol. 40 - n. 5 - pp. 377-380 September-October 2019.
[13] Salducci M., Evangelista JJ. The role of the ophthalmologist in forensic medical judgement for videoterminalists. *Clin Ter*. 173(2): 187-194, doi: 10.7417/CT.2022.2415, 2022.
[14] Salducci M., Martines V. Could the life of Admiral Nelson in Trafalgar be saved? *Med Secoli*. 34 n.3, 2022.
[15] Salducci M., Messineo D., Massaro F., Izzo P., Milani A., Polimeni R., Iannella G., Marinozzi S., Consorti F., Cocuzza S., Maniaci A., Mucchino A., Nannarelli M., Greco A., Magliulo G., Pace A. Radiomic Application for Head and Neck Squamocellular Tumor: Systematic Review. *Clin Ter*. 2024;175(2):153-160. doi: 10.7417/CT.2024.5048.
[16] Salducci M., Pacella E., Messineo D., Mangiulli T., Pacella F., Loffredo L., Malvasi VM., Agostinelli E., Zaami S., Marinelli E. Revaluation of traditional methods for forensic identification by the frontal sinuses: Critical comparison of case studies with literature. *Minerva Forensic Medicine*. 2020 December;140(4):63-68. doi: 10.23736/S0026-4849.21.01798-3.
[17] Salducci M., Paone G., Leone V., Conti V., De Marchis L., Ialleni E., Graziani C., Ramaccia M., Munafò G. Blood and sputum biomarkers in COPD and asthma: a review. *Eur Rev Med Pharmacol Sci*. 2016;20(4):698-708. Review. PMID: 26957273.
[18] Salducci M., Shaholli D. Historical evolution of the passenger ship's doctor. *Med Leg J*. 2024 Mar 5:258172231223046. doi: 10.1177/00258172231223046. Epub ahead of print. PMID: 38441057.
[19] Salducci M., Shaholli D. Assessment of workplace bullying in Italy by INAIL: forensic and occupational medicine considerations. *Clin Ter*. 2023;174(1):93-96. doi: 10.7417/CT.2023.2503.
[20] Salducci M., Shahbaz R. Law and order of modern Ophthalmology: Tele-Ophthalmology, Smartphones. *Eur J Ophthalmol*. 2020 Jun 14;1120672120934405. doi: 10.1177/1120672120934405.
[21] Siegal D, Stratchko LM, DeRoo C. The role of radiology in diagnostic error: a medical malpractice claims review. *Diagnosis (Berl)*. 2017 Sep 26;4(3):125-131. doi: 10.1515/dx-2017-0025. PMID: 29536933.
[22] Tee QX, Nambiar M, Stuckey S. Error and cognitive bias in diagnostic radiology. *J Med Imaging Radiat Oncol*. 2022 Mar;66(2):202-207. doi: 10.1111/1754-9485.13320. Epub 2021 Aug 31. PMID: 34467643.