Errors in Imaging

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Introduction

When examining errors in imaging interpretation, it is important to distinguish between genuine errors and observer variation.[1] For most purposes, an error is defined as any discrepancy in interpretation that differs substantially from peer consensus [2] with the term "discrepancy" being more appropriate than "error" in many contexts.[3] However, determining such discrepancies presents challenges. Peer consensus reached retrospectively may be biased by clinical and other information available at the time of the second interpretation which was not available at the original interpretation. Further, studies have demonstrated considerable variability in pathologists' final diagnoses from surgical specimens and at autopsy,[4] therefore determining the standard against which an interpretation is judged can be challenging.

Discrepancies

Image interpretation, like every human endeavour is prone to variation. A meta-analysis of reported discrepancy rates in human radiology found an overall discrepancy rate of 32.2%.[5] In a study of second readings, experienced abdominal radiologists disagreed with their own previous interpretations 25% of the time.[6] The reason for many of the variations or discrepancies is that radiologists practice in an environment of extraordinarily high uncertainty. The existence of inter- and intra-observer variation does not itself indicate an interpretive error; rather it illustrates the degree to which high levels of uncertainty and inherent variability in the process limits the conclusions of imaging tests.[4]

In imaging, there is a broad range of normal that usually overlaps with the even broader range of abnormal.[4] Image interpretation is rarely binary process (normal or abnormal) given that few disease states present with truly pathognomonic imaging features.[4, 7] Conversely, many distinct disease states can appear nearly identical or share common imaging characteristics further complicating accurate diagnosis.[4]

To make a correct diagnosis a radiologist must use visual detection, pattern recognition, working memory and cognitive reasoning to result in a final interpretation.[2] The dual process theory describes two distinct cognitive pathways for problem solving.[8] In the dual process theory the intuitive approach, known as Type 1 or fast thinking, can be characterised as a form of pattern recognition leading to an automatic and immediate diagnosis using heuristics (mental shortcuts).[8] The deliberate approach, known as Type 2 or slow thinking, occurs when an abnormal pattern or finding is identified, but not immediately recognised, requiring deliberate reasoning and problem solving. There is a tendency to default to a state that there consumes fewer cognitive resources, ie Type 1 or fast thinking.[8] Type 1 thinking is prone to error caused by various inherent cognitive biases which can lead to both perceptual and interpretive errors.[8] As radiologists we commonly rely on Type 1 thinking, especially when overworked and fatigued.

Types of Discrepancies

Discrepancies, or errors, can be categorised in multiple ways. Two broad categories have been identified: perceptual and cognitive (interpretive) errors.[2, 9] Perceptual errors are the most common accounting for 60-80% of radiologists errors.[2] Perceptual errors occur during the initial detection phase of image interpretation. A perceptual error is deemed to have occurred when an abnormality is retrospectively determined to have been present on a diagnostic image but was not seen by the interpreting radiologists at the time of primary interpretation.[2] The underlying cause of this error remains poorly understood.[2] Eye tracking software has shown that a radiologist's vision may dwell on, or frequently return, to the areas of an image that contain an abnormality that is ultimately missed.[10] Specific risks factors for errors of perception have been identified. They include poor conspicuity of the target lesion on the image, reader fatigue, an overly rapid pace of performing interpretations, distractions (emails, text messages) and interruptions (phone calls, other clinicians).[2]

Cognitive errors occur when an abnormality is identified on an image but its importance is incorrectly understood, resulting in an incorrect final diagnosis. This type of error may be secondary to a lack of knowledge, a cognitive bias, misleading clinical information or propagation of an error from a previous report (alliterative error).[2]

Errors can also be categorised as arising from the radiologist or the system.

Radiologist specific errors include:

- Errors of perception
    - Search error (the most common- the abnormality is not seen)
    - Recognition error (the abnormality is seen but not recognised)
- Errors of cognition
    - Lack of knowledge
    - Faulty information gathering (esp ultrasound)
    - Cognitive biases (*see below)
    - Faulty information processing
        - Under call (false negative)
        - Over call (false positive)
    - Failure to realise the limitations of a technique

System Errors include:

- Poor examination technique
- Inadequate training
- Excessive workload
- Poor communication
- Inadequacy of clinical information
- Inadequate equipment
- Unavailability of previous examinations

Other:

- Complications
- Multifactorial Errors
    - More than one type of error present

**Cognitive Biases*[11]:

- Anchoring bias: failing to adjust an initial impression despite receiving additional information
- Confirmation bias: searching for data to reaffirm an existing hypothesis
- Availability bias: judging the probability of an event by the ease with which it comes to mind
- Satisfaction of report: perpetuating an impression from a prior report
- Framing bias: drawing different conclusions from the same information depending on how the information is presented
- Attribution bias: attributing findings to patient characteristics and stereotypes
- Satisfaction of search: decreasing vigilance and or awareness of additional abnormalities after identifying the first abnormality
- Premature closure: accepting a preliminary diagnosis as final
- Inattentional bias: missing findings hiding in plain sight due to unexpected location or nature
- Hindsight bias: retrospectively de-emphasising the difficulty in making the initial diagnosis

  - In human radiology, the four biases that are most common are satisfaction of search, anchoring, confirmation and availability bias.

Strategies for Error Reduction

When evaluating errors it is important to remove any punitive element from the process of error analysis and instil a blameless culture.[2] One of the ways radiologists can reduce error is by a mindful systematic approach to the search of diagnostic images.[2] The use of checklists and semi structured or structured reporting has also been shown to reduce errors.[2] Fatigue plays an important role in errors in imaging and thus must be managed in the workplace. It has been shown that toward the end of a work day radiologists have reduced ability to focus, increased symptoms of fatigue and oculomotor strain and decreased ability to detect abnormalities.[9] Distractions and interruptions have also been shown to increase the error rate so an effort must be made to reduce interruptions and distractions[8 2]

Root Cause Analysis and Just Culture

If errors are identified it is recommended that a "root cause analysis" approach be used.[8] This involves asking:

- What happened?
- Why did it happen?
- What can be done to prevent it happening again?

A root cause analysis approach to mitigation of errors requires good leadership, effective peer learning practices and a culture of quality.[8] Part of the culture of a work place that facilitates a healthy root cause analysis approach is the "just culture" organisational framework. If an error does occur, finding a balance between the extremes of punishment and blamelessness is the goal of developing a just culture.[12] A just culture considers wider systemic issues where things go wrong, enabling professionals and those operating within the system to lean without fear of retribution.[12] The just culture approach is based on the principle of determining "what went wrong" rather than "who made the mistake?" and

Conclusion

Error is an inevitable aspect of image interpretation. The understanding of the causes of errors leads to ways to minimise their occurrence. A supportive peer learning workplace with a just culture is essential for error reduction.

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