CANADA WEST
VETERINARY SPECIALISTS

The unwritten rules of radiology – errors in radiology, what are they, how to recognise and avoid them

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Introduction

Interpreting diagnostic images from any modality is a complex process. The radiologist employs a combination of knowledge, skill and experience to assess images and reach a conclusion. As with all human endeavours, the results are not perfect. Errors are inevitable. Reviews of radiologists' performance report errors may occur in up to 30-40% of interpretations. In many cases errors are trivial and do not have significant impact on diagnosis or treatment, however some are serious. Radiological reports are influenced by many factors and not simply an exercise in lesion detection. A simple binary choice of "normal" or "abnormal" is seldom applicable. The quality and completeness of clinical information has significant effect upon reporting. Rates of lesion detection are usually improved by pertinent clinical data and assessment of the significance of a finding may also be changed by clinical context.

Considerable effort has been devoted to the study of errors and identifying causes. Through a better understanding of the causes of errors we can seek to reduce the occurrence. However, we should also recognise that perfection is not achievable and it is important to avoid a "culture of blame". There is ample legal precedent that radiologists cannot be expected to diagnose every lesion correctly. Strictly speaking, an error only occurs if there can be no dispute about the "correct" interpretation of a study and this interpretation must reflect only the data available at the time of original assessment. It is seldom that this applies and it may be more productive to think of errors as discrepancies, where the original opinion varies from that of a group of experts. Hindsight bias, the tendency to assess images with additional clinical data or knowledge of the final outcome must be avoided in assessing any potential errors

Image interpretation

How radiologists evaluate images has been studied extensively for over half a century. The process of lesion detection can be divided into three phases: fixation, recognition and diagnosis. As the eye scans an image, a vast amount of information is presented to the brain. Fixation occurs when the eye focuses on a portion of the image. Factors

that influence how this data is perceived by the brain include lighting conditions, image sharpness and contrast. Many optical illusions are based on the tendency of the brain to distort data presented to it by the eyes. Once an image has been presented to the brain the second phase, lesion recognition, depends upon a process of comparing this image with the expected normal appearance. Both fixation and recognition are the significantly dependent upon the knowledge and experience of the observer, in effect the quality and quantity of stored normal images in the brain. If the brain recognizes a lesion, the third phase is interpretation. In this phase, the brain determines whether a finding represents a true lesion and what, if any, significance to ascribe to it. The interpretation phase may be affected by factors such as clinical suspicions or prejudices and observer experience.

All three phases of the process can result in errors. The visual search pattern of radiologists has been studied to classify false negative type errors based on a failure at any one stage in the process.

- Search error – the lesion is not fixated or examined in detail.
- Recognition error – the lesion is fixated but for insufficient time to allow the observer to recognise it as a lesion.
- Decision error – the lesion is examined at length but not consciously recognised by the radiologist or dismissed as insignificant.

Error classification

The description of perceptual errors above categorises errors in the visual search phase but that does not address the entire process of image interpretation. There are several schemes for the classification of errors in diagnostic imaging and these have many similarities. Most classify errors according to the contributing factors and effect on the interpretation of images. The following is a combination of several published schemes.

Failure to realise limitations of technique

This is probably a common source of error in veterinary imaging. Errors arise from incomplete studies or non-diagnostic quality studies. We can also include in this category the use of inappropriate imaging tests or modalities. Some widely employed imaging tests are relatively insensitive, such as ultrasound in the detection of hepatic parenchymal disease, and this is frequently not fully appreciated by clinicians and radiologists. In veterinary imaging, we have very limited data on the sensitivity and specificity of modalities and techniques for many diseases.

Lack of knowledge

Limited knowledge may result in failure to recognise a lesion as such or incorrect diagnosis. This may be the result of lack of experience. Errors of this type occur with "exotic" lesions which are not known to the observer. This is a particular problem for radiologists providing remote interpretation as they are often not familiar with the geographic range of diseases nor typical imaging findings such as Dirofilaria immitis, Coccidiodes immitis or Spirocerca lupi infections. The global mobility of some of our clients and their pets contributes to the problem. The emergence of new diseases such as canine parvo virus infection in the 1970s creates problems for everyone as it takes time for knowledge to propagate through the community. In veterinary medicine this type of error can also occur with a "new" imaging modality such as with a novice ultrasonographer encountering a lesion for the first time.

Failure to detect

This type of error is relatively common and frequently difficult to explain. The reviewer fails to detect a lesion. Contributing factors may include lack of conspicuity of a lesion. However, in many cases the lesion is relatively clear and the failure to detect it is difficult to explain. A common form of this class of error in veterinary imaging is the observer failing to detect the absence of a normal structure. Disease is expected to produce lesions which one must find, recognise and assess, when the effect of the pathology is to remove something rather than create something new, it is all too easy to overlook. Factors such as distraction, fatigue and bias likely contribute to these errors. The increasing volume and complexity of CT and MRI studies will probably increase the occurrence of this type of error.

Under-reading/Under-call

To some extent, every image interpretation is a balance between under-reading and over-reading, depending upon many factors not least of which is the perceived consequence of an error. There are several types of under-reading error.

- A lesion is dismissed as a normal variant.
- A lesion is dismissed as an artifact.
- A lesion is not ascribed appropriate significance or attributed to an incorrect aetiology (also referred to as "faulty reasoning").
- "Satisfaction of search" occurs when the observer detects one or several lesions and fails to detect additional lesions.

- The non-discriminating use of rules or numerical formulae to classify patients as normal or diseased. For many such rules, the data to support their use is limited and sometimes the sensitivity and specificity are over stated. Such rules should be used with considerable caution and considered in the context of all available data.

These errors are frequently propagated when a patient has serial imaging studies. If a lesion is overlooked on the first study and later studies are evaluated for progression or resolution of the abnormalities seen on the first study, the abnormalities are repeatedly missed.

Over-reading/Over-call

Similar to the previous category, this type of error is relatively common as diagnoses are seldom as simple as “normal” or “abnormal”

- An anatomic variant or artifact is assumed to represent a lesion.
- A real abnormality is incorrectly defined as the cause of the presenting signs. Such lesions are sometimes referred to as “incidentalomas” and are a common problem with the “screening” imaging tests.
- Previous/quiescent disease is determined to be the cause of the presenting signs.
- Over-diagnosis of endemic disease because “it’s everywhere”.
- “Recency” describes the tendency to diagnose disease because one has seen several examples in a short period of time. This may become a self perpetuating phenomenon.
- Bias is a significant contributing factor to over-reading where historical or clinical data and experience influence interpretation.
- The non-discriminating use of rules or numerical formulae just as with under-reading can erroneously classify patients as diseased.

Faulty reasoning/incorrect diagnosis

When one evaluates images, clinical data are used to reach a conclusion. Errors in evaluating a lesion can occur because one has been supplied with erroneous, incomplete or even misleading information. Even with accurate, good quality clinical data mistakes can be made. Errors can occur when using only the data which supports the preferred hypothesis. A previous diagnosis may be erroneously assumed to be the cause of current clinical signs, while a new diagnosis is overlooked. In some ways this category overlaps with both under-reading and over-reading, particularly when rules and formulae are used for diagnosis. Lost or misplaced previous studies can contribute to these errors.

Poor communication

Errors of this nature occur in reports prepared by radiologists for other specialists or general practitioners. Terms such as 'consistent with', 'most likely', 'possible', 'probable', 'suspect' etc. have quite different meanings and convey quite different levels of confidence for different individuals. Incorrect or vague anatomical descriptions are a common source of error and confusion. Such errors also occur in medical records in general practice. Legibility of records, completeness and use of non-standard abbreviations can all contribute to confusion. Reports can incorporate errors such as incorrect counts (especially ribs or vertebrae) or identify incorrect body parts (transposing right and left or front and hind limb bones).

Complications

These are errors which occur during interventional procedures. Probably the most commonly encountered is haemorrhage from fine needle aspiration or biopsy. As interventional therapeutic techniques become more common so too will associated complications.

Mitigation of errors

Realising that some errors are inevitable is perhaps the most important step. The norm in aviation safety is a "no fault" reporting system, where all errors are reported to the competent authority so that patterns or systemic problems can be recognised and corrected. Such a system has been adopted by some medical authorities as the best practice to address the consequences of an error and limit the chances of recurrence. If errors are identified a technique termed Root Cause Analysis can be used.

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

Within a group of radiologists, such as a specialty practice, university or telemedicine group, there are a number of actions which can be employed to limit errors and improve performance.

- Establish requirements for information to be included in imaging requests.
- Ensure adequate training and staffing. Both professional and technical staff should have frequent access to in house training and formal continuing education. Most specialist groups now require active maintenance of competence.

- Limit workload to avoid fatigue.
- Use of imaging protocols. Consistency in technique should improve quality of interpretation.
- Use of communication protocols. These should be directed to avoiding jargon and non standard abbreviations and establishing procedures for communicating urgent or unexpected imaging findings.
- Double reading. While this may be difficult to institute, even when used on a limited basis it significantly reduces errors. It may also lead to improved communication between radiologists and is effectively a form of continuing education
- Auditing of reports. This can be done by oneself or by peers in a randomised or anonymised manner.
- Multidisciplinary case conferences. These can be an excellent tool to obtain follow up data for cases.

Conclusion

Error is an inevitable product of image interpretation. While we have to accept this we can mitigate errors by admitting them when they occur, attempting to understand their causes and working to improve our performance.

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