National Academy of Sciences
Committee On Diagnostic Error in Health Care

ERRORS IN RADIOLOGY

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Leonard Berlin, MD, FACR
Department of Radiology
Skokie Hospital, Skokie, IL

Professor of Radiology
Rush University Medical College
and
University of Illinois
Chicago, IL
Radiologic Errors

- “Human factor” (Garland, 1949; Tuddenham, 1962)
- “Foibles” of human perception (Renfrew, 1992)
- “Nature of the diagnostic method” (Potchen and Bisesi, 1990)
- ‘Irreducible necessary fallibility emanating from uncertainties inherent in medical predictions based on human observations and the laws of natural science” (Anderson, 1989)
- Inherent in all human activity” (Leap, 1994)
Clinical vs. Radiologic Errors

Many errors that go unnoticed in clinical medicine are readily identified in radiology because images are preserved forever, and can be reviewed after the fact.
Hindsight Bias

The tendency for people with knowledge of the actual outcome of any event to believe falsely that they would have predicted the outcome.
<table>
<thead>
<tr>
<th>Institution</th>
<th>Year</th>
<th>Percentage</th>
</tr>
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<tbody>
<tr>
<td>University of Southern California</td>
<td>1960</td>
<td>48%</td>
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<tr>
<td>Harvard</td>
<td>1975</td>
<td>70%</td>
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<tr>
<td>University of California, San Diego</td>
<td>1981</td>
<td>40%</td>
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<tr>
<td>Mayo Clinic</td>
<td>1983</td>
<td>90%</td>
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<tr>
<td>Sloan Kettering</td>
<td>1984</td>
<td>65%</td>
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<tr>
<td>Columbia Presbyterian</td>
<td>1992</td>
<td>73%</td>
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Are these “true” errors?
Major Discrepancy Rates Among Radiologists’ Interpretations of Abdominal and Pelvic CTs

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<tbody>
<tr>
<td>Interobserver</td>
<td>26%</td>
</tr>
<tr>
<td>Intraobserver</td>
<td>32%</td>
</tr>
</tbody>
</table>

MGH, Eur Rad, 2010;20:1952
Interpretive Error Rates

- RADPEER, 14 facilities
- 20,286 Cases, 250 radiologists
- All-case error rate 3% - 3.5%

Borgstede, JACR 2004;1:59
Error Rate Among Radiology Residents: CT and MRI of Head, Neck and Spine

- 5 year study, Univ. of FL
- 21,796 cases
- Read by resident, checked by staff rad
- Overall error rate 3.9%

Sistrom, Acad Rad 2008;15:934
Radiographic Errors

Perceptual: 70%
Cognitive: 30%
(misinterpretation)
Satisfaction of Search in Osteoradiology

OBJECTIVE. "Satisfaction of search" describes a situation in which the detection of one radiographic abnormality interferes with that of another. This phenomenon has not been investigated in the context of skeletal radiographs. We determined whether satisfaction of search occurs in the interpretation of conventional radiographs of the musculoskeletal system.

SUBJECTS AND METHODS. Twelve volunteers from radiology (10 residents and two attending radiologists) and 11 volunteers from orthopaedic surgery (all residents) were shown to interpret 15 films in which one abnormality was present and 15 films in which two or three abnormalities were present. The cases with multiple findings contained a total of 19 abnormalities. All cases were reviewed from the emergency department. The volunteers reviewed their subjective ability to detect abnormalities in a single-finding case, at least one abnormality on a multiple-finding case, and additional findings in cases with multiple abnormalities. The scores were computed using the chi-square test with Yates correction. Analyses of variance and Bonferroni adjustments were also performed.

RESULTS. Among the cases with single findings, detection rates averaged 11.25. For the 15 multiple-finding cases, the detection rates for one finding averaged 11.26. The difference was statistically significant for the second and third abnormalities in the medium cases. The results were significantly lower, averaging 8.32 (P < 0.001).

CONCLUSION. A significant satisfaction of search effect occurred and was present in the interpretation of radiographs of the musculoskeletal system.

From the Editor's Notebook

Did you ever pay close attention to clinicians looking at an imaging study, say a radiograph of the chest, and wonder what they were thinking about? Some just seem to be standing in front of the viewer staring, waiting for the answer to fall at their feet. It is certainly not an active process. They don't seem to be fully engaged. There is no gesturing or tracing of fingers across the image, no bending forward to take a closer look. No mumbling under the breath or muttering about something they may have seen. No looking at the chart. They just stand there motionless, blankly staring at the image. Is it enough to make you wonder what the devil is going through their minds? Maybe they expect the meaning of the image to be revealed almost immediately, without their input. Unfortunately, this is not always the case. After all, they are important individuals and their time is valuable.

The interpretation of imaging examinations is not intuitive. The gathering of meaningful information from imaging studies requires knowledge of the imaging technique, an understanding of anatomy and its appearance as projected by the imaging technique, familiarity with disease processes that could be encountered, and awareness of the imaging findings that might accompany each of these diseases. You have to know where you are looking and what to look for. In the words of the late, great radiologist Dr. L. Henry Garfield, "You see what you look for and recognize what you know." (Garfield LH, personal communication.)

The interpretation of imaging is neither passive nor easy. It just looks easy. Sitting in a darkened room and looking at films on a viewer or peering at images on a monitor—what could be easier than that? Outsiders can get the wrong impression.

Keep Looking: Satisfaction of Search

The interpretation of images requires concentration. And it isn’t always easy to concentrate. You are bombarded by distractions. There are interruptions with referring physicians, questions by technologists, regard for your next patient, and the day’s demands on your attention. When stumbling to read out the brain, you’ll find these interruptions make it hard to stay focused. The mind wanders.

How to stay focused? Establish a dialogue with yourself to maintain your concentration. Ask yourself questions about the case in question. What am I looking for? What should I be looking for? And then look for it. What am I likely to miss if I am not careful? Are there look-alikes? And what else should I look for now that I have noted this finding? And then...? Keep looking and keep looking until you feel certain that you have made a thorough assessment of the case. Make the effort to step forward; otherwise, you are liable to find yourself acting like one of those clinicians described above staring vacantly at the viewer while thinking of other things.

You can try to impose some systematic method of viewing images, like trying to cover the study systematically. Geometric invariant, say by starting in the upper left hand corner of the image and then proceeding in some set pattern over the remainder of the image. But this is difficult. Geometric patterns of search just don’t work for me. On initial inspection, I find that my eye is drawn to one or more findings for some reason or other, not always explainable, and that I may miss these if I am not alert, aware, or even conscious, before I can comfortably proceed to look at the remainder of the image. Sometimes I go back on one finding or other for what seems like forever before deciding in its meaning and importance, and then I forget to look at the remainder of the examination. This is not good. There is always the potential for errors of omission. Once you have one, it can turn to the next case.

We could all use a gentle reminder to keep looking.

These observations are brought to mind by an interesting and informative article in this issue of the AJR by Ashman, Yu, and Wooten. "Satisfaction of Search in Osteoradiology." [1] "Satisfaction of search" refers to the fact that the detection of one radiographic abnormality may interfere with the detection of other abnormalities. In other words, in viewing radiographs there is a tendency to become satisfied after observing the first abnormality, leading to a failure to search for additional findings. This tendency can be a likely source of diagnostic errors. Now, our conclusion has been scientifically evaluated and found to be true.

The principle of satisfaction of search is not limited to imaging of the musculoskeletal system. Satisfaction of search is a general principle that applies to all forms of imaging. Therefore, a perusal of the article by these researchers would profit anyone involved in diagnostic imaging.

Read, mark, and inwardly digest. Whether you are a generalist or a subspecialist, the article by Ashman et al. [1] is bound to do you good.

Lee F. Rogers, MD
Editor in Chief

References

Alliterative Errors

- Occur because radiologists read reports of previous examinations and are more apt to adopt same opinion
- Attributed to a tendency and need among people to conform to their peers
“Diagnostic Momentum”

J. Groopman, *How Doctors Think*
Root Cause Information for Delay in Treatment Events Reviewed by The Joint Commission

(Resulting in death or permanent loss of function)

<table>
<thead>
<tr>
<th>Root Cause</th>
<th>Frequency</th>
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<tbody>
<tr>
<td>Communication</td>
<td>549</td>
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<tr>
<td>Assessment</td>
<td>537</td>
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<tr>
<td>Leadership</td>
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<td>Human Factors</td>
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<td>Information Management</td>
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<td>Continuum of Care</td>
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<td>Care Planning</td>
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<td>Physical Environment</td>
<td>122</td>
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<tr>
<td>Medication Use</td>
<td>52</td>
</tr>
<tr>
<td>Patient Rights</td>
<td>19</td>
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</table>

The majority of events have multiple root causes

2004 through 2011 (N=677)
Causes of Diagnostic Failures Leading to Malpractice Lawsuits

Missed or delayed diagnoses were most often attributable to missing information that existed at the time of service, but was not available to physicians when they needed it to determine diagnostic decisions. A key gap was the timeliness of radiology data.

CRICO Emergency Leadership Council, 2-14-11
Communication

Physician

Radiologist

Patient
Physicians Ignore Abnormal Radiological Results

- 1,017 outpatient reports of abnormal imaging results were transmitted by computer to referring physicians.
- Physicians failed to acknowledge receipt in 368 (36%) cases.
- In 45 (4%) cases, imaging study was completely lost to follow up. 65% were reported as possible CA.

Singh (Baylor, Houston) J. Am Med Inform Assoc. 2007;14:459
Should radiologists communicate results of exams directly to patients?
Mammogram Reporting May Bypass Physicians

“We believe women are entitled to know the results of their exams and that it is the facilities’ responsibility to inform them. It is unfortunate, but we believe necessary to require such communications. Women simply cannot rely on referring physicians to notify them,” said the President of the National Breast Cancer Coalition.

A.M. News 10-5-99
Direct-to-Patient Laboratory Test Reporting
Balancing Access With Effective Clinical Communication

In February 2014, the Department of Health and Human Services (HHS) issued a landmark ruling allowing patients direct access to completed medical laboratory reports. The ruling took effect April 7, 2014, and gives laboratories 180 days from that date to comply. Although this recent change to the Clinical Laboratory Improvement Amendments (CLIA) empowers patients by removing access barriers to personal health information, it raises a variety of clinical and ethical questions involving practitioners, patients, and society. To capture the benefits of the change and to minimize potential challenges, clinicians will need to proactively counsel patients to ensure that patients do not engage in detrimental self-interpretation of test results, especially because of the abundance of information...
Attitudes of Patients and Physicians Regarding Directly Communicating Abnormal Radiology Results to Patients

• Regarding direct pt on-line access to results, both rads and RPs were concerned pts would not understand rpts and thus lead to greater anxiety and demands on RPs’ and Rads’ time.

• Rads concerned they do not have knowledge to discuss findings with pts.

Johnson, JACR 2010;7:281
Errors: Increasing or Decreasing?
Modern Technology: Help or Hindrance?

- Scrolling
- See too much: incidentalomas
- Templates for reports
- CAD: computed-assisted detection
High Error Rate With Speech Recognition

- Survey of complex imaging reports
- Half were generated by voice recognition (Speech Magic, Nuance), half prepared using conventional transcription
- 52% of speech recognition reports contained at least one error, compared with 22% of conventional transcription reports
- Common mistakes included word omissions, word substitution, added words, poor punctuation

Basma, Toronto, AJR 10/11
Beware of New Technology

Technology doesn’t solve, but only displaces, the problem of perceptual error to a new and different technology, offering the opportunity to make a whole new, and maybe longer, list of mistakes. You can’t buy excellence in a box, though you can keep buying newer, and more expensive boxes.

Robert Jasinski
Reducing Alliterative Errors

• Before rendering a final X-ray interpretation review previously obtained radiographs and reports. This will increase accuracy.
• Be apprised of previous opinions, but do not become biased or attach greater weight to them than with other clinical information.
• Always ask, is there any other diagnosis other than the one I have made or my predecessor has made that can explain the findings?
Clinical history significantly increased perception and improved detection of abnormalities in chest and abdominal radiographs

Berbaum, Acad Rad., 1994;1:217
Check List: Blind Spots at Brain Imaging

The crucial first step in avoiding false-positive results is remembering to evaluate these blind spots with use of a comprehensive checklist for every brain imaging study. A well-developed differential diagnosis will help ensure correct interpretation and appropriate patient treatment.

Bahrami, RadioGraphics 2009;29:1877
### Comprehensive Interpretation Checklist for Routine Brain Imaging

- Clinical history
- Sulci
- Ventricles
- Midline structures
- Parenchymal symmetry (adjust window width and level*)
- Basal cisterns
- Cavernous sinus*
- Meckel cave*
- Dural sinuses*
- Symmetry and density of posterior fossa
- Symmetry and density of brainstem*
- Orbits/globes*
- Parapharyngeal soft tissues*
- Bones (bone window)
  - Skull base foramina*
  - Clivus*

Note.—Contrast-enhanced images should be acquired if infection or malignancy is being considered.
*Potential blind spot.
Reducing Radiologic Errors

- Possess sufficient knowledge of the modality by which the imaging was obtained (CT, MRI, US, NM) and of the anatomic structures (Neuro, Msk, Interventional)
- Second look when possible
- Seek additional patient history, and discuss with ordering physician, when possible
Reducing Errors

Comparisons with relevant previous examinations and reports should be part of the radiologic consultation and report when appropriate and available.
Reducing Radiologic Errors

• Ensure prompt transmission of imaging reports to ordering physician (and to patient?)
• Expend sufficient time for interpreting and reporting radiologic exams
• Be cautious about voice recognition and proofreading reports to the extent possible
Disclosing Errors to the Patient

Ethical and moral values demand it.

Will our “never-admit-liability culture allow it?”
Radiologist As Member of Diagnostic Team

- Technician, doorkeeper, or consultant?
- ACR Appropriateness Criteria
- Restore face-to-face Radiologist/Doctor communication
- By teleradiology
- By I-phone (the future?)
In the 65 years since radiologic errors were first acknowledged, the error rates have not decreased appreciably. This must not dissuade us from making every effort to reduce them now. Yes, to do so is a daunting challenge, but it is one from which we cannot simply shrug our shoulders and walk away.