CAD With an Eye Towards the Radiologist

Elizabeth A. Krupinski, PhD
University of Arizona

Why CAD?

- **False negatives (misses) occur**
  - **Some estimates > 30%**
- **False-positives occur**
  - **Some estimates > 25%**
- **Incorrect classification**
  - **Benign vs malignant**
  - **Wrong diagnosis**

Why CAD?

- **Cognitive overload**
  - **1000s of images generated**
- **Reading time**
  - **More images = more time = fewer cases = less productivity = lower department income**
- **Generalists vs specialists**
  - **Shortages in radiology**

Prompting Endeavors

- **History effects**
  - **Hurt or help? Before or after?**
- **SOS effects**

– **When does it occur?**
- **Checklists & decision trees**
- **What makes a good radiologist?**
  – **Perceptual skills tests**

Prompting

- **History = written/verbal prompt**
  – **Potentially vague, SOS effects**
- **Exploration of physical prompts**
  – **Based on what?**
  – **Conveys what information?**
    - **Location**
    - **Lesion type**
    - **Status probability**

Perceptual Prompting

- **Perceptually-based prompts**
  – **Record eye-position**
  – **Identify error types**
    - **Search, Recognition, Decision**
    - **0, < 1000, > 1000 msec**
  – **Feedback areas based on dwell thresholds**

Visual Search Model

Things to Note

- **Large inter-observer variation**
- **Large intra-observer variation**
- **Task & image dependent**

- Not uniform – fairly random
- Can peripherally detect lesions without fixating
- Can fixate and not "see"
- Not all areas covered

Survival Analysis
Perceptual Feedback
Performance Results
Prompt Types
What Prompts Do

- Restrict dispersion of fixations
- Increase fixation accuracy on target lesion
- Inhibit distracting peripheral effects outside prompt area
- Problem – limited to individual radiologists & what they scan

Can Computers Help?

- Less variation
- Do not fatigue
- Not distracted
- More complete coverage
- Possibly quicker
- Less bias
- Still focus attention
- But …………..

Computer vs Human

Performance Results

- CAD at least as good as human
- CAD better than human
  - Not perfect so still need human
- CAD improves human performance
  - Expert non-expert differences
  - Trust issues

Poller et al.

- Cueing study
  - 90% & 50% sensitivity
  - 0.5 & 2 FPs per image
- One observer ignored cues & only looked at non-cued areas
- Sensitivity ↓ as FP ↑
- Sensitivity lower cued vs no cues
- Non-cued may offset cued gains

CAD, Time & Expertise
Decisions & Dwells
What Do They Want?

- Reliable & consistent
- High sensitivity & specificity
- Quick & intuitive
- Toggle on & off
- Enhancements
  - CAD says it there, I can't see it
  - Segment or process it
- Improve performance