DIAGNOSTIC ERROR in the ER
And … Can Checklists Help?

Mark L Graber MD FACP
Chief, Medical Service – VAMC Northport
Professor and Associate Chair
Dept of Medicine
SUNY Stony Brook, NY

mark.graber@va.gov
## Diagnostic Error Rate in the ER

<table>
<thead>
<tr>
<th>Section</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trauma</td>
<td>8% of pts have missed injuries</td>
</tr>
<tr>
<td>General ER</td>
<td>.6% of 5000 admitted pts at Wayne State</td>
</tr>
<tr>
<td>MI</td>
<td>2-3% of pts sent home have an MI; 90% of pts admitted don’t have an MI or ACS</td>
</tr>
<tr>
<td>Look backs</td>
<td>30% of subarachnoid hemorrhage misdiagnosed; 39% of dissecting AAA delayed diagnosis; A third of neurological diagnoses wrong or likely wrong</td>
</tr>
<tr>
<td>Autopsy</td>
<td>Major unexpected discrepancies that would have changed the management are found in 10-20%</td>
</tr>
<tr>
<td>Expert guess</td>
<td>Arthur Elstein: 10%</td>
</tr>
</tbody>
</table>

Houshian. Missed injuries in a level 1 trauma center. J Trauma 52:715-19, 2002
Moellder. Diagnostic accuracy of neurological problems in the ED. Can J Neurol Sci 2008. 35:335-41
## Conditions that Promote error in the ER

<table>
<thead>
<tr>
<th>Conditions</th>
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</thead>
<tbody>
<tr>
<td>Uncertainty everywhere</td>
</tr>
<tr>
<td>High decision density</td>
</tr>
<tr>
<td>High cognitive load</td>
</tr>
<tr>
<td>Novel situations</td>
</tr>
<tr>
<td>Time constraints</td>
</tr>
<tr>
<td>Tight coupling</td>
</tr>
<tr>
<td>Workload stress</td>
</tr>
<tr>
<td>Low signal-to-noise ratio</td>
</tr>
<tr>
<td>Poor feedback</td>
</tr>
<tr>
<td>Handoff problems</td>
</tr>
<tr>
<td>Shift work factors</td>
</tr>
<tr>
<td>Constant interruptions (10/hr)</td>
</tr>
<tr>
<td>Physical and emotional stress</td>
</tr>
</tbody>
</table>

**Violation-producing conditions:** under\over confidence; risk taking; lack of safety culture; maladaptive personal or group tendencies; Lax oversight or XS oversight; normalization of deviance;
Overconfidence

- **Setting:** 2001. Slovenia – Academic Medical Center
- **Intervention:** 270 ICU deaths. Physicians asked to rate their degree of certainty about the diagnosis

<table>
<thead>
<tr>
<th>% with Dx correct</th>
<th>Actual % with fatal but potentially treatable errors</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Completely Certain</strong></td>
<td>60 %</td>
</tr>
<tr>
<td><strong>Minor Uncertainty</strong></td>
<td>40 %</td>
</tr>
<tr>
<td><strong>Major Uncertainty</strong></td>
<td>34 %</td>
</tr>
</tbody>
</table>

Q 2:

How Do Doctors Think?
Q 2: How Do Doctors Think?
System 1: Automatic, subconscious processing

System 2: Deliberate, conscious thought

Context, environment, mood, biases

? Recognized?

Diagnosis

Education, experience, critical thinking, EBM

EXPERT | HEURISTIC
Tse Illusion
Etiology of Diagnostic Error

- Both System and Cognitive Errors: 46%
- Cognitive Error Only: 28%
- System Error Only: 19%
- No Fault Error Only: 7%
Cognitive Errors: 320

Faulty Knowledge 3 %

Faulty Data Gathering 14 %

Faulty Synthesis 83 %
COGNITIVE ERRORS (n = 320)

Most common:

- Premature closure (39)
- Faulty context generation (26)
- Faulty perception (25)
- Failed heuristic (23)
“Say ... What’s a mountain goat doing way up here in a cloud bank?”
Premature closure = Satisficing

= Falling in love with the first puppy ...

(Herbert Simon)
Q 4: How can we make diagnosis more reliable?

Problems

• Faulty context
• Premature closure
• Failed heuristic
• Framing errors

Solutions

• Consider the opposite
• Crystal ball experience
• Reflection
• Be comprehensive
• Learn the antidotes
A Checklist for Diagnosis

Obtain YOUR OWN, COMPLETE medical history, & a FOCUSED and PURPOSEFUL physical examination

Generate some initial hypotheses; Use EBM;

Pause to reflect – Take a diagnostic “time out”:

• Was I comprehensive?
• Did I consider the inherent flaws of heuristic thinking?
• Was my judgment affected by any other bias?
• Do I need to make the diagnosis NOW, or can I wait?
• What’s the worst case scenario? What are the ‘don’t miss’ entities?

Embark on a plan, but acknowledge uncertainty and ENSURE A PATHWAY FOR FOLLOW-UP
Make the PATIENT your PARTNER
Oct 30th: “Flying Fortress” took off from Wright Field in Dayton Ohio, as the lead competitor. The plane stalled at 300 ft and crashed, killing the two man crew, including Captain Troyer Hill, Boeing’s most experienced test pilot.

Oct 1935:
Military competition:
Martin-Douglass Aircraft vs Boeing’s Flying Fortress

- Twice the range
- 30% faster
- Five times the payload
- First plane with 4 engines
Pilot forgot to release the tail elevators.

“It’s just too much airplane for one man to fly”
The PROBLEM: COMPLEXITY

The SOLUTION: NOT training; NOT redesign

A Checklist

The B-17, and its checklist, flew the next 1.8 million miles without an accident. The military obtained over 13,000, and the B-17 was the workhorse of the Allied air force in World War II.
747
Complexity in Medicine

13,000 known diseases, syndromes, injuries
4,000 possible tests
6,000 medications, treatments, and surgeries

The average limits of human working memory:
7 discrete items
Infected Central Lines

The Problem:

There are 250,000 central line infections/year in the US
Leading to 30,000 deaths
Added cost per infection: $36,000 = $9B annually
Pronovost’s Central Line “Bundle”

1. Wash your hands with soap
2. Clean the area with chlorhexidine antiseptic
3. Cover the patient with sterile drapes
4. Wear a mask, sterile gown and gloves
5. Put a sterile dressing over the line once it’s in

Observation period:
At least 1 step was missed or botched a third of the time
Checklist to Prevent Central Line Infections

- Setting: Michigan ICU’s

- Intervention: 5 item “Pronovost” checklist (sterile field, etc) developed at Johns Hopkins for inserting central lines

- Results:
  - ICU line infection rate: Fell from 4 % to 0 %
  - Total line-assoc infection rate: Decreased by 2/3 rds
  - Total savings: $200,000,000 and 150 lives

But was it the checklist itself, or other factors ??
The Surgical Checklist

• WHO sponsored study in 8 countries
• 19 item checklist:
  – Sign in + Time out + sign out
• Evaluated in 3733 operations:
• Results:
  – Major complications fell from 11 to 7%
  – Death rate fell from 1.5 to 0.7% (p = 0.003)

Haynes et al. NEJM 360: 491-9, 2009
Behind the scenes ....

- 80% used the checklists while observed; 40% if not observed

- Measures were done only $\frac{1}{3}$ of the time before the study, and only $\frac{2}{3}$ during
Gawande’s survey of surgeons:

Do you think you need to use the checklist?

60% - “YES”
40% - “NO”

If you were having elective surgery, would you want YOUR surgeon to use the checklist?

94% - “YES”
A Checklist for Diagnosis

- Obtain YOUR OWN history
- Perform a focused, purposeful exam
- Take a “Diagnostic Time Out”
  - Was I comprehensive?
  - Did I consider the inherent shortcomings of using my intuition (heuristics)?
  - Was my judgment affected by bias?
  - Do I need to make the diagnosis now or can it wait?
  - What’s the worst case scenario?
- Embark on the plan, but ENSURE FOLLOW-UP & FEEDBACK
Checklist Project Consultants

Pat Croskerry, Bob Wears	ER
John Ely	Family med
Peter Pronovost	Central line bundle
Atul Gawande	Surgical checklist
Key Dismukes	Space shuttles
Dan Boorman	Boeing
Phase 1: Get suggestions:
What would help

Phase 2: Try it out and revise
Repeat X 20

Phase 3: Explore usability and workflow
Which patients?
When?
Who?
General checklist
vs
Specific checklist

http://www.youtube.com/watch?v=uHpieuyP1w0
“It is thornlike in appearance, but I need to order a battery of tests.”
The Miracle on the Hudson

- Hit a flock of geese, disabling both engines
- The plane landed safely in the Hudson, sparing all 155 people aboard

Key factors:
- Acting as a team
- Decision support
- Checklists
Decision support tools, including checklists, can help us improve quality, safety & productivity. They address BOTH complexity and criticality.

USE THEM - For safety’s sake, its NOT an option

“You need to start treating them (medical errors) as inexcusable. Ultimately, you should do so for three reasons: Your patients deserve it, your colleagues expect it, and your profession demands it”

“Sully” Sullenberger - 2010
How to be Comprehensive

Use mnemonics and tricks:

ROWCS

VITAMIN C C & D

Electronic decision support
(Isabel, DxPlain)
VITAMIN C C & D

V ascular
I nfecions & intoxications
T rauma & toxins
A uto-immune
M etabolic
I diopathic & iatrogenic
N eoplastic
C ongenital
C onversion (psychiatric)
D egenerative
Aids for Differential Diagnosis

DXplain

http://www.lcs.mgh.harvard.edu/projects/dxplain.html

Isabel

www.isabelhealthcare.com
**DXplain**

- **Chest tightness**
- **Troponin elevation**
- **Hypoxemia**

### Common Diseases
- ++ Myocardium, infarction, acute
- + Unstable angina pectoris
- + Embolism, pulmonary
- + Pericarditis, acute
  - Pneumonia, pneumococcal
  - Angina pectoris
  - Meconium Aspiration Syndrome
  - Tension pneumothorax
  - Pneumonia, mycoplasmal
  - Obstructive sleep apnea

### Rare Diseases
- + Kounis syndrome
- + Massive pulmonary embolism
- + Pulmonary artery sarcoma
  - Lung, alveolar proteinosis
  - Aneurysm, aorta, dissecting
  - Air embolism
  - Misplaced endotracheal tube
  - -- Obliterative bronchiolitis
  - -- Pulmonary lymphangiendotheliomatosis
Diagnostic Errors

• Are common and cause enormous harm; All clinicians make diagnostic errors, but we overestimate our performance and we are overconfident about it

• Most errors involve both system and cognitive components. Cognitive errors most often reflect problems using intuition

• We can make diagnosis more reliable by adhering to the principles of clinical reasoning, practicing reflectively, and insisting on follow-up
### MEDICAL RECORD

**NOTE:** Physician's signature must accompany each entry including standing orders. Date and time for instituting and discontinuing orders must be recorded.

<table>
<thead>
<tr>
<th>DATE AND TIME</th>
<th>PROB. NO.</th>
<th>ORDERS</th>
</tr>
</thead>
</table>

(Another brand, equal in quality, of the same basic drug may be dispensed UNLESS checked)

<table>
<thead>
<tr>
<th>Nurse's Signature</th>
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</thead>
</table>

### Kidney Biopsy Checklist

- 2 functioning kidneys - IVP done
- Not infected. Urine C & S
- Type and cross 2 units PRBC
- Get signed consent
- Bring biopsy supplies

Confirm date/time with:
- Radiology
- Pathology
- Attending

**TIME OUT: RIGHT PATIENT, CORRECT SIDE**

$0.00
Q: Compared to the average driver, how would you rate your driving skills?

Better
About the Same
Worse
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Better
About the Same
Worse

Only 1% of US drivers rate themselves below average

Reason, J  Ergonomics  1990
Survey of academic professionals:

Q: Relative to your peers nationwide, how would you rate your own standing in the academic community?
Survey of academic professionals:

Q: Relative to your peers nationwide, how would you rate your own standing in the academic community?

A: 94% rated themselves in the top half
How likely is diagnostic error?

• It happens, but not to me!

We are overconfident
US Autopsy Rates

<table>
<thead>
<tr>
<th>Year</th>
<th>Autopsy Rate</th>
</tr>
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<tbody>
<tr>
<td>1960</td>
<td>60</td>
</tr>
<tr>
<td>1970</td>
<td>50</td>
</tr>
<tr>
<td>1980</td>
<td>40</td>
</tr>
<tr>
<td>1990</td>
<td>10</td>
</tr>
<tr>
<td>2000</td>
<td>?</td>
</tr>
</tbody>
</table>
The Problem:

There are 250,000,000 operations every year
Leading to 1,000,000 deaths and 7M complications
Half the complications are judged preventable
Post-op Survey:
• What were the names of the people in the room?
• How they would rate the level of communication of the team?

Found:
• Half the time the senior surgeon did not know the names of the team, but when he did, the communication ratings were substantially higher
• Team members allowed to introduce themselves at the start of the operation were much more likely to speak up during the procedure
• One surgeon in 4 believe that junior members of the team should not question the decisions of the senior surgeon
The “Time Out”

- I have the CORRECT patient
- I’m doing the CORRECT procedure
- On the CORRECT side of the body
- And I have
  - the patient’s consent
  - all the tools I’ll need
  - the help of my team – we’re on the same page