Promoting Clinical Statistics Literacy of Emergency Medicine Residents with Clicker Technology

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Research Competency component for Emergency Medicine residents

3 areas of emphasis

- Evidence-based medicine,
- Interpretation of medical literature,
- Performance of research

- All require "familiarity" or "proficiency" with major concepts & methods of clinical statistics.

Why do medical residents need to be statistically literate?

"Because we say so…"

- American Medical Association
- Society for Academic Emergency Medicine (SAEM),
- Accreditation Council for Graduate Medical Education (ACGME),
- Council of Emergency Medicine Residency Directors (CORD)

Why do medical residents need to be statistically literate?

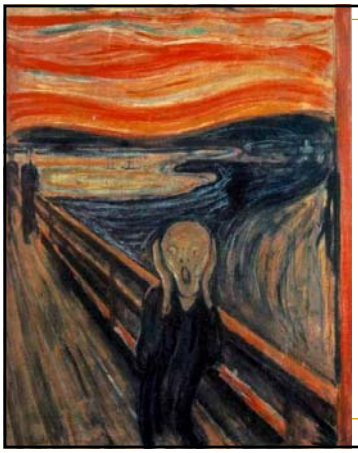
Three goals:

Goal 1: Competency requirements for EM resident training

Goal 2 : "Self-directed, life-long learner"

Goal 3: Evidence-based practice

These require understanding the gist of clinical research articles



The reality…

Primary strategy: Jack Horner model

Relying on others to pull out the "plums"

- Opinion pieces
- Abstracts
- Meetings
- Reputable news outlets
- Not-so-reputable news outlets
- Big Pharma reps

→ **Information is <u>filtered</u>**

Problem 1:
We can't believe everything we read…

"It is simply **no longer possible to believe much of the clinical research that is published**……"

Marcia Angell, MD, Editor *New England Journal of Medicine*

"Drug Companies & Doctors: A Story of Corruption", *New York Review of Books*, Vol 56, No 1; 15 January 2009.

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How reliable is the clinical literature?

- Abstracts:
  - Random sample of 44 abstracts in 5 journals
  - 20% were inconsistent with full article
- Meetings
  - 148 RCT presented at American College of Cardiology meetings 1999-2002
  - 41% (!) differed in efficacy estimate of primary outcome from later published reports

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Problem 2: Expert opinion?
We can't believe everything we hear…

- What are the biases?
  - Drug company shills
  - "Opinion leaders", "Experience" (*a "good" bad example:* CAST trial)
  - Fraud: e.g. Autism and vaccines ("no controversy, it's a manufactroversy")

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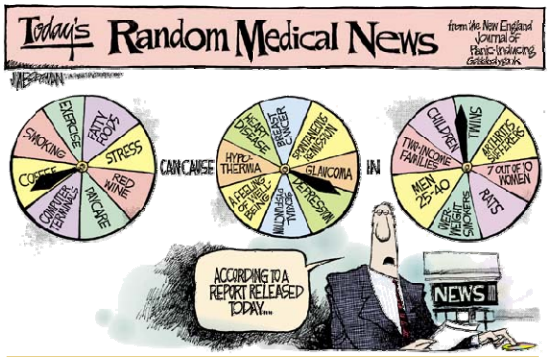
What can we believe?



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It cannot be a question of "belief"

Physicians need **tools** to weigh evidence

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Two (more) problems

- Medical knowledge (& knowledge dissemination) is changing rapidly
  - "Today's therapy …. tomorrow's bad joke"

  → Physicians need to be familiar with clinical research literature
- Medical residents don't have skills to interpret research statistics

  Windish *et al.* ***JAMA***, Vol. 298, No. 9 1010-1022 (September 5, 2007)

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JAMA

Medicine Residents' Understanding of the Biostatistics and Results in the Medical Literature

Donna M. Windish; Stephen J. Huot; Michael L. Green

- Anonymous cross-sectional survey
- 277 residents
- 11 internal medicine residency programs Connecticut, 2006

Windish *et al*. JAMA. 2007;298(9):1010-1022

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Results

- 95% "Important to understand statistical concepts"
- Median knowledge scores 39%

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Three major knowledge areas

(1) *Numbers & measures*
- variables,
- appropriate units,
- distributions, relationships;

(2) *Number processes*
- fractions, operations, ratios, proportions, time, patterns & relationships

(3) *Information handling*
- data & data analysis,
- chance & uncertainty.

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Competency areas identified by CORD

- Identify major **study designs** (randomized controlled clinical trial, case-control, cohort, cross-sectional, case studies), & list the advantages & disadvantages of each
- Identify the **necessary conditions for study reliability & validity**: randomization, blinding, allocation, Intention-to-treat analysis
- **Risk**: Define & interpret odds ratio, relative risk/risk ratio. Determine strength of evidence for risk factors.
- Identify **principles of statistical hypothesis testing:** null & alternative hypotheses; alpha, beta, & statistical power ; type I & type II errors as they relate to sample size & variance.
- **Define major variable types**: interval, ordinal, nominal, discrete, binary, continuous.
- Define & calculate **summary statistics** for continuous data: mean, median, mode, standard deviation, standard error, variance.
- Identify **principles summarizing non-continuous data**; perform simple calculations
- **Statistical tests**: t-test, paired t-test, analysis of variance, chi square, Fisher exact test, & non-parametric tests.
- Distinguish between **statistical & clinical significance**.
- **Diagnostic tests**: Define Incidence/prevalence, sensitivity, specificity, positive predictive value, & negative predictive value. Given a patient case scenario, be able to interpret probabilistic & frequentist statements in terms a patient can understand.
- **Measures of association**: Compare & contrast correlation & regression, & context for use. Distinguish between independent & dependent variables
- **Simple survival analyses** (Kaplan-Meier, Cox proportional hazards): identify and interpret.

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CORD definitions of research competency are not helpful

- 3 categories:
  "Mastery", "Proficiency", "Familiarity"
- Designed for clinical competencies
- Not helpful for assessing statistical "literacy".

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Barriers

- Formal training in statistics is minimal, and early in the curriculum,
  → Information forgotten by residency entry.
- During residency, research competency is addressed through "journal clubs"
  - Unstructured, infrequent, informal

  →Little or no communication,understanding, or retention of complex concepts.
- Negative associations with statistics:
  - Dislike → terror

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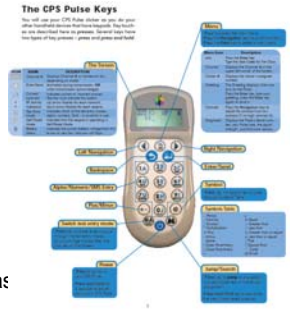
The plan: Obtain a measurable increase in EM resident statistical literacy

Clicker technology
- Increase engagement
- Reinforce concept retention

- 10 in-house resident education sessions
  - 30-40 min ea.
  - Topics cover major CORD competency areas



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Sample question

There are two D-dimer tests on the market for detecting PE. The cutoff level for test A is set at 0.5 ug/mL and for test B at 1 ug/mL. This means:

A. The sensitivity for test B > test A
B. The specificity of test B > test A
C. The sensitivity and specificity are the same for both tests
D. The number of positives is greater with test B than with test A

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Four-step assessment procedure

- ***Pre-intervention assessment***
  - Quiz adapted from Windish *et al*. (EM-specific)
- ***Topic-specific assessment***
  - Topic-oriented case-based scenario
  - 15-30 min explanation of new concepts &/or simple computations.
  - Clicker response to mini-quiz questions
- ***Post-assessment***
  - Quiz adapted from Windish *et al*. (EM-specific)
- ***External assessment***
  - Number of Blackboard web hits on uploaded notes, readings etc

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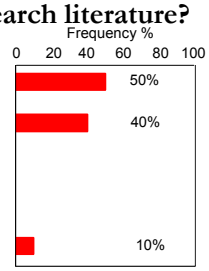
What is the BIGGEST obstacle to understanding clinical research literature?

A. No time to read it
B. Uncertain whether to believe research results
A. Irrelevant to clinical practice
B. Irrelevant to our patient population
C. The statistical gobbledegook



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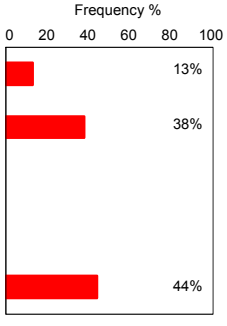
SECOND ranked obstacle

A. No time to read it
B. Uncertain whether to believe research results
C. Irrelevant to clinical practice
D. Irrelevant to our patient population
E. The statistical gobbledegook



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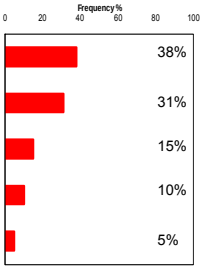
Formal statistical training before residency

A. "Epidemiology" in first year med school
B. 8 hours or less
C. Semester course in college
D. More than one course
E. Degree



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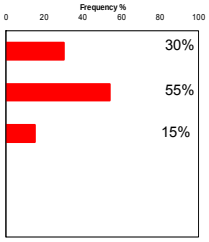
How do YOU most often assess validity of new medical research?

A. Opinion pieces in JAMA, NEJM etc.
B. Abstracts
C. Talks at meetings
D. Media e.g. TV news
E. Pharm reps



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Sample educational sessions

Example 1: RAMBO –Minimising bias
Patient recruitment strategies

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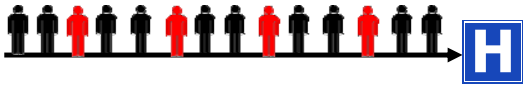
Recruitment: Systematic sampling

Regular system of patient sampling

- Patient stream (alphabetical, birth-date, alternate days, etc).
- Fixed number: Every *n*th patient is sampled

e.g. decimation=every tenth person



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Random sampling

Each patient in the defined population **has an equal chance of selection.**

e.g. We need a sample of 10 patients from a group of 30
random numbers = 15, 24, 26, 2, 16, 4, 23, 1, 19, 14

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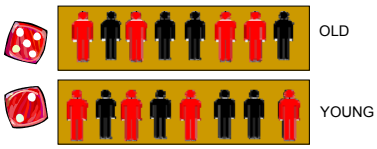
Recruitment: Stratified random sampling

- Pick grouping criteria that might affect outcome

e.g. Age

- Subjects are randomly sampled from each stratum



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A total of 213 patients aged > 50 years with diagnosed CHF were recruited to a RCT as they presented to an outpatient clinic. The goal was to assess the effects of 3 drugs on CHF progression.

Which best describes the **sampling method** by which participants were recruited ?

A. Simple random sampling
B. Convenience sampling
C. Cluster sampling
D. Systematic sampling

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Example 2: Diagnostic tests

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A 60 y.o. man presents with a sore throat. You suspect streptococcal pharyngitis and request a rapid strep antigen (RSA) test.
The **sensitivity** of this test is 80% ; **specificity** is 95%.
The **prevalence** of strep pharyngitis in adults with pharyngitis is 10%.

What are the chances that this patient has strep pharyngitis if the RSA test is positive?

- ✔ A. 64%
- ✘ B. 80%
- ✘ C. 95%
- ✘ D. 98%
- ✘ E. No clue

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What do you need to know?

A. Three simple definitions
B. Basic math skills
- Basic probability (i.e. coin-flipping)
- Convert a percent to a proportion
- Convert a proportion to a percent

From Gigerenzer et al. 2008. Helping doctors and patients make sense of health statistics ***Psych Sci*** 8(2): 53-96

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1. Imagine that you flip a coin 1000 times. How many times would you expect the coin to come up heads in 1,000 flips?

— times out of 1,000

✔ 500

5% got this wrong

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2. A person taking Drug A has a 1% chance of having an allergic reaction. If 1000 people take this drug, how many would you expect to have an allergic reaction?

✔ 10

25% got this wrong

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3. A person taking Drug A has a 1 in 1000 chance of having an allergic reaction. What <u>percentage</u> of people taking this drug will have an allergic reaction?

✔ 0.1

75% got this wrong
Answer range: 0.0001 to 10

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Recall the man with the sore throat

- Sensitivity = 80%
- Specificity = 95%.
- Prevalence =10%.

Secret is to convert these percentages to *whole numbers*

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Construct toy population

1000

Have disease
Prevalence = 10%
100

Don't have disease
900

Results of the test

Sensitivity = 80% → TP
80 TP
20 FN

Specificity = 95% → TN
45 FP
855 TN

PPV = Proportion of people with SP given a positive test
= 80/ (80+ 45) = 64%

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Results

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Results: Not good

Reading comprehension of basic clinical statistics remained poor.

- Pre-test median test score 30%
- Post-test median score 35%.

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Results: Specific knowledge areas

- Clinical research designs NO CHANGE
- Power, significance testing NO CHANGE
- Diagnostics, sensitivity and specificity NO CHANGE
- Sources of bias. NO CHANGE

- GOOD: Computing & comprehension of relative and absolute risk 25% → 70%
  - BUT residents unable to translate this to computation of related metrics e.g. number needed to treat.

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External assessment

- On-line tracking of posted articles and study aids
- Very few, if any, residents availed themselves of these resources

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Bottom line

Clickers increased immediate engagement,

but

There was no obvious reinforcement of learning

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Every Plan A needs a Plan B

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Next steps….

- Fall on my sword
- Recover from depression
- Time really is an issue!
- Strategic brainstorming with new residency education director
- Different, more "hands-on" approach
  - e.g. short exercises with research article excerpts
- Suggestions???

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Questions?

Thank you for your attention!

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