Innumeracy: an impediment to learning Evidence-based Medicine.

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Background:

In the evaluation of diagnostic and therapeutic developments and therapeutic developments most physician lack the methodological competence in clinical Competence in clinical epidemiology, statistics and decision analysis necessary to make judgment soundly.

EBM curriculum

- In last 10 years teaching EBM has become popular in most medical schools

- Interpretation of diagnostic terms like, sensitivity, specificity, PPV, NPV, LR, ROC, form the basis of understanding diagnostic tests

Diagnostic test interpretation

Pretest probability

Application of test: Test characteristics ,
Sensitivity
specificity
LR+, LR-
Post test probability

Aim of our study

To determine how often physicians correctly describe and understand terms used in diagnostic tests

Methods

Terms for searching:

Statistics/ or probability/ or Bayes theorem/or numeracy or innumeracy
Risk assessment/ or data interpretation, statistical

Communication/ or communication barriers/ or
Computer graphics/ and models, statistical/
Visualiz*

Evidence-based medicine/
Clinical competence/
Attitude of health personnel/
Medical staff, hospital/ or physician

Methods

- Medline 1980-2003
- Embase 1988-2003
- PsychInfo 1984-2003
- Web of Science 1993-2003
- Educational websites
- Bibliography of relevant articles.

Methods

- Study design, quality of study, and limitation of study were abstracted by 2 independent reviewers.

- Exclusions: letters to editor,review articles, editorial

Results

8 articles were identified

Case scenarios: 5

Questionnaire: 2

Telephone survey: 1

Telephone survey

- 300 physicians: asked frequency of using Bayesian ROC, sensitivity, specificity, LR

- Bayesian 8(3%), ROC 3(1%), LR 2 (0.66%). Sensitivity(84%)

- Not practical(73%), data not available(26%), math phobic(24%),does not use probabilistic reasoning 9% <25% consider sensitivity prior to order a test

- Non-familiarity with LR and ROC(97%),Bayesian 76%

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Questionnaire format

- 263 Swiss practitioners*
  Correct definition of sens 76%, PPV 61%,
   accurate PPV calculation in 22%
   Method of presentation -related to errors in calculation

*   BMJ 2002;324:824

Questionnaire format

50 GP's from Sydney, Australia

Self administered questionnaires
would not be helpful to understand
I don't understand but would like to
I have understanding
I have understanding and can explain

Interviewed by one reviewer's unaware of the scores
3 expert reviewers agreed on criteria to establish competence

** BMJ 2002;324:950

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Questionnaire format

50 GP in Sydney Australia

  only 13/50 stated they knew PPV, sensitivity, specificity.

However only 1/50 met criteria for knowing PPV

** BMJ 2002;324:950

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Case scenarios.

5 studies using (medical students 1, physician's 4)

Commonest error: overestimating PPV

Presentation as Natural frequency format*
    (accuracy improves 10 to 46%)

J Cancer Edu 1993;8:297
JGIM 1994;9:488
JGIM 2002;17:839
*Acad Med 1998;73:538
Eddy DM 1982

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Case scenarios

234 fifth yr students in 3 Medical Schools in Japan

Confidence in understanding Bayesian think: 14.3%

Consistent error in estimating pretest probability in Intermediate and low risk cases of coronary artery disease

Overestimating PPV in Intermediate and low risk cases of coronary artery disease

JGIM 2002;17:839

Case scenarios

Eddy (1982) reported that 95% of physicians confused sensitivity for test with PPV

Eddy DM. Probablistic reasoning in clinical medicine problems and opportunities. In: Kahneman D, Slovic P, Tversky A(eds). Judgement under uncertainty: heurictics and Biases. Cambridge, UK: Cambridge Press:1982:249

Case scenarios: Natural Frequency format

48 physicians in Munich and Dusseldorf

Case scenarios involving
>   Breast cancer with positive mammogram
>   Colorectal cancer with positive hemeoccults
>   Phenylketonuria and positive Guthrie test
>   Ankylosing spondylitis and positive HLA-B27

Each participant received 4 booklets,
2 in probability Format
 2 natural frequency format

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Case scenarios: Natural Frequency format

Results

Overall correct answers: Bayesian 10%,
Natural frequency 46%

Physicians spent 25% more time solving Bayesian Estimates.

Physicians appeared nervous and uncertain when Solving Bayesian estimates.

Example from Hoffrage and Gigenrenzer (modified)

For a symptom free people over 50 yrs who participate in Colorectal cancer(CRC) screening using the hemoccult test

The probability that one of these people has CRC is 0.3%
In patients with colorectal cancer, the probability of a positive Hemoccult test is 50%.
In patients without CRS the probability of positive hemoccult Test is 3%

What is the probability of a person >50yrs with positive Hemoccult test to actually have CRC?

Example from Hoffrage and Gigenrenzer (modified): Natural frequency format

30 out of every 10,000 people have CRC. Of these
30 people with CRC, 15 people will have a +hemoccult test
Of the remaining 9,970people without CRC, 300 will still
Have a positive hemoccult test.
Imagine a person > 50 yrs who has a positive hemoccult test.
How many people actually have CRC?

Example from Hoffrage and Gigenrenzer

Correct answer increased from 4% to 67% !!

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In Summary:

Inability to correctly determine PPV is a common error

Limitation of our study: few studies, variable study design

Generalizability of the studies, carried out in 4 continents

Implications:

- Physician innumeracy maybe an impediment to EBM

- Need to reassess current method of teaching EBM

- Generate techniques to improve understanding the terms used in Diagnostic testing

- Presentation of data in natural frequency format maybe useful

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