Communicating Scientific Evidence to Patients: Should Strategies be Tailored to Level of Health Numeracy?

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I have no conflicts of interest to disclose
THINGS GOT REALLY INTERESTING WHEN THE STATISTICIAN STARTED DOING WARD ROUNDS
Topics

- Scientific and Numerical Literacy in the U.S.
- Numeracy, Reasoning, and Decision Making
- Contingent Communication Strategies
  - Evidence and Debate
- Using a Computer Adaptive Test of Health Numeracy in the Clinical Setting
- Future directions
Scientific Literacy

The capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions in order to understand and help make decisions about the natural world and the changes made to it through human activity.

Organization for Economic Co-operation and Development (OECD). 2003
Scientific Literacy Measurement

- Scientific facts

- Scientific process

Scientific Method
- Observation
- Hypothesis
- Experiment
- Analysis – Support or reject hypothesis
- New Hypothesis
- Experiment - etc.
Pseudoscience

General Social Survey, National Science Foundation
### Scientific Facts

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>% Corr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The center of the earth is very hot</td>
<td>T</td>
<td>84</td>
</tr>
<tr>
<td>The continents have been moving their location for millions of years and will continue to move</td>
<td>T</td>
<td>83</td>
</tr>
<tr>
<td>Does the earth go around the sun, or does the sun go around the earth?</td>
<td>Earth Around Sun</td>
<td>74</td>
</tr>
<tr>
<td>All radioactivity is man made</td>
<td>F</td>
<td>72</td>
</tr>
<tr>
<td>The fathers gene decide the babies gender</td>
<td>T</td>
<td>63</td>
</tr>
<tr>
<td>How long does it take the earth to go around the sun?</td>
<td>1 year</td>
<td>55</td>
</tr>
<tr>
<td>Electrons are small than atoms</td>
<td>T</td>
<td>53</td>
</tr>
<tr>
<td>Antibiotics kill viruses as well as bacteria</td>
<td>F</td>
<td>51</td>
</tr>
<tr>
<td>Lasers work by focusing sound waves</td>
<td>F</td>
<td>47</td>
</tr>
</tbody>
</table>

Survey of Public Attitudes Toward and Understanding of Science and Technology Questions; General Social Survey, 2012

Factual Understanding of Science in U.S.

Figure 7-6
Mean number of correct answers to trend factual knowledge of science scale: 1992-2012

NOTES: Mean number of correct answers to the nine questions that are included in the trend factual knowledge of science scale; see appendix table 7-8 for explanation, list of questions, and percentage of questions answered correctly. See appendix tables 7-9 and 7-10 for responses to individual questions.


Science and Engineering Indicators 2014

Questions with Possible Relationship to Religious Beliefs

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>% Corr.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The universe began with a huge explosion</td>
<td>True</td>
<td>39</td>
</tr>
<tr>
<td>Human beings, as we know them today, developed from earlier species of animals</td>
<td>True</td>
<td>48</td>
</tr>
</tbody>
</table>
# Probability/Scientific Process

<table>
<thead>
<tr>
<th>Concept</th>
<th>Question</th>
<th>1999</th>
<th>2012</th>
</tr>
</thead>
<tbody>
<tr>
<td>Probability</td>
<td>Risk of genetic illness independent and equal among offspring</td>
<td>64%</td>
<td>65%</td>
</tr>
<tr>
<td>Experimental Design</td>
<td>Need for a control group</td>
<td>34%</td>
<td>34%</td>
</tr>
<tr>
<td>Scientific Process</td>
<td>Testing theory, using control group, or making systematic comparisons</td>
<td>21%</td>
<td>20%</td>
</tr>
</tbody>
</table>

Public Interest in Science and Health

Similar to interest in local school issues and economic issues

Similar to interest in international affairs

Figure 7-2
Public interest in selected science-related issues: 1981–2012
Percent “very interested”

NOTE: Responses to There are a lot of issues in the news, and it is hard to keep up with every area. I’m going to read you a short list of issues, and for each one I would like you to tell me if you are very interested, moderately interested, or not at all interested.


Science and Engineering Indicators 2014
50% surveyed adults read or heard about medical research studies that help doctors know what works best for patients’ care

34% recalled having a physician discuss what scientific research has shown

Most thought decisions based on individual test results and medical history

Beliefs and Values

- All care meets minimum quality standards
- Medical guidelines are inflexible
- More care and new care is better

Carman KL, Health Affairs 2010
Value of Scientific Evidence in Health Scale (VSE–H)

- 3 domains (13 item scale)
  - Scientific Study Details
  - General Health Information
  - Guideline Information
- Survey of urban primary care population (n=300)
- Predictors of VSE–H
  - ↑ Health numeracy
  - ↑ Print health literacy
  - ↑ Education
  - ↑ Age
  - ↑ Intrinsic religiosity
  - ↓ Medical Care System Distrust (competence domain)
Health Literacy

- Cultural and Conceptual Knowledge
- Oral Literacy: Listening and Speaking
- Print Literacy: Writing & Reading
- Numeracy

IOM Report, 2004
Health Numeracy

The ability to understand and apply information conveyed with numbers, tables & graphs, probability, and statistics to effectively communicate with health care providers, take care of one’s health, and participate in medical decisions.

Schapira MM, Med Decis Making, 2012
Health Numeracy

- Number Sense
- Tables & Graphs
- Probability
- Statistics
Skills Needed to Understand EBM

- **Number sense**
  - Magnitude/order/estimation

- **Tables & graphs**
  - Survival curves
  - Rates/incidence

- **Probability**
  - Uncertainty, random processes

- **Statistics**
  - Concepts of inference, uncertainty
  - Scientific study design
  - Scientific process

- **Mental Model of disease process**

**Numeracy & Scientific Literacy**
National Assessment of Quantitative Literacy

<table>
<thead>
<tr>
<th></th>
<th>Below Basic</th>
<th>Basic</th>
<th>Intermediate</th>
<th>Proficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>24%</td>
<td>33%</td>
<td>33%</td>
<td>13%</td>
</tr>
<tr>
<td>Health Literacy</td>
<td>14%</td>
<td>22%</td>
<td>53%</td>
<td>12%</td>
</tr>
</tbody>
</table>

- Simple Addition
- One Step Problems
- Figure out operation
- Multi-step problems

Health Numeracy in Clinical Settings

- 62% of women age 40–50
  - Lifetime risk of dying from BC > 10 year risk
  - Estimating “heads” in 1000 fair coin toss

- 16% of women veterans
  - Convert percentage to proportion
  - Convert proportion to percentage
  - Estimating “heads” in 1000 fair coin toss

- 29%–34% highly educated women
  - Expanded measure of risk/probability questions
  - Lipkus Numeracy Scale

Black WC, JNCI 1995
Lipkus IM Med Decis Making 2001
## Measurement of Health Numeracy

<table>
<thead>
<tr>
<th>Scale Characteristic</th>
<th>Numeracy Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type of Measure</td>
<td>Objective</td>
</tr>
<tr>
<td></td>
<td>Subjective</td>
</tr>
<tr>
<td>Scope</td>
<td>General</td>
</tr>
<tr>
<td></td>
<td>Disease specific</td>
</tr>
<tr>
<td>Literacy domains</td>
<td>Composite</td>
</tr>
<tr>
<td></td>
<td>Numeracy only</td>
</tr>
<tr>
<td>Skill focus</td>
<td>• Health related tasks (appointment, medications)</td>
</tr>
<tr>
<td></td>
<td>• Risk communication skills</td>
</tr>
<tr>
<td></td>
<td>• Probability/Statistical Inference</td>
</tr>
<tr>
<td></td>
<td>• Comprehensive framework</td>
</tr>
</tbody>
</table>
# Health Numeracy & Decision Making

<table>
<thead>
<tr>
<th>Effect</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Up Arrow]</td>
<td>Information seeking</td>
</tr>
<tr>
<td>![Up Arrow]</td>
<td>Deliberative reasoning strategies</td>
</tr>
<tr>
<td>![Up Arrow]</td>
<td>Stable decisions</td>
</tr>
<tr>
<td>![Up Arrow]</td>
<td>Affective response to information</td>
</tr>
<tr>
<td>![Up Arrow]</td>
<td>Attachment of meaning</td>
</tr>
<tr>
<td>![Up Arrow]</td>
<td>Ability to construct preferences</td>
</tr>
<tr>
<td>![Down Arrow]</td>
<td>Framing bias associated with information</td>
</tr>
<tr>
<td>![Down Arrow]</td>
<td>Cognitive burden of processing</td>
</tr>
</tbody>
</table>

Lipkus IM, Peters E, Health Educ Behav, 2009  
Peters E, Med Decis Making 2010  
Galesic M, Health Psychology 2011
## Tailoring Communication Strategies to Health Numeracy?

<table>
<thead>
<tr>
<th>Approach</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal</td>
<td>Apply best practice for risk communication and low numeracy to all</td>
</tr>
<tr>
<td>Contingent</td>
<td>Align communication strategies and numeracy demands of materials to patient skills</td>
</tr>
</tbody>
</table>

Hamm RM, 2007, Med Decis Making  
Benefits of Universal Approach

- No need for screening test
- Equal information provided to all
- Avoid concerns about misclassification
Benefits of Contingent Approach

- Align numeracy skill with numeracy demands
  - Decision Aids
  - Informed Consent
  - Web based sites
  - Research references
- Avoid confusing or overwhelming patient
- Avoid oversimplifying information
- Optimize clinician–patient communication

Hamm RM, 2007, Med Decis Making
Garcia-Retamero, 2010, Med Decis Making
Limitations of Numeracy Screening

- Respondent burden
- Developed in majority populations
- Negative affective response
- Variable domain content
- Lack of meaningful clinician reports
Limited Evidence Base: 3 RCT’s

- Sharing REALM results with providers lead to increase use of low HL strategies in patients with DM but decreased clinician satisfaction with visit
- Communication training and report of Newest Vital Sign scores in PC increased use of tailored health communication strategies but need for continued clinician training identified
- HTN education in the ER setting tailored to health literacy increased HTN knowledge

Seligman, JGIM 2005
Welsch, J Am Board Fam Med, 2011
Guise, J Health Communication, 2012
Numeracy Understanding in Medicine Instrument (NUMi): Computer Adaptive Test

- Item Response Theory (IRT)
- Cross-cultural research methods
- Theoretical Framework
  - Number sense
  - Tables & Graphs
  - Probability
  - Statistics
- Item level analysis (n=1000)
- Item Parameters
  - Difficulty -3.0 to 3.0
  - Discrimination 0.0 to 3.0
- Written Versions & Computer Adaptive Test

Schapira MM, J Gen Intern Med 2011
Schapira MM, Med Decis Making 2012
Schapira MM, J Health Communication 2014
Computer Adaptive Test (CAT)

- Algorithm and Monte Carlo Simulations
- English and Spanish versions
- Items selected based on respondent ability
- Testing Experience
  - Options: Language/Voice Over
  - Color pictures
- Results
  - Ability score
Computer Adaptive Test

Item 1
Average Difficulty

Easier Item

Harder Item

✔

✕

✔

✕

✔

✕

Low Numeracy

High Numeracy
NUMi Website:
http://www.med.upenn.edu/numi/

Numeracy Understanding in Medicine Instrument

What is the NUMi?
NUMi stands for Numeracy Understanding in Medicine Instrument, an objective test of health numeracy that is appropriate for both research and clinical settings. The NUMi will indicate how well a person will understand education materials, instructions, or other forms of communication that involve numbers, tables, & graphs, probability or statistics. The NUMi was developed and validated using item response theory (Med Decis Making 2012;32:851-865)

Health Numeracy Definition
The ability to understand medical information presented with numbers, tables and graphs, probability, and statistics and to use that information to communicate with your health care provider, take care of your health, and participate in medical decisions.
According to the picture below, what percent (%) of women are likely to develop breast cancer in their lifetime?

A. 12%
B. 4%
C. 8%
D. 16%
Ann has a family history of breast cancer. Ann can decrease her 5-year risk of breast cancer by 50% if she takes a prevention medicine. According to the picture below, what is Ann’s 5-year risk of getting breast cancer if she takes the medicine?

A. 2%
B. 4%
C. 8%
D. 16%
Andrea has Stage 2 breast cancer. According to the graph below, what is Andrea’s chance of surviving 3 years after her diagnosis?

A. 56%
B. 82%
C. 92%
D. 100%
In general, the findings from a scientific study that compares 2 treatments will be more accurate if the doctor decides who gets which treatment than if the patients randomly receive one treatment or the other.

A. True
B. False
A study compared two cancer treatments. The odds of surviving with treatment A compared to treatment B was 2 to 1. Statistically, the Odds Ratio and 95% Confidence Interval was found to be 2.0 (0.8 –4.2). This study shows that treatment A works better than treatment B.

A. True
B. False
Final Score

- Psychometric results
  - Theta (Numeric Ability) –3.0 to 3.0

- Creation of meaningful clinician report
  - Structured interviews
  - Pilot testing of format/content of report
  - Categories: Low, Medium, High Numeracy
PHYSICIAN REPORT OF HEALTH NUMERACY:  Patient Name

Health numeracy reflects a person’s ability to understand and use numbers in taking care of their health. Your patient has taken a test of health numeracy. The test consisted of questions that assessed his/her ability to use 1) basic math skills, 2) tables and graphs, 3) basic probability concepts and 4) statistics used in risk communication and medical decision making.

Your patient’s NUMI health numeracy score is presented below from 1 (Lowest) to a 6 (Highest)

**Result:** Health Numeracy Ability = Low

<table>
<thead>
<tr>
<th>Concepts Patient May Understand</th>
<th>Concepts Patient May Not Understand</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage of Disease</td>
<td>Survival Curves</td>
</tr>
<tr>
<td>Single risks if presented with one format (% or frequency)</td>
<td>Changing between risk formats</td>
</tr>
<tr>
<td>Recurrence estimate when presented with a denominator of 100</td>
<td>Confidence intervals</td>
</tr>
<tr>
<td></td>
<td>Scientific study design</td>
</tr>
<tr>
<td></td>
<td>Statistical significance</td>
</tr>
<tr>
<td>Here are communication tips for numeric information if your patient has low numeracy</td>
<td></td>
</tr>
<tr>
<td>Confirm understanding</td>
<td>Explain graphs and tables</td>
</tr>
<tr>
<td>Minimize math needed by patient</td>
<td>Explain the numerator and denominator when using frequencies</td>
</tr>
<tr>
<td>Use descriptive words with numbers to show risk and probability</td>
<td>Explain math symbols and decimals</td>
</tr>
</tbody>
</table>
Proof of Concept Study

- **Hypothesis:** Screening for health numeracy will
  - Increase patient centered communication
  - Decrease decisional conflict

- **Clinical setting**
  - Breast cancer treatment consultation
  - Surgical or medical oncology visits

- **Pre–study clinician training**

- **Protocol**
  - Pre–visit CAT NUMi using tablet computer
  - Report to clinician pre–visit
  - F/u patient and clinician assessments

Supported by ACS Research Scholar Award
Outcomes

- Audio-recording of consultation
- Patient reported outcomes
  - Knowledge of disease and treatment options
  - Patient centeredness of care
  - Decisional conflict
- Clinician reported outcomes
  - Satisfaction with CAT NUMi intervention
  - Satisfaction with visit
Interest in scientific evidence in health is high among the U.S. public
Use of evidence in DM limited by levels of scientific literacy and numeracy
Tailored communication strategies may optimize incorporation of evidence in DM
Need for additional evidence in this area
Current investment in CER/SDM creates an opportunity to advance this area and promote translation of CER to the clinical setting
Thank You

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