The Importance of Numeracy for Decision Making in Health

Wendy Nelson
National Cancer Institute
August 14, 2012
In patients with multiple risk factors for heart disease, Lipitor reduces risk of heart attack by 36%*

If you have risk factors such as family history, high blood pressure, age, low HDL (‘good’ cholesterol) or smoking.

*That means in a large clinical study, 3% of patients taking a sugar pill or placebo had a heart attack compared to 2% of patients taking Lipitor.

Lipitor atorvastatin calcium tablets

DR. ROBERT JARVIK
Inventor of the Jarvik Artificial Heart and Lipitor User
Absolutely Relative: Hypertension

**Absolute change** in outcome rate:

A RCT of over 6,000 men with mild hypertension shows that the drug treatment reduced overall mortality from 7.8% in the “usual care” control group to 6.3%, a statistically significant reduction in mortality of 1.5%.

**Relative change** in outcome rate:

When 7,825 men were studied in a RCT, the drug treatment for mild hypertension reduced the overall mortality rate by 20.3% compared with that in the control group of men who received usual medical care. The difference was statistically significant.

Forrow et al., *The American Journal of Medicine*, 1992
Absolutely Relative: How Research Results Are Summarized Can Affect Treatment Decisions

LACHLAN FORROW, M.D., WILLIAM C. TAYLOR, M.D., Boston, Massachusetts,
ROBERT M. ARNOLD, M.D., Pittsburgh, Pennsylvania

Figure 1. Comparisons between responses of physicians to the paired summaries, which describe the same study results in two different ways. See Table I for text of summaries.
Medicare Prescription Drug Coverage (Part D)

You'll also pay only 86% of the plan's cost for covered generic drugs until you reach the end of the coverage gap.

**Example:** Mr. Jones reaches the coverage gap in his Medicare drug plan. He goes to his pharmacy to fill a prescription for a covered generic drug. The price for the drug is $20 and there is a $2 dispensing fee that gets added to the cost. Once the 14% coverage is applied to the $22, he will pay $18.92 for the covered generic drug. The $18.92 amount he pays will be counted as out-of-pocket spending to help him get out of the coverage gap.
### Medicare Part A Hospital Coinurance/Deductible

<table>
<thead>
<tr>
<th>What Medicare Pays</th>
<th>What Medigap Pays</th>
<th>What You Pay (for Covered Services)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days 1-60</td>
<td>Days 1-60</td>
<td>Days 1-60</td>
</tr>
<tr>
<td>All but $1,156</td>
<td>$1,156 (Part A Deductible)</td>
<td>$0</td>
</tr>
<tr>
<td>Days 61-90</td>
<td>Days 61-90</td>
<td>Days 61-90</td>
</tr>
<tr>
<td>All but $289 per day</td>
<td>$289 per day</td>
<td>$0</td>
</tr>
<tr>
<td>Days 91-150 (while using your 60 lifetime reserve days)</td>
<td>Days 91-150 (while using your 60 lifetime reserve days)</td>
<td>Days 91-150 (while using your 60 lifetime reserve days)</td>
</tr>
<tr>
<td>All but $578 per day</td>
<td>$578 per day</td>
<td>$0</td>
</tr>
<tr>
<td>Additional 365 Days</td>
<td>100% of Medicare-approved expenses</td>
<td>$0 of Medicare-approved expenses</td>
</tr>
<tr>
<td>$0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>After the Additional 365 Days</td>
<td>After the Additional 365 Days</td>
<td>All costs</td>
</tr>
<tr>
<td>$0</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Medicare Part A Skilled Nursing Facility Coinurance (for Medicare-covered stays)

<table>
<thead>
<tr>
<th>What Medicare Pays</th>
<th>What Medigap Pays</th>
<th>What You Pay (for Covered Services)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days 1-20</td>
<td>Days 1-20</td>
<td>Days 1-20</td>
</tr>
<tr>
<td>100% of approved amounts</td>
<td>$0</td>
<td>$0</td>
</tr>
<tr>
<td>Days 21-100</td>
<td>Days 21-100</td>
<td>Days 21-100</td>
</tr>
<tr>
<td>All but $144.50 per day</td>
<td>$144.50 per Day</td>
<td>$0</td>
</tr>
<tr>
<td>After 100 Days</td>
<td>After 100 Days</td>
<td>After 100 Days</td>
</tr>
<tr>
<td>$0</td>
<td></td>
<td>All costs</td>
</tr>
</tbody>
</table>

### Part A Hospice Care Coinurance or Copayment

<table>
<thead>
<tr>
<th>What Medicare Pays</th>
<th>What Medigap Pays</th>
<th>What You Pay (for Covered Services)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100% for hospice care</td>
<td>$5 for prescription drugs</td>
<td>$0</td>
</tr>
<tr>
<td>All but $5 for prescription drugs</td>
<td>5% for inpatient respite care</td>
<td></td>
</tr>
<tr>
<td>95% for inpatient respite care</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
“Nolvadex is not for every woman at high risk. In the study, women taking Nolvadex were 2 to 3 times more likely to develop uterine cancer or blood clots in the lung and legs, although each of these occurred in less than 1% of women.”
# Drug Facts: NOLVADEX (tamoxifen)

**What is this drug for?** Reduce the chance of getting breast cancer.

**Who might consider taking it?** Women at high risk of getting breast cancer (1.7% or higher risk over 5 years). You can calculate your breast cancer risk at http://bcra.ncl.nih.gov/btc.

**Who should not take it?** Women who are pregnant or breastfeeding.

**Recommended testing** Have a yearly checkup that includes a gynecological examination and blood tests.

**Other things to consider doing** No other medicines are approved to reduce breast cancer risk for women who have not had breast cancer.

## NOLVADEX Study Findings Table

13,000 women at high risk of getting breast cancer were given NOLVADEX or a sugar pill for 6 years. Here's what happened:

<table>
<thead>
<tr>
<th></th>
<th>Women given a sugar pill</th>
<th>Women given NOLVADEX (20 mg a day)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>What difference did NOLVADEX make?</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did NOLVADEX help?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fewer women got invasive breast cancer (1.1% fewer)</td>
<td>2.4% 24 in 1000</td>
<td>1.3% 13 in 1000</td>
</tr>
<tr>
<td>No difference in dying from breast cancer</td>
<td>About 0.07% in both groups 0.7 in 1000</td>
<td></td>
</tr>
<tr>
<td>Did NOLVADEX have side effects?</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Life threatening side effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More women had a blood clot in their leg or lungs (0.3% more)</td>
<td>0.4% 4 in 1000</td>
<td>0.7% 7 in 1000</td>
</tr>
<tr>
<td>More women got invasive uterine cancer (0.6% more)</td>
<td>0.3% 3 in 1000</td>
<td>0.9% 9 in 1000</td>
</tr>
<tr>
<td>No difference in having a stroke</td>
<td>About 0.4% in both groups 4 in 1000</td>
<td></td>
</tr>
<tr>
<td><strong>Symptom side effects</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>More women had hot flashes (12% more)</td>
<td>68% 680 in 1000</td>
<td>80% 800 in 1000</td>
</tr>
<tr>
<td>More women had vaginal discharge (20% more)</td>
<td>35% 350 in 1000</td>
<td>55% 550 in 1000</td>
</tr>
<tr>
<td>More women had cataracts needing surgery (1.1% more)</td>
<td>2.0% 20 in 1000</td>
<td>3.1% 31 in 1000</td>
</tr>
<tr>
<td><strong>Other things to know</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No difference in dying (from anything)</td>
<td>About 1% in both groups 10 in 1000</td>
<td></td>
</tr>
</tbody>
</table>

**How long has the drug been in use?**

Nolvadex was first approved by the FDA in 1982 - Studies show that most serious side effects or recalls of new drugs happen during their first 5 years of approval.

Woloshin, Schwartz, Welch in *Dartmouth Medicine*, Spring 2008
Figure 1.

Literacy Levels and Average Literacy Proficiencies for the Total Population

PROSE

Average Proficiency 272

Percentage in Level

<table>
<thead>
<tr>
<th>Level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>21</td>
<td></td>
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<tr>
<td>5</td>
<td>3</td>
<td></td>
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DOCUMENT

Average Proficiency 267

Percentage in Level

<table>
<thead>
<tr>
<th>Level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
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</thead>
<tbody>
<tr>
<td>1</td>
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<td>3</td>
<td></td>
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</table>

QUANTITATIVE

Average Proficiency 271

Percentage in Level

<table>
<thead>
<tr>
<th>Level</th>
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<th>3</th>
<th>4</th>
<th>5</th>
</tr>
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<td></td>
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<tr>
<td>3</td>
<td>31</td>
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<td>4</td>
<td>17</td>
<td></td>
<td></td>
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<tr>
<td>5</td>
<td>4</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

National Adult Literacy Survey
Kirsch et al., Adult literacy in America, 2002

Quantitative Literacy: Level I
Quantitative Literacy: Level II

The price of one ticket and bus for "Sleuth" costs how much less than the price of one ticket and bus for "On the Town"?

THEATER TRIP

A charter bus will leave from the bus stop (near the Conference Center) at 4 p.m., giving you plenty of time for dinner in New York. Return trip will start from West 45th Street directly following the plays. Both theaters are on West 45th Street. Allow about 1½ hours for the return trip.

Time: 4 p.m., Saturday, November 20
Price: “On the Town” Ticket and bus $11.00
      “Sleuth” Ticket and bus $8.50
Limit: Two tickets per person
You need to borrow $10,000. Find the ad for Home Equity Loans on page 2 in the newspaper provided. Explain to the interviewer how you would compute the total amount of interest charges you would pay under this loan plan. Please tell the interviewer when you are ready to begin.

**FIXED RATE • FIXED TERM**

**HOME EQUITY LOANS**

<table>
<thead>
<tr>
<th>Amount Financed</th>
<th>Monthly Payment</th>
</tr>
</thead>
<tbody>
<tr>
<td>$10,000</td>
<td>$156.77</td>
</tr>
<tr>
<td>$25,000</td>
<td>$391.93</td>
</tr>
<tr>
<td>$40,000</td>
<td>$627.09</td>
</tr>
</tbody>
</table>

120 Months 14.25% APR
Health Numeracy/Quantitative Literacy/Statistical Literacy

• The degree to which individuals have the capacity to access, process, interpret, communicate, and act on numerical quantitative, graphical, biostatistical, and probabilistic health information needed to make effective health decisions (Golbeck et al., American Journal of Preventive Medicine, 2005)

• The capacity of individuals to obtain, interpret and understand basic health information and services and the competence to use such information and services in ways which are health-enhancing (Joint Committee on National Health Education Standards, 1995)

• The individual-level skills needed to understand and use quantitative health information, including basic computation skills, ability to use information in documents and non-text formats such as graphs, and ability to communicate orally (Ancker & Kaufman, Journal of the American Medical Informatics Association, 2007)
Why is numeracy important today?

- There has been a shift from provider-centered decision making to a patient-centered decision making model: the onus is on patients to understand risk.
- The recent emphasis on evidence-based medicine means that the public is routinely exposed to research findings and risk communication.
- Numeracy is essential for making effective health decisions (e.g., selecting a health insurance plan, choosing a hospital, evaluating direct-to-consumer advertising).
- A basic understanding of numbers is necessary to navigate the health care system.
- Low numeracy impairs risk communication and perception of risk and benefit.
- Low numeracy is associated with poorer treatment/medication compliance.
Numeracy: Health Behaviors and Health Outcomes

- Low numeracy is associated with overestimation of cancer risk (Schwartz et al., 1997)
- Utilities elicited from low numerate individuals may not be a meaningful reflection of their values for health states (Woloshin et al., 2001)
- Low health literacy is associated with: poor knowledge of chronic diseases (e.g., hypertension, diabetes); poor self-management skills (Williams et al., 1998); lower use of preventive health services (Scott et al., 2002); hospital admissions (Baker et al., 2002)
- Low numeracy associated with poor anticoagulation control (Estrada et al., 2004)
- Higher diabetes-related numeracy associated with higher perceived efficacy for diabetes management (Cavanaugh et al., 2008)
Assessing Numeracy

• Imagine that we flip a fair coin 1,000 times. What is your best guess about how many times the coin would come up heads in 1,000 flips?

• In the BIG BUCKS LOTTERY, the chance of winning a $10 prize is 1%. What is your best guess about how many people would win a $10 prize if 1000 people each buy a single ticket to BIG BUCKS?

• In ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISJHONG SWEEPSTAKES win a car?
Asthma Numeracy Questionnaire

Here are some examples of statements or questions patients might hear in a doctor’s office.

1. Your doctor asks you to take 30 mg of prednisone every day for a week. The pharmacist gives you a bottle of 5 mg tablets. How many pills should you take each day?
   □ □

2. If a patient has a 1% chance of developing osteoporosis or bone loss:
   that means
   a. Out of 1000 patients, one will develop bone loss
   b. Out of 100 patients, one will develop bone loss
   c. Out of 10 patients, one will develop bone loss
   d. Out of 5 patients, one will develop bone loss
   e. The patient will develop bone loss
   f. The patient will never develop bone loss

3. You have a peak flow meter. Your Danger or Red Zone is 50% of your best reading. Your best reading is 400 L/min. What is your Danger Zone?
   □ □ □ L/min or less

4. You are told the Green Zone (the OK zone) is a reading between 80% and 100% of your best reading. Your Worry Zone is between 50% and 80% of your best reading. Your best reading is 400 L/min. When are your readings in the Worry Zone?
   a. Between 300 and 400 L/min
   b. Between 200 and 320 L/min
   c. Between 200 and 300 L/min
   d. Between 240 and 320 L/min
   e. Between 100 and 300 L/min

Apter et al., Journal of Asthma, 2006
Asthma Numeracy Skill and Health Literacy
Apter et al., *Journal of Asthma*, 2006

**Objective:** To assess understanding of numerical concepts in asthma self-management (N = 73 adult asthma patients)

**Measures:** Asthma Numeracy Questionnaire (ANQ), STOFHLA, REALM

**Results**
- Lower ANQ scores associated with a history of hospitalizations
- Lower ANQ scores associated with a history of emergency room visits for asthma
- These relationships not seen with STOFHLA scores

**Conclusions**
- “Widely used measures of health literacy do not identify many adults who lack numerical skills needed for asthma self-management.”
- The ANQ can identify numeracy difficulties with asthma self-management that are useful for clinicians delivering asthma care
- “Numeracy appears to be a unique literacy property related to asthma outcomes.”
### Nutrition Facts

<table>
<thead>
<tr>
<th>Serving Size</th>
<th>1/2 cup</th>
</tr>
</thead>
<tbody>
<tr>
<td>Servings per container</td>
<td>4</td>
</tr>
</tbody>
</table>

**Amount per serving**

<table>
<thead>
<tr>
<th>Calories</th>
<th>250</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fat Cal</td>
<td>120</td>
</tr>
<tr>
<td>%DV</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total Fat</th>
<th>13g</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sat Fat</td>
<td>9g</td>
</tr>
<tr>
<td>Cholesterol</td>
<td>28mg</td>
</tr>
<tr>
<td>Sodium</td>
<td>55mg</td>
</tr>
<tr>
<td>Total Carbohydrate</td>
<td>30g</td>
</tr>
<tr>
<td>Dietary Fiber</td>
<td>2g</td>
</tr>
<tr>
<td>Sugars</td>
<td>23g</td>
</tr>
<tr>
<td>Protein</td>
<td>4g</td>
</tr>
<tr>
<td>%DV</td>
<td>8%</td>
</tr>
</tbody>
</table>

* Percent Daily Values (DV) are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs.

**Ingredients:** Cream, Skim Milk, Liquid Sugar, Water, Egg Yolks, Brown Sugar, Milkfat, Peanut Oil, Sugar, Butter, Salt, Carrageenan, Vanilla Extract.

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### Figure 1B. Questions and answers score sheet for the newest vital sign — English.

**READ TO SUBJECT:** This information is on the back of a container of a pint of ice cream.

**QUESTIONS**

1. If you eat the entire container, how many calories will you eat?
   - **Answer** 900 is the only correct answer

2. If you are allowed to eat 60 g of carbohydrates as a snack, how much ice cream could you have?
   - **Answer** Any of the following is correct:
     - 1 cup (or any amount up to 1 cup)
     - Half the container
   - Note: If patient answers "2 servings," ask "How much ice cream would that be if you were to measure it into a bowl?"

3. Your doctor advises you to reduce the amount of saturated fat in your diet. You usually have 42 g of saturated fat each day, which includes 1 serving of ice cream. If you stop eating ice cream, how many grams of saturated fat would you be consuming each day?
   - **Answer** 13 is the only correct answer

4. If you usually eat 2500 calories in a day, what percentage of your daily value of calories will you be eating if you eat one serving?
   - **Answer** 10% is the only correct answer

Pretend that you are allergic to the following substances: Penicillin, peanuts, latex gloves, and bee stings.

5. Is it safe for you to eat this ice cream?
   - **Answer** No

6. (Ask only if the patient responds "no" to question 5): Why not?
   - **Answer** Because it has peanut oil.

**Total Correct**
Nutrition Label Survey

![Nutrition Facts Table](image)

**Question:** How many grams of total carbohydrates are in $\frac{1}{2}$ of a bagel?

**Correct response:** 28 grams

**Common errors:** Did not apply serving size; incorrect calculation; read % Daily Value column for Total Carbohydrate (19%); used % Daily Value column in calculation.

**Percent correct:** 60%
Question: How many grams of dietary fiber are in 5 candies?

Correct response: 1 gram

Common errors: Multiplied dietary fiber by 5 (misinterpretation of serving size); multiplied total dietary fiber for a 2000 calorie diet (25g) by 5; multiplied % Daily Value column for Dietary Fiber (4%) by 5.

Percent correct: 66%

Rothman et al., American Journal of Preventive Medicine, 2006
**Nutrition Facts**

Serving Size 8 fl oz (240 mL)
Servings Per Container 2.5

<table>
<thead>
<tr>
<th>Amount Per Serving</th>
<th>% Daily Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories 100</td>
<td></td>
</tr>
<tr>
<td>Total Fat 0g</td>
<td>0%</td>
</tr>
<tr>
<td>Sodium 25mg</td>
<td>1%</td>
</tr>
<tr>
<td>Total Carbohydrate 27g</td>
<td>9%</td>
</tr>
<tr>
<td>Sugars 27g</td>
<td></td>
</tr>
<tr>
<td>Protein 0g</td>
<td></td>
</tr>
</tbody>
</table>

*Percent Daily Values are based on a 2,000 calorie diet.

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**Question:** You drink the whole bottle of soda. How many grams of total carbohydrates does this contain?

**Correct response:** 67.5 grams

**Common errors:** Did not apply serving size; incorrect calculation; read % Daily Value column for Total Carb. (9%) or used it in calculation.

**Percent correct:** 32%
Findings From the Nutrition Label Survey

**Objective**: Examine patients’ ability to read and understand nutrition labels

**Measures**: Rapid Estimate of Adult Literacy in Medicine (REALM), Wide Range Achievement Test (WRAT-3)

**Results**
- 77% had greater than a 9\(^{th}\) grade reading level; 37% had 9\(^{th}\) grade math skills
- On average, patients answered 69% of questions correctly
- Understanding of food labels was significantly associated with numeracy, literacy, education, and higher income

**Conclusions**
- Ability to interpret food labels is highly correlated with literacy/numeracy skill
- Even patients with higher education can have difficulty interpreting food labels
Development and validation of the Diabetes Numeracy Test (DNT)
Mary Margaret Huizinga\textsuperscript{1,2,3}, Tom A Elasy\textsuperscript{1,2,3}, Kenneth A Wallston\textsuperscript{4}, Kerri Cavanaugh\textsuperscript{5}, Dianne Davis\textsuperscript{3}, Rebecca P Gregory\textsuperscript{3}, Lynn S Fuchs\textsuperscript{6}, Robert Malone\textsuperscript{7}, Andrea Cherrington\textsuperscript{8}, Darren A DeWalt\textsuperscript{7}, John Buse\textsuperscript{7}, Michael Pignone\textsuperscript{7} and Russell L Rothman\textsuperscript{1,2,3}

Abstract

\textbf{Background:} Low literacy and numeracy skills are common. Adequate numeracy skills are crucial in the management of diabetes. Diabetes patients use numeracy skills to interpret glucose meters, administer medications, follow dietary guidelines and other tasks. Existing literacy scales may not be adequate to assess numeracy skills. This paper describes the development and psychometric properties of the Diabetes Numeracy Test (DNT), the first scale to specifically measure numeracy skills used in diabetes.

\textbf{Methods:} The items of the DNT were developed by an expert panel and refined using cognitive response interviews with potential respondents. The final version of the DNT (43 items) and other relevant measures were administered to a convenience sample of 398 patients with diabetes. Internal reliability was determined by the Kuder-Richardson coefficient (KR-20). An \textit{a priori} hypothetical model was developed to determine construct validity. A shortened 15-item version, the DNT15, was created through split sample analysis.

\textbf{Results:} The DNT had excellent internal reliability (KR-20 = 0.95). The DNT was significantly correlated (p < 0.05) with education, income, literacy and math skills, and diabetes knowledge, supporting excellent construct validity. The mean score on the DNT was 61\% and took an average of 33 minutes to complete. The DNT15 also had good internal reliability (KR-20 = 0.90 and 0.89). In split sample analysis, correlations of the DNT-15 with the full DNT in both sub-samples was high (rho = 0.96 and 0.97, respectively).

\textbf{Conclusion:} The DNT is a reliable and valid measure of diabetes related numeracy skills. An equally adequate but more time-efficient version of the DNT, the DNT15, can be used for research and clinical purposes to evaluate diabetes related numeracy.
Question 1

You are told to follow the sliding scale shown here. The sliding scale indicates the amount of insulin you take based upon your blood sugar levels.

<table>
<thead>
<tr>
<th>If Blood sugar is:</th>
<th>Units of Insulin</th>
</tr>
</thead>
<tbody>
<tr>
<td>130-180</td>
<td>0</td>
</tr>
<tr>
<td>181-230</td>
<td>1</td>
</tr>
<tr>
<td>231-280</td>
<td>2</td>
</tr>
<tr>
<td>281-330</td>
<td>3</td>
</tr>
<tr>
<td>331-380</td>
<td>4</td>
</tr>
</tbody>
</table>

How much insulin would you take for a blood sugar of 295?

**ANSWER _____ units**

Correct answer: 3 units

Percent answered correctly 85%

---

Question 2

After seeing the Doctor, you are given the following instruction to lower a high blood sugar level before a meal:

“Starting with a blood sugar of 120, take 1 unit of Humalog insulin for each 50 points of blood sugar.”

How much insulin should you take for a blood sugar of 375?

**ANSWER _____ units**

Correct: 5 units

Percent answered correctly 37%
Diabetes Numeracy Test (DNT)

**Objective:** To develop a scale to measure numeracy skills used in diabetes

**Measures:** REALM, WRAT-3, Diabetes Knowledge Test

**Results**
- N= 398 adult diabetes patients
- 83% completed high school; 31% had greater than 9\textsuperscript{th} grade numeracy
- DNT significantly associated with diabetes knowledge, education, SES, literacy, numeracy, and complex insulin regimens

**Conclusions**
- The full DNT and DNT15 are reliable and valid scales that may be useful in identifying patients with limited diabetes-related numeracy skills
- The DNT15 is appropriate for research and clinical use to evaluate diabetes-related numeracy
What is the best way to communicate risk information visually?
Design Features of Graphs in Health Risk Communication: A Systematic Review

Jessica S. Ancker, MPH, Yalini Senathirajah, Rita Kukafka, DrPH, MA
Justin B. Starren, MD, PhD

Abstract This review describes recent experimental and focus group research on graphics as a method of communication about quantitative health risks. Some of the studies discussed in this review assessed effect of graphs on quantitative reasoning, others assessed effects on behavior or behavioral intentions, and still others assessed viewers’ likes and dislikes. Graphical features that improve the accuracy of quantitative reasoning appear to differ from the features most likely to alter behavior or intentions. For example, graphs that make part-to-whole relationships available visually may help people attend to the relationship between the numerator (the number of people affected by a hazard) and the denominator (the entire population at risk), whereas graphs that show only the numerator appear to inflate the perceived risk and may induce risk-averse behavior. Viewers often preferred design features such as visual simplicity and familiarity that were not associated with accurate quantitative judgments. Communicators should not assume that all graphics are more intuitive than text; many of the studies found that patients’ interpretations of the graphics were dependent upon expertise or instruction. Potentially useful directions for continuing research include interactions with educational level and numeracy and successful ways to communicate uncertainty about risk.
STANDARD TIRES

Cost: $225 for 4

Annual Blowout Injury Risk (per 5,000,000 MI drivers): number of serious injuries:

IMPROVED TIRES

Cost: $? for 4

Annual Blowout Injury Risk (per 5,000,000 MI drivers): number of serious injuries:
Chance of Success Calculation

Probability of success on terazosin = 31%

Legend:

🌟 = achieved treatment goals
🟥 = did not achieve treatment goals

If you take terazosin, you have a 31% chance of achieving your desired level of BPH symptoms. If you choose watchful waiting (don’t take any medicine, wait and see), you have a 9% chance of achieving your desired level of BPH symptoms.

These probabilities are shown schematically above. Consider 100 men who choose a treatment. The light faces indicate men who have achieved their desired level of symptoms. The dark faces indicate men who are still bothered by symptoms of BPH.
The Paling Perspective Scale © John Paling 1992

Ancker et al., Journal of the American Medical Informatics Association, 2006
### Cancer Deaths from Lifetime Radon Exposure

<table>
<thead>
<tr>
<th>Radon Level (pCi/L)</th>
<th>Extra Cancer Deaths (out of 1000 people)</th>
<th>Equivalent Smoking Risk</th>
<th>Advice</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>500 in 1000</td>
<td><img src="image" alt="10 Packs per day" /></td>
<td>HIGH TO VERY HIGH RADON LEVELS: Measurements near the upper end of this range are much higher than the EPA action guideline. Exposure to such levels is very dangerous. For residents living in homes at the higher end of this range, action should be taken within the next couple of weeks to substantially reduce their exposure. If prompt action is not possible or is not effective, they should consider moving until the radon levels are reduced. Exposure to levels at the lower end of the range is also unsafe. Residents living in homes at these levels should act to reduce the readings within the next couple of months.</td>
</tr>
<tr>
<td>40</td>
<td>200 in 1000</td>
<td><img src="image" alt="2 Packs per day" /></td>
<td>MODERATE TO HIGH RADON LEVELS: Measurements in this range are above the EPA action guideline. Exposure to these levels is a significant risk if it extends over many years. Residents should carefully evaluate the cause of their elevated levels and make plans to reduce the levels permanently. To minimize the cumulative risk, this permanent action should be completed in the next year or two. In the meantime, residents may want to avoid prolonged exposure to areas of the home where the levels are highest.</td>
</tr>
<tr>
<td>20</td>
<td>100 in 1000</td>
<td><img src="image" alt="8 cigarettes per day" /></td>
<td>At 4 pCi/L, or above, EPA recommends that you reduce your radon level.</td>
</tr>
<tr>
<td>10</td>
<td>50 in 1000</td>
<td><img src="image" alt="6 cigarettes per day" /></td>
<td>LOW TO MODERATE RADON LEVELS: Measurements in this range fall below the EPA action guideline. Radon levels at the lower end of this range present a low health risk. Radon levels at the higher end of this range, extended over a lifetime, present a moderate health risk. Any plan to lower the levels should be carefully evaluated to ensure that it is likely to be effective, since it is often difficult to reduce levels below this range. Many authorities do not recommend trying to reduce levels in this range, especially for homes near the lower end. Residents who decide to try to reduce their levels below this range can take several years to act without adding significantly to their risk.</td>
</tr>
<tr>
<td>4</td>
<td>20 in 1000</td>
<td><img src="image" alt="2 cigarettes per day" /></td>
<td>VERY LOW TO LOW RADON LEVELS: Measurements in this range are no higher than the outdoor &quot;background&quot; level in many areas. Exposure to these levels does not call for action. Even at these low levels, there is a small risk associated with lifetime exposure to radon. However, authorities agree efforts to reduce radon levels still further are likely to be expensive and ineffective.</td>
</tr>
<tr>
<td>2</td>
<td>10 in 1000</td>
<td><img src="image" alt="2 cigarettes per day" /></td>
<td></td>
</tr>
</tbody>
</table>
Figure 1  The 6 formats in each of the 3 add-on conditions. The top row shows how the numbers (percentage being displayed) were displayed with each format, the middle row shows how the scales were added, and the bottom row shows how both numbers and scales were added to each format.

Improving Understanding of Adjuvant Therapy Options Via Simpler Risk Graphics

Brian J. ZIKMUND-FISHER, PhD1,2,3, Angela FAGERLIN, PhD1,2,3, and Peter A. UBEL, MD1,2,3,4

1VA Health Services Research & Development Center for Clinical Management Research, VA Ann Arbor Healthcare System, Ann Arbor, MI
2Center for Behavioral and Decision Sciences in Medicine, Ann Arbor, MI
3Division of General Internal Medicine, University of Michigan, Ann Arbor, MI
4Department of Psychology, University of Michigan, Ann Arbor, MI

Abstract

Background—To help oncologists and breast cancer patients make informed decisions about adjuvant therapies, online tools such as Adjuvant! provide tailored estimates of mortality and recurrence risks. However, the graphical format used to display these results (a set of four horizontal stacked bars) may be suboptimal. We tested whether using simpler formats would improve comprehension of the relevant risk statistics.

Materials and Methods—1,619 women ages 40-74 completed an Internet-administered survey vignette about adjuvant therapy decisions for a patient with an ER+ tumor. Participants were randomized to view one of four risk graphics: a base version that mirrored the Adjuvant! format or alternate graphs that showed only two options (those that included hormonal therapy), used a pictograph format, or included both changes. Outcome measures included comprehension of key statistics, time required to complete the task, and graph perception ratings.

Results—Both simplifying format changes significantly improved comprehension, especially when they were implemented together. Compared to participants who viewed the base 4-option bar graph, respondents who instead viewed a 2-option pictograph version were more accurate when reporting the incremental risk reduction achievable from adding chemotherapy to hormonal therapy (77% vs. 51%, p<0.001), answered that question quicker (Median time = 28 sec. vs. 42, p<0.001), and liked the graph more (M=7.67 vs. 6.88, p<0.001).

Conclusions—Although most patients will only view risk calculators such as Adjuvant! in consultation with their clinicians, simplifying the graphical design could significantly improve patients’ comprehension of statistics essential for informed decision making about adjuvant therapies.
Options for Women With ER+ Breast Cancer

- No additional treatment
- Hormonal therapy
- Chemotherapy
- Hormonal therapy and chemotherapy
No Additional Therapy
- 70 out of 100 women are alive in 10 years.
- 23 out of 100 women die because of cancer.
- 7 out of 100 women die of other causes.

Hormonal Therapy
- 7 out of 100 women are alive because of therapy.

Chemotherapy
- 3 out of 100 women are alive because of therapy.

Chemotherapy and Hormonal Therapy
- 9 out of 100 women are alive because of therapy.
Hormonal Therapy

- 77 out of 100 women are alive in 10 years.
- 23 out of 100 women die because of cancer.
- 7 out of 100 women die of other causes.

Chemotherapy and Hormonal Therapy

- 2 more women out of 100 women are alive because of additional therapy.

Zikmund-Fisher et al., Cancer, 2008.
Improving Understanding of Adjuvant Therapy Options Via Simpler Risk Graphics: Results

Zikmund-Fisher et al., *Cancer*, 2008
What is the best way to communicate risk numerically?
Breast Cancer Screening

• The prevalence of breast cancer is 1%
• If a woman has breast cancer, the probability that she tests positive is 90%
• If a woman does not have breast cancer, the probability that she will test positive is 9% (false-positive rate)

A woman tests positive. What does this mean?

A. The probability that she has breast cancer is about 81%
B. Out of 10 women with a positive mammogram, about 9 have breast cancer
C. Out of 10 women with a positive mammogram, about 1 has breast cancer
D. The probability that she has breast cancer is about 1%

Gigerenzer et al, Psychological Science in the Public Interest, 2008
Breast Cancer Screening

- 10 out of every 1,000 women have breast cancer
- Of these 10 women with breast cancer, 9 test positive
- Of the 990 women without cancer, about 89 nevertheless test positive

A woman tests positive. What does this mean?

A. The probability that she has breast cancer is about 81%
B. Out of 10 women with a positive mammogram, about 9 have breast cancer
C. Out of 10 women with a positive mammogram, about 1 has breast cancer
D. The probability that she has breast cancer is about 1%

Gigerenzer et al, *Psychological Science in the Public Interest*, 2008
C. Out of 10 women with a positive mammogram, about 1 has breast cancer

Gigerenzer et al, *Psychological Science in the Public Interest*, 2008
Suggested Reading


Suggested Reading


