COMMUNICATING RISKS AND BENEFITS:
An Evidence-Based User’s Guide

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Chapter 7: Quantitative Information

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Summary

For patients to make informed decisions about their health care, they must understand the risks and benefits of their treatment options, including the numeric likelihoods. Unfortunately, many patients have difficulty understanding numerical information. Evidence-based recommendations are made for improving the communication of numerical information.

Introduction

Approximately 50% of Americans cannot accurately calculate a tip. Almost a quarter of college educated adults do not know what is a higher risk: 1%, 5%, or 10%. The innumeracy that plagues Americans has a profound impact on patients’ ability to understand statistical rates of the risks and benefits of treatment options. Thus, it is not sufficient to simply tell patients that 10% of people experience a side effect...because in many cases, the patients will not be able to understand that information or incorporate it into their decision making.

In the present chapter, we review the concept and measurement of numeracy and summarize the evidence for communicating quantitative health information. We close the chapter by offering practical evidence-based advice on how best to communicate quantitative health information.

What does the science say about this aspect of communication?

Numeracy: its concept, measurement, and influence on information processing. Numeracy has been defined in a number of ways, with the broadest definition being the ability to comprehend, use, and attach meaning to numbers. Numeracy is assessed using both objective and subjective measures. Objective measures are basically math tests. Among the first objective measures of numeracy was a three-item test created by Schwartz et al. The questions revolved around probability, the ability to convert percentages to proportions and vice versa. This scale was incorporated into larger measures by Lipkus et al. and Peters et al. that used health-related questions. Other objective numeracy measures include the Test of Functional
Health Literacy (TOFHLA)\textsuperscript{6} the Medical Data Interpretation Test,\textsuperscript{7} which measures ability to interpret medical statistics and understand information related to disease, and the New Vital Sign, which uses nutrition panels as the context.\textsuperscript{8} Objective measures of numeracy provide the best estimate of people’s ability to understand and use numbers. A weakness of such measures is the significant time required to complete them, which may reduce their usefulness in research or clinical practice, and the frustration people report when completing them.\textsuperscript{9}

Subjective numeracy scales assess numerical ability without asking participants to perform mathematical computations. Rather, people assess their own ability to handle numeric information. Several measures currently use this approach. The Subjective Numeracy Scale (SNS) asks four questions that measure perceived ability (e.g., How good are you at calculating a 15% tip?) and four that measure preference for receiving information.\textsuperscript{9,10} The SNS measure takes less time to complete than Lipkus et al.’s objective numeracy measure and is less frustrating and stressful to complete.\textsuperscript{9} Furthermore, it has been found to correlate moderately with Lipkus’s objective numeracy measure and to predict some of the behaviors and abilities that Lipkus’s measure predicts (e.g., comprehension of survival curves).\textsuperscript{10} Additionally, the STAT-Confidence scale assesses people’s confidence in their understanding of medical statistics.\textsuperscript{11}

Individuals with higher numeracy skills comprehend more health information\textsuperscript{12} and attend to, remember, weigh, and, ultimately, use quantitative information more in their judgments and decisions.\textsuperscript{13-16} Less numerate individuals, on the other hand, appear more likely to weigh and use non-quantitative information, such as narratives and their own mood states, to inform their decision making.

In sum, researchers interested in numeracy have two types of measures from which to choose: objective and subjective. The best measure for any study will depend on the time constraints of participants, the importance of retaining participants in follow-up studies, and the value of obtaining actual numeric ability.

**Communicating risk and benefit in qualitative vs. quantitative terms.** Risks and benefits of patient treatments can be described qualitatively and/or quantitatively. With a qualitative description, a patient might be told there is a “low chance” of a side effect from a surgical procedure. In contrast, a quantitative description would describe the same risk numerically — the patient has a 1 out of 100 (1%) chance of developing the side effect. The two approaches, however, are not equally effective.\textsuperscript{17} One significant concern is the lack of agreement about what terms, such as low risk, mean. To one person a low risk is equated with a risk of 1%, whereas to a second person a low risk might be 10%.\textsuperscript{18} Furthermore, research has shown that, in the absence
of numeric benefits and risks (with only verbal descriptors of likelihood), consumers exhibit heightened (and perhaps exaggerated) perceptions of risks and benefits and are less able to identify which are the superior drugs.\textsuperscript{19-21}

To make quantitative information easier to understand, it is critical that the information be presented in an understandable way.

**Making numerical information comprehensible and useable**

**Less is more.** In three studies, Peters and colleagues tested whether providing lay decision makers with less information, rather than more, could result in the best outcomes.\textsuperscript{3} These studies showed that requiring less cognitive effort (e.g., by providing less information) in hospital quality reports resulted in better decision making through improved comprehension and higher quality choices, particularly among participants with lower numeracy skills.

This effect was also demonstrated with the breast cancer communication tool called “Adjuvant Online!” (http://www.adjuvantonline.com). This online tool is designed to help oncologists communicate patient benefits from receiving hormonal therapy and chemotherapy.\textsuperscript{22} Typically, patients are presented with the risks of no additional treatment, each treatment alone, or both hormonal therapy and chemotherapy. However, for most women, only two choices are appropriate. Zikmund-Fisher and colleagues tested the impact of providing only those two choices and found that, when fewer options were presented, knowledge and speed of processing increased significantly.\textsuperscript{23} These studies point towards the importance of having medical experts identify more and less critical elements of a decision so that risk communicators can choose strategically how to present them.

**Gain and loss framing.** Gain and loss framing refers to how one describes risks and benefits (e.g., the number of people who survive or die, respectively). Research has shown that decisions are sensitive to this information framing.\textsuperscript{24-29} For example, McNeil and colleagues asked patients, graduate students, and physicians to imagine they had lung cancer and make a treatment decision (surgery vs. radiation) based on cumulative probabilities and life-expectancy data.\textsuperscript{30} The authors manipulated the description of surgery, presenting it in terms of survival or mortality chances. In all three populations, more individuals chose surgery when they were told that it had a 90% survival rate than when they were told that the surgery had a 10% mortality rate.

Edwards and colleagues' review of the literature found that loss frames messages were generally more effective than gain frames.\textsuperscript{31} When the target behavior is prevention (e.g., infant car restraints, regular physical exercise), however, gain-framed messages are more effective\textsuperscript{25,27} as gain frames work better in situations where the outcomes are certain (e.g., using car seats decreases injuries and deaths of children). On the other hand, with uncertainty and risk (e.g., whether a mammogram will result in a cancer diagnosis), loss frames are more effective in promoting the desired behavior.\textsuperscript{25}
Absolute risk, relative risk, and number needed to treat (NNT). When explaining risks associated with treatment, three approaches exist to describe how the treatment changes risk. For example, when explaining the benefits of taking chemoprevention to prevent breast cancer, risk reduction could be described as (1) a 50% risk reduction (relative risk reduction), (2) a reduction from a 6% risk of breast cancer to 3% (absolute risk reduction) or (3) the number of women needed to take chemoprevention to prevent cancer in one of them (NNT).

Comprehension of information and risk perceptions differ across these three formats. Sheridan and colleagues found that NNT was the most difficult format for patients to understand and recommended that it never be the sole way that information is presented. Additionally, when information is presented in a relative risk format, the risk reduction seems larger and treatments are viewed more favorably than when the same information is presented using an absolute risk format. This is as true for the lay public as it is for medical students.

Natural frequency versus percentages. When providing data to patients about the risks and benefits of treatment, clinicians can present the data using either percentages (10% of patients) or natural frequencies (10 out of every 100 patients). A number of studies have examined people’s understanding of risk and benefit information based on whether the data were presented in terms of frequencies or percentages. Results (and their underlying explanation) have been equivocal.

The choice between frequencies and percentages also can affect people’s perceptions of the riskiness of the treatment. For instance, Peters and colleagues asked participants to imagine they had severe headaches and that a medicine existed that could decrease headache frequency. Participants read about a possible side effect of the drug in a percentage format (10% of patients get a blistering rash) or frequency format (10 patients out of 100 get a blistering rash). Less numerate participants perceived the medicine as less risky when side-effect information was presented using percentages rather than frequencies. Peters et al., interpreted their results as being due to the frequency formats eliciting greater emotional imagery compared to percentage formats, which were relatively abstract and meaningless.

Time frames. When considering the time frame to use when presenting risk or benefit information, it is critical to consider the following: (1) the time frame for which the best statistics are currently available, (2) the time frame over which events occur, and (3) the time frame that is most understood by patients.

The time span chosen can influence both knowledge and risk perceptions. People often fail to adjust their risk perceptions to account for longer time spans. For example, people are more likely to increase their use of seatbelts if told they have a 33% lifetime risk of serious injury without seat belts compared
with being told the much smaller risk of injury in a single trip.\textsuperscript{44} Even when people receive risk information in survival graph format (which explicitly shows how risk changes with time), they often fail to adjust their risk perceptions to account for the time span displayed.\textsuperscript{45,46}

**Graphical presentation of risk.** It is often recommended that graphs be used in addition to presenting numerical information.\textsuperscript{46} Graph types each have their advantages and drawbacks.\textsuperscript{47,48} Identifying the goal of the communication can help to identify the best graph type. If the goal is to help people comprehend comparisons, bar graphs are an excellent choice. If understanding trends over time is the goal, a line graph would be most beneficial. Similarly, pie graphs are superior for accurate judgments about proportions, whereas pictographs are most successful at highlighting the number of people affected, and not affected, by a medical treatment.

Graphs can influence more than one kind of comprehension. Some graphs influence verbatim understanding of precise information, whereas others facilitate understanding the gist of information.\textsuperscript{49} A recent study compared the ability of five graph types (bar graph, pie graph, clock graph, pictograph, and sparkplug) to communicate gist and verbatim information (See Figure 1).\textsuperscript{12} Pie and pictographs were superior for communicating gist information (e.g., Which drug resulted in the fewest number of patients needing a bypass surgery?), whereas bar graphs and pictographs were best at communicating verbatim knowledge (accurate reporting of precise numerical information). Systematic studies of the effects of graphs, however, have not been conducted with increasing numbers of attributes (e.g., a medication with ten side effects that each required its own graph). Graphs can influence behavior too. For example, graphs that emphasize the numerator of a risk produce more risk-avoidant behaviors. Conversely, pictographs, which display numerator and denominator information, decrease risk-avoidant behaviors.\textsuperscript{39}

**Incremental risk format.** As most treatments have side effects, it is important for patients to understand the likelihood they will experience one. Thus, it is important to make clear the differences between the baseline risk of a side effect (i.e., risk that is present without treatment) and the additional/incremental risk experienced due to the treatment.

One method to facilitate comprehension is to visually separate baseline risk from treatment risk. To do this, an initial pictograph presents the patient’s baseline risk. A second pictograph adds a new color to represent the additional people who would experience the side effect due to treatment (See Figure 2). In a study of over 600 women considering taking tamoxifen as chemoprevention, we found that this method reduced worry about medication side effects and reduced perceived likelihoods of experiencing a side effect.\textsuperscript{50} Debate exists in the literature whether this approach can be used successfully with tables.\textsuperscript{50,51}
Figure 1. Five types of graphical formats

- **Bar Graph**
  - *Each graph represents 100 people*
  - Need bypass surgery

- **Pie Graph**
  - *Each graph represents 100 people*

- **Clock Graph**
  - *Each graph represents 100 people*

- **Pictograph**
  - Each symbol represents 100 people
  - Need bypass surgery

- **Spark Plug**
  - *Each graph represents 100 people*
  - Need bypass surgery
Figure 2. Pictograph showing added risk

---100
---90
---80
---70
---60
---50
---40
---30
---20
---10
---0

Cataracts

*Cataracts* make one or both eyes cloudy, and make it hard to see.

Among 100 women our age who did take *tamoxifen*...

- The additional risk caused by taking *tamoxifen*:
  - 0.4 more women out of 100 (0.4%) would now get cataracts.

You may also return to any previous section using the menu at left.

The use of interpretive labels. People making decisions can be quite poor at using numeric information in making decisions. Interpreting the meaning of numeric information (e.g., tell patients how good or bad a 9% risk is) can have a robust influence in health judgments and choices across diverse adult populations. In one series of studies, providing interpretive labels resulted in greater use of numeric quality-of-care information in judgments and less reliance on an irrelevant affective state among the less numerate. Decision makers given interpretive labels nonetheless appeared to process the numeric information (and not ignore it due to the presence of labels). In another study, interpretive labels for test results (that a test came back “positive” or “abnormal”) induced larger changes to risk perceptions and behavioral intentions than did numeric results alone. The normative appropriateness of these changes is often unclear, however, so that interpretive labels should be applied with great care.

What general practical advice can the science support?

In this final section, we recommend ways to *nudge* individuals towards better comprehension and greater welfare. How to present information is an important choice for information providers that should be made with care using an evidence-based approach.

1. **Provide numeric likelihoods of risks and benefits.** Describing risks solely with words, such as *You have a low chance of experiencing a side effect* is ineffective. It does not provide patients with the details needed to make an informed decision; it increases risk perceptions, and patients vary in their interpretations of what low and high risks are. Thus, it is imperative to provide patients with numerical estimates of the risks and benefits associated with treatment options. The existence of individuals with lower numeracy skills does not mean that we should avoid presenting numerical
information. Instead, we should work to make numbers more accessible for all individuals. Furthermore, making numbers more accessible is unlikely to have a negative impact on those with higher numeracy skills as they can more flexibly understand information presented in different formats. In addition, information-processing skills decrease under stress. Thus, even highly numerate people can benefit from simple educational materials.

2. **Provide absolute risks, not just relative risks.** Patients are unduly influenced when risk information is presented using a relative risk approach; this can result in suboptimal decisions. Thus, an absolute risk format should be used.

3. **Keep denominators constant for comparisons.** It is difficult for patients to compare across treatments when different denominators are used. A single denominator should be chosen for comparisons (e.g., 1 in 10,000, 337 in 10,000). It is easier for patients to understand whole numbers (e.g., 1 in 10,000) rather than fractions or decimals (.01 in 100); thus, if risks are very small, larger denominators will be necessary.

4. **Keep time frames constant.** To facilitate comparisons, use the same time frame when presenting risks and benefits.

5. **Use pictographs and other visual aids when possible.** Graphs make numeric information easier to understand and pictographs are the best graph for communicating both gist and verbatim knowledge.

6. **Make the differences between baseline and treatment risks and benefits clear.** Use pictographs to show baseline risks in one color and the risks due to treatment in a different color.

7. **Reduce the amount of information shown as much as possible.** Health educators and clinicians are often motivated to provide patients with as much information as possible. However, with more information, patients may not know where to focus their attention and what information should be most important in their decisions. Thus, it is critical that providers of medical information think carefully about which information is key and exclude non-critical information.

8. **Provide both positive and negative frames.** People, particularly those who are less numerate, are unduly influenced by whether a treatment is described in positive or negative terms (e.g., survival rates versus mortality rates). Whenever possible, describe the risks and benefits using both frames. For instance “60% of men who have surgery to treat their prostate cancer will be impotent. This means that 40% of men will not experience impotence.”

9. **Take care using interpretive labels or symbols to convey the meaning of important information.** Interpreting the meaning of numeric information
(in terms of its goodness or badness) can affect people’s risk perceptions and change their decision making. It can also improve integration of multiple pieces of numeric information. This technique should, however, be used only when it appears that decision makers are using numeric information inappropriately (e.g., ignoring objective quality-of-care indicators in hospital judgments).

10. Test communications prior to use. It is critical to test educational materials prior to use to determine understandability and to make sure patients do not perceive bias in the materials and like them well enough to use. An iterative testing process is critical (see below for suggestions).

**How does one evaluate communications implementing this advice?**

**No budget.** Even when developing communications with no budget, opportunities exist to evaluate them. First, ask experts to review the materials for accuracy and balance. Second, ask coworkers (e.g., housecleaning and cafeteria staff), colleagues, friends, or family (particularly those with less education and experience in risk communication) to evaluate and comment on materials. Ask (1) how understandable the material seemed, (2) whether the amount of information was right, (3) how balanced the material was (in terms of presenting the treatment options), (4) how much they would recommend this material, and (5) how it could be improved.

**Modest budget.** Additional strategies include one-on-one cognitive interviews. During the cognitive interviews, you can (1) test for comprehension of the materials (e.g., with quizzes after each section) and (2) ask participants to describe their emotional reactions to different sections. It is especially important to include people with less education and lower numeracy and literacy levels and those of different races and genders.

**Serious budget.** Additional strategies include (1) employ a literacy expert to test the reading and numeracy levels of materials to ensure they are around 6th to 8th grade level (and to provide recommendations for improving the materials if necessary) and (2) test your materials (and alternatives) with a representative sample.

**Conclusions**

Just as it is no longer appropriate for physicians to dictate treatments to patients, it is also no longer appropriate to write educational materials without thought for how people will understand or use it. Although it is a significant challenge to create materials understandable to populations with low literacy and numeracy skills, the reality is that many individuals have difficulty reading simple text and working with numbers. Therefore, care must be taken to ensure that patients can use educational materials and understand the risks and benefits of their options to make an informed decision.
Additional resources


Endnotes


