

Numeracy Skill And The Communication, Comprehension, And Use Of Risk-Benefit Information

Careful attention to information presentation can help the less numerate use important numbers in their health decisions.

by **Ellen Peters, Judith Hibbard, Paul Slovic, and Nathan Dieckmann**

ABSTRACT: Current health care policy emphasizes improving health outcomes and the efficacy of health care delivery by supporting informed consumer choices. At the same time, health information often involves uncertainty, and many people may lack the skills and knowledge to process this information, manage their health and health care, and make informed choices. Innumeracy, an element of poor health literacy, is associated with the comprehension and use of important health information. We review this literature and examine what can be done to help less numerate people act more effectively and take charge of their health. [*Health Affairs* 26, no. 3 (2007): 741–748; 10.1377/hlthaff.26.3.741]

INCREASINGLY, THE EMPHASIS OF HEALTH CARE policy is to tap the potential power of informed consumers to improve health outcomes and the efficacy of health care. Employers and payers, recognizing the essential role that consumers can play in containing costs and improving care, have undertaken initiatives to influence consumers' behavior. They have urged consumers to change the way they select and use health care and how they manage their day-to-day health. Attempts have been made to encourage consumers to select high-performing providers, health plans, and facilities; choose evidenced-based, cost-effective treatments; collaborate with their providers; initiate and maintain healthy behavior; and manage their own symptoms and conditions. At the same time, consumers are being asked to assume a greater share of their health care costs than ever before. As a result, choices have become more consequential for patients, in terms of both financial and health outcomes.¹

However, not all consumers have the skills needed to use health information. A

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key concern is whether the policy approach of giving greater responsibility to patients will further disadvantage those with limited skills. Health literacy has been linked with higher health care costs and could be a driver of health disparities. In a recent study, health reading literacy and numeracy were found to independently influence the comprehension and use of information about hospital choices.² Inadequate numeracy might be an important barrier to patients' understanding of their health situations and to their obtaining high-quality care.

Health care information can be complex, and different sources can yield contradictory advice. Chronic disease patients, for example, must make many choices daily that have major implications for their health and need for care. They often must follow complex treatment regimens with uncertain risks and benefits, monitor their own conditions, make lifestyle changes, and decide when to seek professional care. We tend to assume that simply providing information will result in a level playing field for all. However, many consumers lack the skills, knowledge, and motivation to access credible sources, process information, and make informed choices. Consequently, they have more health crises and functional declines than those who do have the skills, knowledge, and motivation.³

The purpose of this paper is to examine the concept of numeracy, why numeric skill is important to health care decisions, and what the best practices are for the presentation of numeric health information. We limit our review to (1) what is known about the influence of numeracy on comprehension and use of risk-benefit information and (2) what strategies exist for supporting the use of numeric information in patient choice.

Definition Of 'Numeracy' And Extent Of Innumeracy

Numeracy is an element of health literacy that refers to the ability to understand numbers. Researchers have measured it through both objective math tests and self-reported perceptions of math ability.⁴ Based on the National Adult Literacy Survey, almost half of the general population has difficulty with relatively simple numeric tasks such as calculating (using a calculator) the difference between a regular price and a sales price or estimating the cost per ounce of a grocery item.⁵ These people do not necessarily perceive themselves as "at risk" in their lives because of limited skills.

Having fewer numeric skills, however, is associated with lower comprehension and less use of health information. Many patients cannot perform the basic numeric tasks required to function in the current health care environment. For example, 26 percent in one study were unable to understand information about when an appointment was scheduled.⁶ Another study found that 16 percent of highly educated people incorrectly answered straightforward questions about risk magnitudes (for example, Which represents the larger risk: 1 percent, 5 percent, or 10 percent?).⁷ Understanding numeric information in real health situations is often much more difficult than in hypothetical situations.

Understanding Numbers: Essential For Health Decisions

Uncertainty abounds in health care settings, and successful communication of uncertain information to all patients becomes critical. The human mind, however, has difficulty coping with complicated information, and people tend to reduce the burden of processing such information by using simplifying strategies. At least four kinds of uncertainty exist in health care settings and result in the use of simplifying strategies.

■ **Uncertainty in health care settings.** To begin with, uncertainty exists about the magnitude or severity of possible benefits and risks (for example, the extent of pain reduction). Patients' testimonials may provide such information, but they can also overwhelm statistical information in health decisions.⁸ Second, uncertainty may exist about the strength of current evidence—for example, concerning a treatment or the quality of care offered by a hospital. In processing information of uncertain accuracy or reliability, people tend to accept information fully or reject it completely, without adjusting for data quality. This “best-guess” strategy simplifies information integration but ignores uncertainty.⁹ Thus, showing confidence intervals, for example, might reduce use of information. Because the less numerate tend to trust numerical information less than their more numerate peers do, a reasonable expectation is that they will be more likely than others to reject information that they perceive to be inaccurate or unreliable.¹⁰

Third, patients and consumers are often uncertain about how to weigh risks and benefits in choices. Each of these topics is important, but no research appears to examine interactions of these topics with numeracy skill. Finally, uncertainty exists about the likelihood of different outcomes. Side effects or complications, for example, occur with almost all treatments. They do not necessarily happen to everyone, but physicians cannot predict exactly who will experience them. Instead, evidence-based medicine might provide a population-based likelihood (for example, the Gail model indicates that a woman has a 6 percent lifetime chance of breast cancer). Similarly, the likelihood of receiving high-quality care in a hospital might vary across local hospitals, but exactly who will receive that care is unknown. Patients, however, can choose a hospital where high-quality care is more likely. Comprehension and use of likelihood information varies depending both on a person's numeracy skill and the format of the information.¹¹

■ **Skills needed to understand risk-benefit information.** A hierarchy of skills is needed to comprehend and use information about the likelihood of risks and benefits. First, information must be available, accurate, and timely, and the patient must be able to acquire it from tables, charts, and text.¹² Then, patients often must make calculations and inferences. For example, given survival rates for chemotherapy versus hormone therapy, a cancer patient must calculate the difference between therapies and infer the meaning of that difference. Next, patients must remember information either for a short period (if the decision is made quickly) or after an extended delay, and memory ability differs across patient populations. The patient must be

able to weight factors to match his or her needs and values and, finally, must make trade-offs, either mundane or emotionally devastating, to ultimately arrive at a health decision. This process can be quite difficult.

Numeric Skills Associated With The Quality Of Health Decisions

■ **Evaluating risks and benefits of health options.** Those with inadequate numeracy have more difficulty using numeric information to inform their choices than do those with good numeric skills. For example, the National Institutes of Health (NIH) recommends that women ages 40–49 assess the need for mammography screening with their doctors. Patients, in this case, have to evaluate the risks and benefits of health options themselves, or else physicians must substitute their judgments for their patients' preferences.¹³ Lisa Schwartz and colleagues concluded that quantitative descriptors of risk were necessary in such cases because qualitative descriptions were too ambiguous.¹⁴ However, less-numerate women in their study could not accurately determine the benefits of screening from the numbers provided.

■ **Following complex health regimens.** Numeracy skill also appears to influence the ability to follow complex health regimens. Low numeracy was common in a group of patients who took warfarin to reduce stroke risk and was associated with poorer anticoagulation control.¹⁵ In addition, limited numeracy might be an important barrier to the meaningful assessment of patients' values. For example, less numerate women who were asked to assess the value of imaginary health states (such as heart disease and osteoporosis) using standard techniques had more difficulty and provided less valid assessments than those who were highly numerate.¹⁶ A substantial minority of physicians also have difficulty understanding and interpreting numeric medical data, which suggests that physicians might not always be reliable translators of health information for patients.¹⁷

■ **Weighing short-term against long-term benefits.** Intertemporal choices represent an important, neglected area of health research, as patients are often asked to incur concrete costs now (take medication, feel anxious about getting a test) to reap long-term, but abstract and probabilistic, rewards later. Research in non-health-related domains suggests that (compared with more numerate patients) less numerate patients will be more likely to weigh short-term costs and benefits than those occurring in the distant future.¹⁸

Best Practices In Presenting Numeric Health Information

People who differ in numeracy appear to have different needs for decision aids. Some preliminary research has focused on how comprehension and quality of decisions (for example, choosing the best insurance plans) vary as a function of the interaction between numeracy and the format of provided information.

■ **Less is often more.** People tend to comprehend more and make better-

informed decisions when the presentation format makes the most important information easier to evaluate and when less cognitive effort is required.¹⁹ Results from three experiments were particularly strong for those with lower numeracy skills and support the idea that “less is more” when one is presenting consumers with comparative performance information to make hospital care choices. In one study, respondents who were given only the most relevant information about hospital quality (for example, percentage of patients receiving recommended care) were better able to comprehend that information and were more likely to choose a higher-quality hospital compared with respondents who received the same quality information plus less-relevant information (for example, the number of general care beds). In a second study, making only a more important quality measure easier to evaluate rather than making all indicators easier to evaluate led to more choices of higher-quality hospitals. In a third study, less cognitive effort was more; presenting quality information in a format in which a higher number means better (the number of registered nurses per 100 patients) compared to one where a lower number means better (the number of patients per registered nurse) facilitated comprehension and helped respondents make better choices.

If hospital decisions are to be aided by information about quality as well as cost, then reports need to show only important quality measures (or at least highlight them), make them easier to evaluate (for example, by using well-tested symbols), and present data in accordance with cognitive expectations (that is, higher numbers mean better performance). For those with poor numeracy skills, the effect of information presentation on comprehension and choice is even more marked.

■ **Reduce required inferences and calculations.** Other options for reducing cognitive effort have not been tested with numeracy but are likely to be effective. For example, information providers should reduce required inferences and calculations. In one study, a sizable minority could not infer a monthly premium when told that the previous year’s premium was \$100 a month and the premium increase was 2 percent (instead of being told that this year’s premium would be \$102).²⁰ Small probabilities should not be presented as one chance out of a larger number (1 of 50; 1 of 1,000); instead, information providers should keep the denominator constant to reduce effort and increase comprehension and use of the information (20 of 1,000; 1 of 1,000). Risks should also be compared using the same time span. The use of visual cues such as stars to highlight the meaning of information is also likely to help, as is ordering and summarizing information.²¹ As mentioned earlier, presenting higher-level statistical concepts (for example, confidence intervals) to consumers should be avoided, because people tend to accept or reject information fully without adjusting for data quality.²²

■ **Test formats carefully to reduce numeracy effects.** It is well known that people often respond more strongly to options that are described as losses rather than (equivalent) gains.²³ For example, patients are more likely to obtain a screening test if the costs associated with not getting screened are emphasized rather than the

benefits of getting screened.²⁴ Although not yet tested in a health context, one of the authors (Peters) and other colleagues found that less numerate decisionmakers were influenced more by different (but equivalent) frames of numeric information than were those with high numeracy skills.²⁵ Carefully tested formats might reduce these effects.

■ **Other aids.** Research on presenting numeric information about risks and benefits is still relatively new, but some general themes have emerged. Visual displays, for example, can increase both comprehension and risk perceptions.²⁶ Hannah Faye Chua and colleagues demonstrated that visual displays of gum disease influenced cognitive and affective representations of risky options and increased willingness to pay to decrease risk.²⁷ The affective influence, in particular, might be critical to risk perceptions and behavior.²⁸ Presenting absolute risks (for example, 3 out of 1,000 will have a stroke) increases comprehension over the use of relative risks (50 percent higher chance of stroke).²⁹ Results are mixed as to whether percentage (13 percent) or frequency (13 out of 100) formats promote the greatest understanding.³⁰ There is general agreement that decimals (its likelihood is .03) should not be used. Finally, individualized risk estimates rather than general population figures increase uptake of screening tests but might not be evidence of more-informed decisions.³¹

Highly numerate people are likely to pay more attention to numbers, comprehend them better, translate them into meaningful information, and ultimately use them in decisions, compared with their less numerate peers.³² The decisions of the less numerate are likely to be informed less by numbers and more by other non-numeric sources of information such as their emotions, mood states, and trust or distrust in physicians and the health system. Careful attention to information presentation should allow everyone—particularly the less numerate—to attend more to important numbers and use them more effectively in decisions. Approaches to presenting numeric information should be tested with target audiences whenever possible, and refinements should be made to increase the comprehensibility and usability of the information.

A New Definition Of ‘Health Literacy’

To be a competent health care consumer in the current environment, one must be able to understand health care information and use it in making choices. Comprehension is based in large part on the difficulty of the material and on the individual’s skills. It might also be a matter of motivation, or how much “effort” a person is willing to exert to understand and make good choices.³³ A traditional definition of *health literacy* concerns individual patients’ abilities. We believe that this definition should also include the format of the provided information and what it requires from patients.

Of course, any deliberate framing of information raises ethical questions about manipulating patients’ preferences. A strong case for such manipulation is presented by Cass Sunstein and Richard Thaler, who argue for a program of “libertar-

ian paternalism” that acknowledges the fact that neutral framing of information does not exist and suggests that communications should employ formats that are likely to promote patients’ welfare.³⁴ But the ultimate choice is left to the individual, following the libertarian perspective.

IDEALLY, WE SHOULD STRIVE TO PRESENT important health information to patients and their families so as to encourage the best decisions for all, without hurting those who might already be disadvantaged. A further goal is to satisfy patients and other decisionmakers that they are adequately informed given the present state of knowledge. Meeting these goals requires careful thought devoted not only to the content of health information but also to the format in which it is presented. What format is chosen will influence how well the information is understood and used by people who vary in ability, time, and motivation. Failing to meet these objectives will lead to dissatisfaction, system inefficiencies, and serious health and financial consequences for those struggling to make good choices within our complex health care environment.

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NOTES

1. J.K. Iglehart, “Changing Health Insurance Trends,” *New England Journal of Medicine* 347, no. 12 (2002): 956–962; and R.E. Herzlinger, “Let’s Put Consumers in Charge of Health Care,” *Harvard Business Review* 80, no. 7 (2002): 44–55.
2. J.H. Hibbard et al., “Consumer Competencies and the Use of Comparative Quality Information: It Isn’t Just about Literacy,” *Medical Care Research and Review* (forthcoming).
3. E.N. Marcus, “The Silent Epidemic—The Health Effects of Illiteracy,” *New England Journal of Medicine* 355, no. 4 (2006): 339–341; and C.A. Estrada et al., “Literacy and Numeracy Skills and Anticoagulation Control,” *American Journal of the Medical Sciences* 328, no. 2 (2004): 88–93.
4. L.M. Schwartz et al., “The Role of Numeracy in Understanding the Benefit of Screening Mammography,” *Annals of Internal Medicine* 127, no. 11 (1997): 966–972; I.M. Lipkus, G. Samsa, and B.K. Rimer, “General Performance on a Numeracy Scale among Highly Educated Samples,” *Medical Decision Making* 21, no. 1 (2001): 37–44; and A. Fagerlin et al., “Measuring Numeracy without a Math Test: Development of the Subjective Numeracy Scale (SNS),” *Medical Decision Making* (forthcoming).
5. I.S. Kirsch et al., *Adult Literacy in America: A First Look at the Findings of the National Adult Literacy Survey*, 3d ed., April 2002, <http://nces.ed.gov/pubs93/93275.pdf> (accessed 2 March 2007).
6. M.V. Williams et al., “Inadequate Functional Health Literacy among Patients at Two Public Hospitals,” *Journal of the American Medical Association* 274, no. 21 (1995): 1677–1682.
7. Lipkus et al., “General Performance.”
8. A. Fagerlin, C. Wang, and P.A. Ubel, “Reducing the Influence of Anecdotal Reasoning on People’s Health Care Decisions: Is a Picture Worth a Thousand Statistics?” *Medical Decision Making* 25, no. 4 (2005): 398–405.
9. C.F. Gettys, C. Kelly, and C.R. Peterson, “The Best Guess Hypothesis in Multistage Inference,” *Organizational Behavior and Human Performance* 10, no. 3 (1973): 364–373; and D.A. Schum and W.M. DuCharme, “Comments on the Relationship between the Impact and the Reliability of Evidence,” *Organizational Behavior and Human Performance* 6, no. 2 (1971): 111–131.
10. A.D. Gurmankin, J. Baron, and K. Armstrong, “The Effect of Numerical Statements of Risk on Trust and Comfort with Hypothetical Physician Risk Communication,” *Medical Decision Making* 24, no. 3 (2004): 265–

- 271.
11. Schwartz et al., "The Role of Numeracy"; and E. Peters et al., "Numeracy and Decision Making," *Psychological Science* 17, no. 5 (2006): 407–413.
 12. Information can also be acquired orally; it is not a focus of the present paper, however, as we are interested in how to maximize the comprehension and use of numeric information presented in print form.
 13. A.S. Elstein, G.B. Chapman, and S.J. Knight, "Patients' Values and Clinical Substituted Judgments: The Case of Localized Prostate Cancer," *Health Psychology* 24, no. 4 Supp. (2005): S85–S92.
 14. Schwartz et al., "The Role of Numeracy."
 15. Estrada et al., "Literacy and Numeracy Skills."
 16. B.J. Zikmund-Fisher et al., "Validation of the Subjective Numeracy Scale (SNS): Effects of Low Numeracy on Comprehension of Risk Communications and Utility Elicitations," *Medical Decision Making* (forthcoming); and S. Woloshin et al., "Assessing Values for Health: Numeracy Matters," *Medical Decision Making* 21, no. 5 (2001): 382–390.
 17. S.L. Sheridan and M. Pignone, "Numeracy and the Medical Student's Ability to Interpret Data," *Effective Clinical Practice* 5, no. 1 (2002): 35–40.
 18. D.J. Benjamin, S.A. Brown, and J.M. Shapiro, "Who Is 'Behavioral'? Cognitive Ability and Anomalous Preferences," 5 May 2006, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=675264 (accessed 8 February 2007); and S. Frederick, "Cognitive Reflection and Decision Making," *Journal of Economic Perspectives* 19, no. 4 (2005): 24–42.
 19. E. Peters et al., "Less Is More in Presenting Quality Information to Consumers," *Medical Care Research and Review* (forthcoming).
 20. M.L. Finucane et al., "Aging and Decision-Making Competence: An Analysis of Comprehension and Consistency Skills in Older versus Younger Adults Considering Health-Plan Options," *Journal of Behavioral Decision Making* 15, no. 2 (2002): 141–164.
 21. J.H. Hibbard et al., "Strategies for Reporting Health Plan Performance Information to Consumers: Evidence from Controlled Studies," *Health Services Research* 37, no. 2 (2002): 291–313.
 22. Gettys et al., "The Best Guess."
 23. D. Kahneman and A. Tversky, "Prospect Theory: An Analysis of Decision under Risk," *Econometrica* 47, no. 2 (1979): 263–291.
 24. A. Edwards et al., "Presenting Risk Information—A Review of the Effects of 'Framing' and Other Manipulations on Patient Outcomes," *Journal of Health Communication* 6, no. 1 (2001): 61–82.
 25. Peters et al., "Numeracy."
 26. I.M. Lipkus and J.G. Hollands, "The Visual Communication of Risk," *Journal of the National Cancer Institute: Monographs* 25 (1999): 149–163; and E.R. Stone et al., "Foreground: Background Salience: Explaining the Effects of Graphical Displays on Risk Avoidance," *Organizational Behavior and Human Decision Processes* 90, no. 1 (2003): 19–36.
 27. H.F. Chua, J.F. Yates, and P. Shah, "Risk Avoidance: Graphs versus Numbers," *Memory and Cognition* 34, no. 2 (2006): 399–410.
 28. P. Slovic et al., "Affect, Risk, and Decision Making," *Health Psychology* 24, no. 4 Supp. (2005): S35–S40; and E. Peters et al., "The Impact of Canadian versus U.S. Cigarette Warning Labels on Smoking Attitudes," *Nicotine and Tobacco Research* (forthcoming).
 29. G. Gigerenzer and A. Edwards, "Simple Tools for Understanding Risks: From Innumeracy to Insight," *British Medical Journal* 327, no. 7417 (2003): 741–744.
 30. Ibid.; E.A. Waters et al., "Formats for Improving Risk Communication in Medical Tradeoff Decisions," *Journal of Health Communication* 11, no. 2 (2006): 167–182; and Peters et al., "Numeracy."
 31. A. Edwards et al., "Personalised Risk Communication for Informed Decision Making about Entering Screening Programs," *Cochrane Database of Systematic Reviews* no. 1 (2003): CD001865.
 32. Peters et al., "Numeracy."
 33. Hibbard et al., "Consumer Competencies."
 34. C.R. Sunstein and R.H. Thaler, "Libertarian Paternalism Is Not an Oxymoron," *University of Chicago Law Review* 70, no. 4 (2003): 1159–1202.