HELPING DOCTORS AND PATIENTS MAKE SENSE OF HEALTH STATISTICS: TOWARDS AN EVIDENCE-BASED SOCIETY

Gerd Gigerenzer
Harding Center for Risk Literacy, Max Planck Institute for Human Development, Germany
gigerenzer@mpib-berlin.mpg.de

Collective statistical illiteracy is the phenomenon that the majority of people do not understand what health statistics mean, or even consistently draw wrong conclusions without noticing. For instance, few are aware that higher survival rates with cancer screening do not imply longer life, or that the statement that mammography screening reduces the risk of dying from breast cancer by 20% in fact means that 1 less woman out of 1,000 will die of breast cancer. I argue that statistical illiteracy (i) is common to patients, journalists, and physicians alike; (ii) is created by nontransparent framing of information that is sometimes an unintentional result of lack of understanding, but can also be an intentional effort to manipulate or persuade people; and (iii) is a consequence of the ongoing lack of efficient training in statistical thinking in the educational system.

STATISTICAL ILLITERACY IN HEALTH

The classical doctor–patient relation is based on (the physician's) paternalism and (the patient's) trust in authority, which makes statistical literacy a nonissue; the same holds for the traditional combination of determinism (physicians who seek causes, not probabilities) and the illusion of certainty (patients who seek certainty although there is none). I provide one illustration for patients' and doctors' striking but largely unnoticed level of statistical illiteracy.

Patients

Screening for prostate cancer with prostate-specific antigen (PSA) tests is often encouraged by physicians. The fact box (Figure 1) shows the benefit and harms that men age 55 and older can expect when taking the test. The two randomized trials available show either no reduction in prostate cancer-specific deaths (the U.S. study) or a reduction of 0.7 in 1,000 in the European study. Note that neither study found a reduction in total mortality or all-cancer mortality. What does the public know about the benefit of screening?

Prostate cancer screening with PSA test: per 1,000 men 55+		
	NO screening	Screening over 9 years
Benefits?		
Cancer mortality	23.8	23.9
Prostate cancer specific mortality USA	2.3	2.3
Prostate cancer specific mortality Europe	3.7	3.0
Risks?		
False positives with biopsies	—	50 - 200
Unnecessary treatments (e.g. prostatectomy)	—	10 - 30

Source: Gøtzsche & Nielsen (2006) and Woloshin & Schwarz (2009).

Figure 1. Benefits and harms of prostate-specific antigen (PSA) tests

In the first representative European-wide study in nine countries with over 10,000 face-to-face interviews, men were asked to estimate the reduction of prostate-cancer mortality through

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regular participation in screening (Gigerenzer, Mata & Frank, 2009). The response alternatives were 0, 1, 10, 50, 100, 200 (out of 1,000), and “I don’t know.” Figure 1 shows that the best estimates are 0 or 1 in 1,000. In the U.K., only 1% of men chose one of these two alternatives, 4% in France, 5% in the Netherlands, 6% in Germany and Poland, 8% in Austria and Italy, and 14% in Spain. The highest percentage of accurate estimates of the benefit, 23%, came from Russian men—most likely not because they were better informed, but because they were less misinformed. Overall, 89% of men overestimated the benefits of PSA tests tenfold or more, or did not know. The group of men in the 50s and 60s targeted by screening programs was even less well informed.

Physicians

Physicians are expected to understand health statistics, such as potential benefits or the chances of a disease given a positive test. Yet that is not the case for the majority of experienced physicians that my collaborators and I have trained and tested. For instance, I trained 1,000 physicians in risk communication as part of their continuing education in 2006 and 2007. In one session, I asked 160 gynecologists about the following routine event: A woman tests positive in a screening mammography. She wants to know what her chances are that she actually has breast cancer. You know the following information about women in this region:

- a prevalence of 1%,
- a sensitivity of 90%, and
- a false-positive rate of 9%.

Just to be sure, I explained all three concepts. Then I asked: What is the best estimate for the probability of breast cancer given the positive test? The response alternatives were 1%, 10%, 81%, and 90%. The majority of gynecologists (60%) thought the chances were 81% or 90%, while 19% and 21% thought that chances were 10% or 1%. If patients knew about this variability in physicians’ statistical thinking, they would be rightly disturbed. Rather than teaching the physicians Bayes’ rule, which most usually forget soon afterwards, I taught them to translate conditional probabilities (such as sensitivities) into natural frequencies (Gigerenzer, 2002): “Think of 1,000 women who participate in screening. We expect that 10 have breast cancer, and 9 of these test positive. Of the 990 who do not have cancer, we expect that about 89 nevertheless test positive.” That representation helps to see that there are about 98 who test positive, of whom only 9 have cancer. When natural frequencies were used, 87% of the gynecologists saw that the best estimate was 10 in 1,000.

NONTRANSPARENT RISK COMMUNICATION

As these two cases of statistical illiteracy illustrate, the key problem lies in how the information is framed. For prostate cancer screening, the results of the European randomized study have been touted in the press as a 20% relative risk reduction, without mentioning that this is equivalent to an absolute risk reduction from 3.7 to 3.0 in 1,000. The 20% of British and French men who believed that PSA screening would result in 200 less prostate cancer deaths out of 1,000 may well have confused the absolute with the relative risk reduction. For mammography screening, natural frequencies provide a transparent framing of the information, while conditional probabilities confuse or mislead the majority of physicians.

Nontransparent statistical information is the rule rather the exception in health care. Information pamphlets, web sites, leaflets distributed to doctors by the pharmaceutical industry, and even medical journals regularly report evidence in nontransparent formats, suggesting to the naïve reader big benefits of featured interventions and small harms. The key problem is that most physicians and patients have never been taught the difference between transparent and nontransparent framing. What can be done?

Teach Statistical Thinking

So far, few medical schools if any teach statistical thinking (as opposed to statistical rituals) in a way that students can understand. The same holds for primary and secondary schools; otherwise doctors' and patients’ innumeracy would not be so severe. Changing this requires familiarizing children early on with the concept of probability and teaching statistical literacy as the art of solving real-world problems rather than applying formulas to toy problems about coins and dice. Another major precondition for statistical literacy is transparent risk communication. I recommend using frequency statements instead of single-event probabilities, absolute risks instead of relative risks, mortality rates instead of survival rates, and natural frequencies instead of conditional probabilities. Statistical literacy is a prerequisite for educated participation in a technological democracy. Understanding risks and asking critical questions can also shape the emotional climate in a society so that hopes and anxieties are no longer as easily manipulable and the public can develop a better informed and more relaxed attitude towards health.

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