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I. INTRODUCTION

Humans are weak at probabilistic reasoning. When confronted with particular statistics relating to uncertain events, people often greatly misestimate the events' likelihoods. Doctors and patients are humans. As a group, they also are subject to this foible. Because medical care options typically involve probabilistic reasoning, the failure to reasonably grasp their potential consequences may lead to unwise advice and choices. Grossly overestimated risks may traumatize patients. Consent to procedures based on substantial misapprehensions of their costs and benefits is hardly informed.

There are several areas of the law in which the consequence of misestimating probabilities may come into play, including negligence and contributory negligence, products liability, DNA and fingerprint identification, and paternity testing. In what follows I show the reach of the problem in the medical care context. Then I turn to the nature of probabilistic reasoning. It is not as transparent as one might expect. The established approaches to probabilistic reasoning include the Bayesians and the frequentists. Their theories are briefly explicated. We will find that the Bayesian approach is not as intuitive as the frequentist approach. I then speculate as to why the frequentist approach is easier to grasp. It may be the evolutionary result of the way in which ancestral humans gained and processed probabilistic information on the prehistoric savanna. Be that as it may, I then ponder the availability of legal remedies for the harm that may ensue from a medical prognosis that is grossly misleading because it is put in Bayesian, rather than frequentist, terms. Two tort theories are examined: informed consent and

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the negligent infliction of emotional harm. Neither theory, I conclude, offers general relief without some development. Perhaps the medical profession should handle this problem itself by better training and methods of explaining medical choices.

II. THE PROBLEM

Shortly after your routine annual physical, your doctor asks you to return promptly to his office to discuss the results of the blood tests. Since this return visit had not been needed before, you are a bit anxious when you sit down in his office. Following formal niceties, he gets down to business. "I have some bad news for you. One of the test results was positive. While, as usual, there are no perceptible symptoms at this stage, it appears that you may have an aggressive disease that is usually fatal."

You take a deep breath and ask for more information. Your doctor reports that the prevalence of this disease is 1/1000, but that the test has a false positive rate of 5%. There are no available follow-up tests. The only way to tell for sure whether you have the disease is to do an exploratory operation. If it turns out that you have the ailment, the operation can offer some relief but no real hope of full recovery.

Composing yourself as well as you can, you ask what the numbers associated with the test mean. "What are the chances that I actually have this disease?" "Well," your doctor responds, as would perhaps nearly half of all physicians, "I'm not a statistician, but it seems that the chances you have it are about 95%."[1]

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1. These numbers come from a study done at Harvard Medical School among twenty house officers, twenty attending physicians, and twenty fourth-year medical students. *See* Ward Casscells et al., *Interpretation by Physicians of Clinical Laboratory Results*, 299 NEW ENG. J. MED. 999, 999 (1978). On the chance of having the disease, 45% of the respondents answered 95%. *Id.* at 1000. Only 18% correctly answered less than 2%. *Id.* at 999-1000. "The average of all answers was 55.9 per cent, a 30-fold overestimation of disease likelihood." *Id.* at 1000. The actual study used this less dramatic hypothetical: "If a test to detect a disease whose prevalence is 1/1000 has a false positive rate of 5%, what is the chance that a person found to have a positive result actually has the disease, assuming that you know nothing about the person's symptoms or signs?" *Id.* at 999. "If the physician greatly overestimated the likelihood that such results had clinical consequence, the patient might be subjected to unnecessary investigation and worry." Casscells et al., *supra*, at 1000.

You put off the decision on whether to have the exploratory operation. You need some time to think about it. At home, a relative urges you to get a second opinion, so you take your test results to another doctor. Once in her office, she looks at the test results and, though admitting she knows nothing about your health status, explains what they mean:

> 1 out of every 1000 Americans has [this] disease. [This] test [you took] has been developed to detect when a person has [the disease]. Every time the test is given to a person who has the disease, the test comes out positive (i.e., the "true positive" rate is 100%). But sometimes the test also comes out positive when it is given to a person who is completely healthy. Specifically, out of every 1000 people who are perfectly healthy, 50 of them test positive for the disease (i.e., the "false positive" rate is 5%).[2]

"Ah!" you blurt out. "If there are fifty false positives for every true positive, then the chance of me actually having the disease is only about 2%." She replies, "That's the way I figure it too."[3] As it turns out, this is more accurate "bayesian reasoning."[4]

Obviously, you are greatly relieved at the revised prognosis. Indeed, I can relieve you even more by reporting that you actually do not have this disease after all. But in the meantime, you were severely traumatized by the original prognosis. Though not a pessimistic person, you heard the death knell with this report of having a 95% probability of suffering from a fatal disease. Even though you did not act on the mental suffering you endured, some may choose to "not go gentle into

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2. The test of this form of the medical diagnosis problem was conducted at Stanford University. *See* Leda Cosmides & John Tooby, *Are Humans Good Intuitive Statisticians After All? Rethinking Some Conclusions from the Literature on Judgment Under Uncertainty*, 58 COGNITION 1, 24 (1996).

3. In this frequentist version of the diagnosis problem by Cosmides and Tooby, 56% of the respondents answered that the chances of having the disease are 2%, 28% said the chances are 1/1000 (0.1%), and 4% said the chances are 95%. *See id.* at 27. In replicating the original, non-frequentist version of the problem by Casscells at Harvard Medical School, 56% of the Stanford students answered that the chances of having the disease are 95%, 12% said 2%, and 12% said 1/1000 (0.1%). *See id.*

4. *See id.* at 27. Cosmides and Tooby "use the term *bayesian reasoning*—with a small 'b'—to refer to any cognitive procedure that causes subjects to reliably produce answers that satisfy Bayes' rule, whether that procedure operates on representations of frequencies or single-event probabilities." *Id.* at 9.

that good night,"[5] by, for example, quitting their jobs (once making sure their medical insurance would not be cancelled), running up bills, dropping lifetime projects, taking high risks, "setting things straight" with certain people, et cetera. Had you been diagnosed with a high probability of a socially abhorred ailment, you may have been shunned by others and suffered irreversible consequences.[6] Whatever the final consequence, the original prognosis caused you significant harm of various types. Why was the prognosis so far off? What is to be done about it? After examining the nature of probabilistic reasoning, I consider these two questions in turn.

A. Difficulties in Probabilistic Reasoning

"Probabilities quantify uncertainty."[7] The meaning and application of probabilistic reasoning has long been subject to

5. DYLAN THOMAS, *Do Not Go Gentle into that Good Night*, *in* THE COLLECTED POEMS OF DYLAN THOMAS 128 (1957) ("Do not go gentle into that good night, / Old age should burn and rave at close of day; / Rage, rage against the dying of the light."). Steven Pinker ascribes to natural selection "our deepest strivings," including "why we do not go gentle into that good night but rage, rage against the dying of the light." STEVEN PINKER, THE BLANK SLATE: THE MODERN DENIAL OF HUMAN NATURE 52 (2002).

6. For example, one woman who received a false positive when screened for HIV in the mid-90's was shunned by her colleagues, lost her job, had unprotected sex thinking it would make no difference, did not touch her young son for fear of infecting him, and, in general, underwent severe emotional suffering. *See* GERD GIGERENZER, CALCULATED RISKS: HOW TO KNOW WHEN NUMBERS DECEIVE YOU 3-4 (2002) [hereinafter GIGERENZER, CALCULATED RISKS]. The attorney for a patient who was informed of a false positive for HIV stated: "With a positive result you may not be able to get insurance, establish a mortgage or buy a car." Caitlin A. Schmid, Note, *Protecting the Physician in HIV Misdiagnosis Cases*, 46 DUKE L.J. 431, 431 (1997) (quoting Jennifer Ditchburn, *Man Sues Doctor Who Allegedly Misdiagnosed AIDS Virus: Negative Result Was Revealed Month After First Diagnosis*, OTTAWA CITIZEN, July 23, 1995, at A5). In *Hartwig v. Oregon Trail Eye Clinic*, a suit by a woman stuck by a contaminated hypodermic needle possibly infected with HIV, the woman's husband was ready to testify that "during the 6-month period after her accident, [she] would disappear into a room and cry for hours on end, was impatient with their children, and showed no affection for him or their children. . . . [She was also] shunned by their friends because of the friends' irrational fear of HIV infection." 580 N.W.2d 86, 88, 89 (Neb. 1998). In the similar case of *Williamson v. Waldman*, the victim allegedly became depressed and "suffered 'lifestyle changes,'" refused to have another child in fear of it being infected, and suffered a loss of earning capacity. 696 A.2d 14, 16-17 (N.J. 1997).

7. Ward Edwards, *Conservatism in Human Information Processing*, *in* JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES 359, 359 (Daniel Kahneman et al. eds., 1982). "A probability, according to Bayesians . . . , is simply a number between zero and one that represents the extent to which a somewhat idealized person believes a statement to be true." *Id.*

debate.[8] The fundamental divide is between Bayesians, who contend that probability refers to subjective degrees of confidence that an event has occurred, and frequentists, who see it as referring to the objective frequencies of events among repeated activities, and not the likelihood of a particular, unique event.[9] In any case, Bayes' rule is often used to calculate unique events,[10] as in the introductory hypothetical about the fatal disease. The Bayesian and frequentist approaches to probability are similar and are often used interchangeably.[11]

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8. *See, e.g.*, GERD GIGERENZER, ADAPTIVE THINKING: RATIONALITY IN THE REAL WORLD 244 n.1 (2000) [hereinafter GIGERENZER, ADAPTIVE THINKING]; GERD GIGERENZER ET AL., THE EMPIRE OF CHANCE: HOW PROBABILITY CHANGED SCIENCE AND EVERYDAY LIFE § 8.2, at 274-76 (1982) [hereinafter GIGERENZER ET AL., EMPIRE OF CHANCE]; Stephen R. Perry, *Risk, Harm, and Responsibility*, *in* PHILOSOPHICAL FOUNDATIONS OF TORT LAW 321, 322-29 (David G. Owen ed., 1995). For an example of the debate in a legal context, compare D.H. Kaye, *Apples and Oranges: Confidence Coefficients and the Burden of Persuasion*, 73 CORNELL L. REV. 54 (1987), with Neil B. Cohen, *Conceptualizing Proof and Calculating Probabilities: A Response to Professor Kaye*, 73 CORNELL L. REV. 78 (1987) [hereinafter Cohen, *Conceptualizing*].

9. There are also other meanings of probability. *See* GIGERENZER ET AL., EMPIRE OF CHANCE, *supra* note 8, § 8.2, at 276; Charles Yablon, *The Meaning of Probability Judgments: An Essay on the Use and Misuse of Behavioral Economics*, 2004 U. ILL. L. REV. 899, 906-20. For introductions to the development and controversies surrounding probabilistic reasoning, see ELLIOTT SOBER, PHILOSOPHY OF BIOLOGY § 3.2 (2d ed. 2000); Neil B. Cohen, *Confidence in Probability: Burdens of Persuasion in a World of Imperfect Knowledge*, 60 N.Y.U. L. REV. 385, 391-92 (1985) [hereinafter Cohen, *Confidence*]; Cosmides & Tooby, *supra* note 2, at 2-9; *see also* Gerd Gigerenzer & Ulrich Hoffrage, *How to Improve Bayesian Reasoning Without Instruction: Frequency Formats*, 102 PSYCHOL. REV. 684, 694-95 (1995) (outlining "three major non-Bayesian cognitive algorithms"). "[T]he frequentist interpretation of probability has been dominant since about 1840." GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 246. For an extensive historical introduction, see GIGERENZER ET AL., EMPIRE OF CHANCE, *supra* note 8, §§ 1.1-3.8, at 1-122.

10. Cohen, *Confidence*, *supra* note 9, at 391 ("Theory eventually caught up with intuition, and by the 1950's probability estimates of unique events had been incorporated into probability theory."). "By the mid-1970's, however, an articulate backlash had developed." *Id.* Others "have rebutted these arguments and have bolstered those supporting the use of subjective probabilities in legal analysis." *Id.* at 392.

11. *See* Cohen, *Conceptualizing*, *supra* note 8, at 87-88.

But Bayes' rule is not easy to apply.[12] Bayes' rule is: $p(H|D) = p(H)p(D|H) / p(H)p(D|H) + p(-H)p(D|-H)$, where *D* refers to the data and *H* to the hypothesis being tested. In the hypothetical case, *D* refers to the positive test results, *H* to whether the patient has the disease, and *-H* to the conclusion that the patient does not have the disease. Plugging the numbers in the hypothetical into Bayes' rule yields the following result: $p(H|D) = (.001)(1) / [(.001)(1) + (.999)(.05)] = .0196$, or 1.96%. This is the same result as was found by use of frequency analysis,[13] but the calculation is considerably more difficult. The use of Bayes' rule is not intuitive,[14] and the reasoning of most people fails to follow it.[15] Nevertheless, medical texts usually rely on it.[16]

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12. Nevertheless, "[i]n the last few decades, the standard probability format has become a common way to communicate information ranging from the medical and statistical textbooks to psychological experiments." Gigerenzer & Hoffrage, *supra* note 9, at 686. Yet in the courtroom, other than in paternity cases, which "are exceptional in terms of the ease with which the available evidence lends itself to Bayesian aggregation . . . , Bayes's theorem is rarely used . . . where the complexities of translating evidence into a digestible Bayesian form can be daunting." Jonathan J. Koehler, *Probabilities in the Courtroom: An Evaluation of the Objections and Policies*, *in* HANDBOOK OF PSYCHOLOGY AND LAW 167, 177 (D.K. Kagehiro & W.S. Laufer eds., 1992) (omitting citations to paternity cases "of Bayesian confusion and error"). For a brief discussion of how juries and judges sometimes misunderstand "the prevailing Bayesian approach" with respect to DNA matches in a criminal case, see David Wasserman, *Forensic DNA Typing*, *in* A COMPANION TO GENETHICS 349, 353-54 (Justine Burley & John Harris eds., 2002). "The integration of DNA evidence into legal proof presents several challenges that go beyond the usual doubts about lay comprehension of scientific and quantitative evidence." *Id.* at 353.

13. More exactly, the frequency analysis would be: one out of a thousand has the disease. With a false positive rate of 5%, of the remaining 999, 49.95 of them (999 x .05) will test positive. Therefore, the chances of having the disease following a positive test is 1 / (1 + 49.95) = 0.0196, or 1.96%.

14. Lev R. Ginzburg et al., *Judgment Under Uncertainty: Evolution May Not Favor a Probabilistic Calculus*, 19 BEHAV. & BRAIN SCI. 24, 24 (1996) ("Probability theory is almost paradoxically nonintuitive.").

15. *See* GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 61 (mentioning "an avalanche of studies reporting that laypeople's reasoning does not follow Bayes' rule"); Lainie Friedman Ross, *Genetic Testing of Children: Who Should Consent?*, *in* A COMPANION TO GENETHICS, *supra* note 12, at 114, 114 (citing studies that "reveal that both physicians and patients have a difficult time grasping probabilities"); Reid Hastie & W. Kip Viscusi, *What Juries Can't Do Well: The Jury's Performance As a Risk Manager*, 40 ARIZ. L. REV. 901, 909-10 (1998) ("A flood of empirical results and interpretations has demonstrated that people are not well-endowed to reason coherently about the probabilities of occurrence of individual events. . . . [B]y and large, information about probabilities is often misunderstood and misused."). Even Stephen Jay Gould, no fan of evolutionary psychology, *see, e.g.*, Stephen Jay Gould, *Sociobiology and Human Nature: A*

The initial hypothetical is relatively simple. Unlike most real world situations, the test produces no false negatives. When false negatives are added to a problem, doctors may do even worse. For example, in one study physicians were tested on this problem:

> The probability that a patient has breast cancer is 1%. . . . If the patient has breast cancer, the probability that the radiologist will correctly diagnose it is 80% [i.e., there are 20% false negatives]. If the patient has a benign lesion (no breast cancer), the probability that the radiologist will incorrectly diagnose it as cancer is 9.6% (false positive rate). . . . What is the probability that a patient with a positive mammogram actually has breast cancer?[17]

Of the 100 physicians in the study, 95 estimated the probability of the woman having breast cancer to be about 75%.[18] If they had plugged the data into Bayes' rule, they

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Postpanglossian Vision, *in* SOCIOBIOLOGY EXAMINED 283, 283 (Ashley Montagu ed., 1980), agrees that "our minds are not built (for whatever reason) to work by the rules of probability . . . ." Stephen Jay Gould, *The Streak of Streaks*, N.Y. REV. BOOKS, Aug. 18, 1988, at 8, *reprinted in* STEPHEN JAY GOULD, BULLY FOR BRONTOSAURUS: REFLECTIONS IN NATURAL HISTORY 463, 469 (1991). For the proposition that the persuasiveness of statistical information depends on its formulations in terms of probabilities or frequencies, see Jonathan J. Koehler, *The Psychology of Numbers in the Courtroom: How to Make DNA-Match Statistics Seem Impressive or Insufficient*, 74 S. CAL. L. REV. 1275, 1277-78 (2001).

16. *See* GIGERENZER, CALCULATED RISKS, *supra* note 6, at 5.

17. *See* GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 60 (citing David M. Eddy, *Probabilistic Reasoning in Clinical Medicine: Problems and Opportunities*, *in* JUDGMENT UNDER UNCERTAINTY, *supra* note 7, at 249, 252-54); Gerd Gigerenzer, *Is the Mind Irrational or Ecologically Rational?*, *in* THE LAW AND ECONOMICS OF IRRATIONAL BEHAVIOR 37, 52-55 (Francesco Parisi & Vernon L. Smith eds., 2005) [hereinafter Gigerenzer, *Irrational*]; Gigerenzer & Hoffrage, *supra* note 9, at 685-86; Gerd Gigerenzer, *The Psychology of Good Judgment: Frequency Formats and Simple Algorithms*, 16 MED. DECISION MAKING 273, 275-77 (1996) [hereinafter Gigerenzer, *Good Judgment*].

18. *See* GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 60. In replicating this study with physicians, Gigerenzer found 8% of the physicians got the Bayesian answer. *Id.* at 66. The median estimate of having breast cancer was 70%. *Id.* Gigerenzer reports that the director of one university clinic, who estimated the probability of having breast cancer as 90%, nervously commented, "I never inform my patients about statistical data. I would tell the patient that mammography is not so exact, and I would, in any case, perform a biopsy." *Id.* at 65. Does this satisfy the strictures of informed consent? Based on my search of the primary legal literature, I would guess that this doctor's tactic is not uncommon. For example, in a Boolean search of Westlaw cases with the terms and connectors "'informed consent' or 'malpractice' w/200 'false positive' or 'false negative'," not one relevant case turned up. Other comparable Boolean searches of Westlaw and Lexis also turned up negative.

would have found this result: $p(H|D) = (.01)(.80) / [(.01)(.80) + (.99)(.096)] = .078$. The actual probability is 7.8%, not nearly ten times larger as most of the doctors estimated. The estimates of the vast majority of these doctors were off by nearly an order of magnitude.[19] We can well imagine the differences in the reactions of most women and their loved ones to hearing that their likelihood of having breast cancer is 75% rather than 7.8%. Certainly their choices of treatment options would be accordingly skewed.[20]

If the physicians had used frequentist terms in analyzing the problem, they may have reasoned this way: Out of every thousand women patients, ten of them have breast cancer (1%). For every thousand women patients, eight of them will be correctly diagnosed by the radiologists as having the cancer (80% of the ten with cancer). Of the remaining 990 patients without the cancer (1000 – 10), ninety-five of them will be

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19. "A survey of the medical literature on mammography reveals that physicians regularly confuse the predictive accuracy of the test (the probability the patient has cancer given a positive mammography) with its retrospective accuracy (the probability of a positive mammography given that the patient has cancer)." GIGERENZER ET AL., EMPIRE OF CHANCE, *supra* note 8, at 258 (citation omitted). "Equating the two can result in errors of an order of magnitude or more." *Id.* But this is not the only problem. Once the confusion is avoided, physicians "must still deal with the impact of this evidence on the patient's prior probability of having breast cancer." *Id.* For example, if the patient sought the examination because she had discovered a lump:

> [h]er prior probability of having cancer is significantly different from that for an asymptomatic patient examined in a screening clinic. . . . Yet practicing physicians, following the medical texts and journals that instruct them, usually ignore or drastically underweight these prior probabilities in evaluating the import of a positive mammogram, greatly increasing the number of biopsies performed.

Id. In concluding this chapter ("Numbers Rule the World"), the authors note that "[p]robability and statistics have indeed become the very guide of life." *Id.* at 270. But for reasons that go beyond merely the difficulty in understanding the use of the concepts:

> there is no application so innocuous as to be neutral, in the sense of simply mirroring the bare facts of the matter. . . . It is part of our Pythagorean creed to believe that quantification is merely description, but the reverberations of the applications of statistics show how far this claim strays from the mark.

GIGERENZER ET AL., EMPIRE OF CHANCE, *supra* note 8, at 270.

20. In the face of the uncertainties that currently beset breast cancer treatment, one doctor reportedly urges radical surgery for his patients, though whether this is the best course is unknown, because the patients "neither comprehend nor tolerate knowledge of the uncertainties inherent in choosing treatment." GIGERENZER, CALCULATED RISKS, *supra* note 6, at 16. If paternalism is a medical response to known risks and uncertainties, how much more overreaching may be rationalized from inaccurately pessimistic estimates?

incorrectly diagnosed as having it (9.6% of 990). Therefore, for every 103 (8 + 95) patients diagnosed as having breast cancer, only eight of them actually have it, which equals 7.8% (8/103). While it is hard to argue that the frequentist calculation is simple,[21] it certainly is easier than using Bayes' rule.[22]

Humans do so poorly at coping with Bayes' rule because they tend to ignore base rates,[23] among other things.[24] For

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21. Based on the percentage of my students whose eyes roll or glass over when I introduce them to the straightforward notion of discounting, I would guess that lawyers, if not doctors, would struggle with even frequentist probabilities. Gigerenzer reports that "[s]ome physicians and legal scholars have told me that one reason to study medicine or law was to avoid statistics and psychology." Gigerenzer, *Irrational*, *supra* note 17, at 56. One might wonder if my claim that statistical innumeracy may give rise to medical malpractice might some day be directed toward legal malpractice. Me, too. Indeed, the problem may be greater than that:

> There is . . . growing evidence that people . . . have considerable difficulty expressing their risk estimates numerically. . . . One questionnaire included queries such as, "Which of the following numbers represents the biggest risk of getting a disease? __1 in 100[;] __1 in 1000[; and] __1 in 10." Roughly twenty percent of the respondents . . . answered that question incorrectly. Likewise, the questionnaire asked: "If the chance of getting a disease is 20 out of 100, this would be the same as having a ___ % chance of getting the disease." Almost thirty percent of all respondents . . . answered incorrectly. Other studies have reinforced this finding of a significant "innumeracy" problem.

Jon D. Hanson & Douglas A. Kysar, *Taking Behavioralism Seriously: Some Evidence of Market Manipulation*, 112 HARV. L. REV. 1420, 1544 (1999) (footnotes omitted). That the frequentist presentation format may be useful, but not a panacea, see Jeffrey J. Rachlinski, *The Uncertain Psychological Case for Paternalism*, 97 NW. U. L. REV. 1165, 1209-11 (2003).

22. *See* Cosmides & Tooby, *supra* note 2, at 22-38; Gigerenzer & Hoffrage, *supra* note 9, at 697 (noting that "mathematically equivalent information formats need not be psychologically equivalent"). For some of the latest work pursuing these issues, see, for example, Gary L. Brase et al., *Individuation, Counting, and Statistical Inference: The Role of Frequency and Whole-Object Representations in Judgment Under Uncertainty*, 127 J. EXPERIMENTAL PSYCHOL.: GEN. 3 (1998). When the director of the university clinic who estimated the probability of having breast cancer at 90% was given the problem in a frequency format, his nervousness dissipated and with the remark, "That's so easy," he came up with the proper answer. GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 66. Overall, 46% of the physicians gave the proper Bayesian answer when questioned in the frequency format. *Id.*

23. *See, e.g.*, Jay J.J. Christensen-Szalanski & James B. Bushyhead, *Physicians' Use of Probabilistic Information in a Real Clinical Setting*, *in* JUDGMENT AND DECISION MAKING: AN INTERDISCIPLINARY READER 259, 264 (Terry Connolly et al. eds., 2000); Jonathan J. Koehler, *The Base Rate Fallacy Reconsidered: Descriptive, Normative, and Methodological Challenges*, 19 BEHAV. & BRAIN SCI. 1, 2-3 (1996); Aaron D. Twerski & Neil B. Cohen, *Informed Decision Making and the Law of Torts: The Myth of Justiciable Causation*, 1988 U. ILL. L. REV. 607, 628-30 [hereinafter Twerski & Cohen, *Decision Making*] (providing an example in frequentist terms). But experience may help. *See*

example, in the study above of the problem of estimating the likelihood of having breast cancer following a positive mammogram, the base rate is 1%. That is, only 1% of all women have the disease. Considering this information in light of false negatives, how would one predict that a particular woman with a positive mammogram has about a 75% chance of having the disease? It would seem that the base rate was ignored, leading perhaps to this type of rough calculation: 80% of those with a positive mammogram are correctly diagnosed with cancer, but this must be discounted by the 9.6% false positives, so knocking about 10% off the 80% leaves 70% or so.

Why do humans tend to ignore base rates when it appears that even some animals attend to them?[25] Is it because human minds have "shoddy software" that creates this cognitive illusion, as some commentators contend?[26] If indeed this is the case, then it would seem to have legal significance. Insofar as we base legal liability on the standard of the reasonable person—the person of ordinary prudence—and this person is incapable of adequately dealing with probabilities in some circumstances, it would seem that legal responsibility should be adjusted accordingly. Or perhaps the reasonable person should be held to a higher standard of prudence. There is additional reason, beyond only trying to overcome the disability, to get to

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Christensen-Szalanski & Bushyhead, *supra*, at 269; Koehler, *supra*, at 1 (arguing that the base rate fallacy has been "oversold," especially "where base rates are implicitly learned or can be represented in frequentist terms" and other particular circumstances).

24. *See, e.g.*, GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 57. "The literature of the last 25 years has reiterated again and again the message that people are bad reasoners, neglect base rates most of the time, neglect false positive rates, and are unable to integrate base rate, hit rate [(sensitivity or rate of true positives)], and false positive rate the Bayesian way." *Id.* at 61 (citation omitted). In general, people are poor at estimating likelihoods in the face of risk and uncertainty. *See generally* CHOICES, VALUES, AND FRAMES (Daniel Kahneman & Amos Tversky eds., 2000); JUDGMENT UNDER UNCERTAINTY, *supra* note 7; RATIONAL CHOICE: THE CONTRAST BETWEEN ECONOMICS AND PSYCHOLOGY (Robin M. Hogarth & Melvin W. Reder eds., 1987). *But see* ALEXANDER J. FIELD, ALTRUISTICALLY INCLINED?: THE BEHAVIORAL SCIENCES, EVOLUTIONARY THEORY, AND THE ORIGINS OF RECIPROCITY 276-80 (2001) (discussing the debate over how poorly humans reason statistically); Gregory Mitchell, *Taking Behavioralism Too Seriously? The Unwarranted Pessimism of the New Behavioral Analysis of Law*, 43 WM. & MARY L. REV. 1907 (2002) (contending that humans display greater rationality than implied by legal behavioralists from the research literature).

25. *See* GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 57.

26. *Id.*

the root causes of human struggles with estimating probabilities and their solutions.

B. Evolutionary Causes?

Rather than dwell on the question of why humans are supposedly burdened with shoddy mental software relating to probability estimations, "[t]he program of ecological rationality suggests a different question: In what environments, past or present, would neglect of base rates be rational? The answer is, when information is acquired through natural sampling, which yields simple counts (not normalized by base rates . . .)."[27] The quoted commentator, Gerd Gigerenzer, is the leading exponent of this position.[28] I turn mainly to his analysis for edification.

During the millions of years in which ancestral humans were evolving on the African savanna, which was presumably our own "environment of evolutionary adaptiveness,"[29] individuals procured information about risks and uncertainties by taking note of events as they unfolded.[30] For example, maybe they made note of the fact that early each spring certain root vegetables could almost always be found on the sunny side of a particular stand of trees, or that on six occasions over the last ten years a herd of zebras was found in a particular far valley shortly after the rains began. Perhaps they observed on each of the last twenty times that large numbers of vultures were

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27. *Id.*

28. *See generally, e.g.*, *id.*; Gigerenzer, *Good Judgment*, *supra* note 17; Gerd Gigerenzer, *Does the Environment Have the Same Structure as Bayes' Theorem?*, 14 BEHAV. & BRAIN SCI. 495 (1991); Gigerenzer & Hoffrage, *supra* note 9. For additional citations, see GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 307-09.

29. *See* John Tooby & Leda Cosmides, *The Psychological Foundations of Culture*, *in* THE ADAPTED MIND 19, 69 (Jerome H. Barkow et al. eds., 1992) ("[The] functional organization in the organism—its set of adaptations—is designed to exploit the enduring properties of the environment in which it evolved (termed its environment of evolutionary adaptedness, or EEA) . . . .").

30. GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 57 ("During most of their history—before the advent of probability theory—humans, like animals, have acquired information about uncertainties and risks through natural sampling of event frequencies rather than in terms of probabilities or percentages."); Leda Cosmides & John Tooby, *From Evolution to Behavior: Evolutionary Psychology As the Missing Link*, *in* THE LATEST ON THE BEST: ESSAYS ON EVOLUTION AND OPTIMALITY 277, 282 (John Dupré ed., 1987) ("Natural selection gave us information processing machinery to produce behavior, just as it gave us food processing machinery to produce digestion. This machinery selects—and frequently seeks—particular information from the environment . . . .").

circling in the sky a dead or dying animal was below them, but on three of these occasions a dangerous pride of lions was also there devouring a dead animal, and on eight of the occasions a threatening pack of hyenas was there feeding. If, say, a clan acts on this accumulated information and goes hunting for zebras in the far valley shortly after the rains begin only to come back empty-handed, they will take this into account the next time the rains begin: now it has been six times out of eleven that the zebras have been there, so perhaps we should not spend our time going so far when there are other opportunities for game nearer by.

This attention to frequencies, or natural sampling, does not require information regarding base rates.[31] Natural sampling simply requires "updating event frequencies from experience."[32] As in the example above, before the last experience with zebra hunting, the frequency of finding them in the far valley following the rains was six out of ten. Now it is six out of eleven. Thus, ancestral humans gathered numerical information regarding degrees of uncertainty by means of an original format of natural frequencies acquired by natural sampling.[33]

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31. *See* GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 57; Gigerenzer & Hoffrage, *supra* note 9, at 687.

32. *See* GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 63. "Natural sampling is different from systematic experimentation, in which the sample sizes (the base rates) of each treatment group are fixed in advance." *Id.*

33. *Id.* at 62; Gigerenzer & Hoffrage, *supra* note 9, at 686-87. "Natural frequencies report the final tally of a natural sampling process." GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 63. "The sequential acquisition of information by updating event frequencies *without* artificially fixing the marginal frequencies (e.g., of disease and no-disease cases) is what we refer to as *natural sampling*." Gigerenzer & Hoffrage, *supra* note 9, at 686 (citation omitted). Boehm refers to "actuarial intelligence," meaning "the intuitive human capacity, seen abundantly in hunter-gatherers, to think stochastically and to understand rather complex systems on an intuitive but statistically valid, predictive basis." CHRISTOPHER BOEHM, HIERARCHY IN THE FOREST: THE EVOLUTION OF EGALITARIAN BEHAVIOR 183-87 (1999); *see generally* DAVID M. BUSS, EVOLUTIONARY PSYCHOLOGY: THE NEW SCIENCE OF THE MIND 380-82 (1999) (discussing frequency representations and judgment under uncertainty). For the view that humans may not excel at processing frequencies, see Ginzburg et al., *supra* note 14, at 24 (arguing that "humans seem to be ill-equipped to process frequency information"). Gigerenzer offers supporting evidence of human frequency innumeracy. After noting that a particular physician, aware of the significance of base rates and false positives, said he would advise a woman that she is likely to have breast cancer after a positive test, probabilities notwithstanding, Gigerenzer wonders how the radiologist could "perform mammography screening for 25 years and not notice that most women who test positive do not have breast cancer." GIGERENZER, CALCULATED RISKS, *supra* note 6, at 112 (pointing out that the majority of physicians in a

Along with greater computational simplicity,[34] thinking of risk and uncertainty in terms of natural frequencies rather than Bayesian probabilities facilitates the recognition of the confidence level in the calculated likelihoods.[35] Drawing on the zebra example, if we say that the probability of finding zebras following the rains is 0.6, this does not telegraph whether this conclusion is based on five trips to the far valley in which zebras were found three times, or fifty trips in which zebras were found thirty times. Obviously we would be more confident of the 0.6 probability of finding the zebras if it was based on fifty trips rather than five. Three out of five may have been a fluke. There may have been some unusual floods in recent years that drove the animals to the far valley from their usual grazing grounds. Or, to the contrary, the animals may not have been there those two years only because unusual floods cut them off from the valley. Time will tell, or hint. On the other hand, if the clan went to the valley only twice following the beginning of the rains and both times found no game, they would be more likely to hunt there again at that time of the year than if they went there five times without success, even though the Bayesian probability in both cases is 0.0. Putting the chances in terms of frequencies, say, six findings of zebras out of ten trips, leads to an automatic updating of the implicit confidence level when, following the next hunt, the frequency becomes six out of eleven.

Some of the scholarly literature on human reasoning is consistent with the proposition that natural frequencies have driven the evolution of mental algorithms.[36] The literature

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related experiment also failed to notice). For the modular, domain-specific, cognitive aspect of human reasoning about frequencies, see Cosmides & Tooby, *supra* note 2, at 63-68.

34. Gigerenzer & Hoffrage, *supra* note 9, at 687 ("Bayesian algorithms are computationally simpler when information is encoded in a frequency format rather than a standard probability format.").

35. *See* Cosmides & Tooby, *supra* note 2, at 16-17. For the importance of confidence levels when using probabilities to meet legal burdens of persuasion, see Cohen, *Conceptualizing*, *supra* note 8, at 91-93; Cohen, *Confidence*, *supra* note 9, at 385.

36. Gigerenzer and his fellow researchers found that the intuitive calculations behind various cognitive functions of the human brain align with different theories of statistics: "Elementary functions such as sensory detection, discrimination, and recognition in memory are controlled by a statistician of the Neyman-Pearson-Wald school, causal reasoning by a Fisherian statistician, perceptual estimation and judgment by a statistician of the Karl Pearson school, and induction and opinion revision by a Bayesian statistician." GIGERENZER ET AL., EMPIRE OF CHANCE, *supra* note 8, at 233.

includes "(a) a body of studies that report that humans can monitor frequencies fairly accurately, (b) the thesis that humans process frequencies (almost) automatically . . . , (c) the thesis that probability learning and transfer derive from frequency learning, and (d) developmental studies on counting in children and animals."[37] Gigerenzer contends that the human ability to reason better with frequencies than with Bayesian probabilities is bottomed on "evolutionary (and developmental) primacy of natural frequencies and ease of computation."[38] This hypothesis has been tested in real life situations.[39]

III. TORT LAW RAMIFICATIONS

In the healthcare context, the misestimation of consequences because their probabilities are expressed in terms of Bayes' rule may substantially impinge on patients, as suggested by the introductory story. In this section I consider whether there are legal remedies for the ensuing harms. Two tort theories are explored: (1) whether a patient actually gives informed consent when she is misled by a Bayesian presentation of the relevant data and (2) whether a patient traumatized by an overestimation of risk stemming from its expression in Bayesian terms may have a claim against the healthcare provider for the negligent infliction of emotional harm.

A. Informed Consent

Under the law of torts, a patient must first properly agree to any medical procedure. The doctrine of informed consent protects the autonomy of the patient.[40] In the words of Cardozo,

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37. GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 64 (citations omitted).

38. *Id.* In another book, Gigerenzer generalizes beyond frequencies and probabilities: "The heuristics used by humans . . . are adaptive strategies that have evolved in response to the need to draw inferences and make decisions with bounded knowledge and limited time. Cognitive resources being limited, good reasoning relies on a toolbox of ecologically rational fast and frugal strategies." GERD GIGERENZER ET AL., SIMPLE HEURISTICS THAT MAKE US SMART 171 (1999). For a review of the major classes of heuristics, see *id.* at 358-62.

39. *See* GIGERENZER, ADAPTIVE THINKING, *supra* note 8, at 64-76.

40. Marjorie Maguire Shultz, *From Informed Consent to Patient Choice: A New Protected Interest*, 95 YALE L.J. 219, 222 (1985) ("In the face of value pluralism, factual indeterminacy, and increasing options, patient autonomy has become a central principle of both popular and philosophical analysis of medical decisionmaking.") (footnotes omitted); *see generally* DAN B. DOBBS, THE LAW OF TORTS §§ 250-51 (2000). For skepticism as to

"Every human being of adult years and sound mind has a right to determine what shall be done with his own body . . . ."[41] Consent is informed when material information about the proposed procedure, such as the procedure's risks, necessity, and reasonable alternatives, is revealed.[42] In a nutshell, doctors must fully disclose the significant, material costs and benefits of the proposed procedure and alternatives, including the alternative of no treatment at all.[43] Depending on the

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whether patient autonomy has affected "the decisionmaking process" as much as has often been assumed, see Aaron D. Twerski & Neil B. Cohen, *The Second Revolution in Informed Consent: Comparing Physicians to Each Other*, 94 NW. U. L. REV. 1, 2-3 (1999).

41. Schloendorff v. Society of N.Y. Hosp., 105 N.E. 92, 93 (N.Y. 1914).

42. *See, e.g.*, Canterbury v. Spence, 464 F.2d 772, 782 n.27 (D.C. Cir. 1972) (stating that the disclosure rule requires the physician generally to "inform[] the patient in non-technical terms as to what is at stake: the therapy alternatives open to him, the goals expectably to be achieved, and the risks that may ensue from particular treatment and no treatment"). "Informed choice is, first and foremost, a *process* right," protecting the patient's right "to evaluate all material information in making decisions," and often involving "an ongoing process" among the parties with a "dynamism all its own." Twerski & Cohen, *Decision Making*, *supra* note 23, at 649.

43. Under medical malpractice and products liability, "the informed choice question asks whether the doctor or vendor provided the patient or buyer adequate information to make an intelligent choice." Twerski & Cohen, *Decision Making*, *supra* note 23, at 607-08. In the medical context, physicians "owe their patients a fiduciary duty, which includes an obligation to act exclusively in the patient's interests and to disclose all information material to those interests." Peter H. Schuck, *Rethinking Informed Consent*, 103 YALE L.J. 899, 916 (1994); *see also* Shultz, *supra* note 40, at 279 ("Doctors are universally conceded to be fiduciaries; as such they have special duties to serve their clients' interests."). In these cases, "the more common claim of a patient is that the doctor inadequately warned of the risks of a given medical intervention, or that the doctor did not adequately explain alternative modes of treatment (including the option of non-treatment)." Twerski & Cohen, *Decision Making*, *supra* note 23, at 610. The practice of informed consent in this country seems far from ideal. One representative of the World Health Organization notes: "In the U.S., the average physician-patient contact is five minutes. Most of the information is presented in a vocabulary that is unintelligible to the patient." GIGERENZER, CALCULATED RISKS, *supra* note 6, at 16-17. In response, one doctor said: "Sixty percent of patients, conservatively estimated, do not have the intellectual capacity to make decisions about treatments themselves." *Id.* at 17. This is especially true, one might add, when the data is put in Bayesian terms. Another physician said: "The meeting between physician and patient is a ritual. False positives have no place in this ritual." *Id.* at 18. Gigerenzer writes that true informed consent is rare because the patients do not know what questions to ask, they are highly emotional under the circumstances, and "there is innumeracy among physicians, which puts informed consent out of reach." *Id.* at 98. Institutional, professional, and economic factors also constrain the physician's ability to facilitate informed consent. *See id.* at 112-14.

Behavioral economists have identified other problems in expressing probabilistic information in a manner that allows the patient to give truly informed consent. For one, prospective treatment outcomes can be represented in terms of either mortality or survival rates. These alternative representations are logically equivalent. Eldar Shafir et al., *Money* jurisdiction, the doctor who undertakes a medical procedure without obtaining express, implied, or substituted consent commits either a battery or negligence.[44] In the context of the

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Illusion, *in* CHOICES, VALUES, AND FRAMES, *supra* note 24, at 335, 338. Nevertheless, in one experiment in which subjects were to choose between either surgery or radiation therapy for lung cancer, "the percentage of respondents who favored radiation therapy rose from 18 percent in the survival frame to 44 percent in the mortality frame. This result was observed among experienced physicians, statistically sophisticated business students, as well as clinic patients." *Id.*; *see* Barbara J. McNeil et al., *On the Elicitation of Preferences for Alternative Therapies*, *in* JUDGMENT AND DECISION MAKING: AN INTERDISCIPLINARY READER, *supra* note 23, at 272, 278-79. This consequence may run afoul of the ideal in which the physician is simply to convey relevant information objectively to the patient for her consideration. One commentator has "argued that if preferences are constructed in the process of informing, framing the options, and eliciting the response, the rationale behind the shared model of consent cannot be defended." Paul Slovic, *The Construction of Preference*, *in* CHOICES, VALUES, AND FRAMES, *supra* note 24, at 489, 502 (citation omitted). To help patients manage their preferences, "patients and physicians might be advised to sift and weigh alternative reasons or justifications, to work toward developing a rationale for action." *Id.* Yet, "there is little reason to believe that more informal procedures in which the treatments are described in general terms without quantitative statistical data are less susceptible to the effects of different methods of presentation." McNeil et al., *supra*, at 279. A further problem is raised by studies that suggest that people are weak at "forecast[ing] changes in their hedonic responses to stimuli" and "tend to make decisions about future consumption without due consideration of possible changes in their tastes." Daniel Kahneman, *New Challenges to the Rationality Assumption*, *in* CHOICES, VALUES, AND FRAMES, *supra* note 24, at 758, 767 (citations omitted). Regarding an operation that may significantly change the patient's life, "truly informed consent is only possible if patients have a reasonable conception of expected long-term developments in their hedonic responses, and if they assign appropriate weight to these expectations in the decision." *Id.* (questioning whether paternalistic intervention may be appropriate in some of these circumstances).

44. Other theories of recovery are possible, such as fraud, violation of a statute, or guaranteed outcomes, depending on the circumstances. *See* FAY A. ROZOVSKY, CONSENT TO TREATMENT §§ 1.3.3, 1.3.4 (3d ed. 2006). Since these theories are unlikely to be applicable to the innocent misestimations considered here, however, they are not addressed by this article.

Arkansas subscribes to the negligence theory of informed consent. *See generally, e.g.*, Fuller v. Starnes, 268 Ark. 476, 479, 597 S.W.2d 88, 90 (1980); Eady v. Lansford, 351 Ark. 249, 253-54, 92 S.W.3d 57, 60 (2002) (citing section 16-114-206 of the Arkansas Code for the appropriate standard for measuring the scope of "the physician's duty to disclose risks" and "the degree of disclosure necessary to render a consent adequate and informed . . . ."). Nevertheless, battery may still have a place in the context of Arkansas informed consent cases; there is some case law suggesting that a medical-battery claim might provide an additional means of recovery in suits where lack of informed consent is established under the negligence standard of section 16-24-206(b) of the Arkansas Code. *See* Arthur v. Zearley, 320 Ark. 273, 283, 285, 895 S.W.2d 928, 933-34 (1995) (striking down class certification in medical malpractice action where the individual issue of informed consent was "foundational to" and necessarily "woven throughout" each of the plaintiffs' multiple tort claims, which included battery); Parkerson v. Arthur, 83 Ark. App. 240, 250, 125 S.W.3d 825, 831-32 (2003) (dismissing plaintiff's battery claim in informed difficulties in understanding probabilities, I examine these two theories in turn.

1. The Battery Theory

Without proper consent, the touching of a patient by a doctor is unlawful and therefore a battery, even if no actual harm is demonstrated.[45] Under this theory of informed consent, misrepresentation of the material facts vitiates the consent. Unlike the related tort doctrine of fraud, which usually requires the representation to be culpably false,[46] the contract doctrine of misrepresentation reaches entirely innocent assertions of fact. A perfectly sincere misrepresentation will suffice to trigger liability by negating purported consent.[47] For example, a claim of misrepresentation stands even though the doctor truly and reasonably believes in the accuracy of the misinformation provided the patient.

While the claim of battery has historically required an unlawful touching, some courts have relaxed this requirement in cases involving informed consent in order to protect the autonomy interests of the patient. For example, some courts

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consent case not because battery was an improper theory, but because once the plaintiff's informed consent claim had been properly dismissed, the battery claim, which was based on a lack of informed consent, left no genuine issues of fact to be resolved).

45. Shultz, *supra* note 40, at 224 ("Patient autonomy was initially identified with and subsumed under an interest in physical security, protected by rules proscribing unconsented touch.").

46. *See generally* DOBBS, *supra* note 40, §§ 469-83.

47. It is common for courts and commentators to run together misrepresentation, fraud and deceit. *See, e.g.*, ROZOVSKY, *supra* note 44, § 1.3.3. Technically, misrepresentation, narrowly conceived, is not a theory of recovery at all, but rather a claim that a contract, or its particular terms, are unenforceable as obtained without proper agreement. *See, e.g.*, 1 E. ALLAN FARNSWORTH, FARNSWORTH ON CONTRACTS § 4.10, at 468-69 (3d ed. 2004); JOHN EDWARD MURRAY, JR., MURRAY ON CONTRACTS § 95, at 543-45 (4th ed. 2001). Deceit and fraud are usually considered synonymous and constitute a theory of recovery in tort. *See* DOBBS, *supra* note 40, § 469, at 1344 ("The terms fraud, deceit, and misrepresentation are used as the name of a tort."). Indeed, a misled patient may have a claim of negligent misrepresentation against her provider. *See id.* ("Negligent misrepresentation may also be actionable in some cases, but only when the defendant is under a duty to use care in communicating, as where the defendant is in a special relationship with the plaintiff."). But this theory is not pursued here because, under the circumstances, it would largely overlap with the theory of informed consent. *See generally id.* § 472. Actually, the contract claim of misrepresentation may be met by demonstrating that the misrepresentation was either fraudulent or material. *See* 1 FARNSWORTH, *supra*, § 4.12, at 480; MURRAY, *supra*, § 95, at 538-39.

under a battery theory have called for doctors to disclose the risks of refusing diagnostic procedures, such as pap smears or fetal genetic tests.[48] Much of this type of data will doubtlessly be in probabilistic terms. Without the relaxation of the requirement of unlawful touching, the doctor's misestimations of probabilities would not be actionable when the patient declines follow-up procedures. Nevertheless, though there may be ways to avoid the strictures of a battery theory, in recent decades the large majority of courts have jettisoned the battery theory of informed consent in favor of the more compatible negligence theory.[49]

Still, for those jurisdictions retaining a battery theory for informed consent cases, whether a doctor misinforms a patient about the risks of a medical procedure due to the difficulty of understanding probabilities may turn on details.[50] To start with a fairly easy example, in the original illustration of the usually fatal disease, suppose the doctor states only this:

> I have some bad news for you. One of the test results was positive. While, as usual, there are no perceptible symptoms at this stage, it appears that you may have an aggressive disease that is usually fatal. As I look at your test results, it seems that the chances that you have the disease are about 95%.

If the patient relies on this estimation in deciding to have an operation, it is hard to argue that the consent was informed. But what if the doctor had added, "While I'm no statistician, as I look at your test results . . . "? This precautionary clause, "I'm

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48. *See, e.g.*, Truman v. Thomas, 611 P.2d 902, 906 (Cal. 1980) ("If a patient indicates that he or she is going to *decline* the risk-free test or treatment [here, a routine pap smear test], then the doctor has the additional duty of advising of all material risks of which a reasonable person would want to be informed before deciding not to undergo the procedure."); Berman v. Allan, 404 A.2d 8, 13-15 (N.J. 1979) (involving a wrongful birth). "The wrongful birth claim is asserted by the mother [who] . . . typically claims that, but for the defendant's negligence in testing or counseling, the mother would have terminated a pregnancy to avoid birth of a child with serious genetic defects." DOBBS, *supra* note 40, § 291, at 792.

49. *See, e.g.*, Twerski & Cohen, *Decision Making*, *supra* note 23, at 611-12. For a well-reasoned rejection of the battery theory, see Trogun v. Fruchtman, 207 N.W.2d 297, 312-13 (Wis. 1973).

50. *See* Twerski & Cohen, *Decision Making*, *supra* note 23, at 627 ("Unless we know the manner in which the withheld information would have been presented, we often cannot credibly predict its effect."). This uncertainty complicates the question whether there is a causal link between the missing information and the patient's decision. *See id.* at 638-39.

no statistician," seems insufficient to put the patient on guard when the raw test data is not conveyed. But what if, as in the original example, the doctor gives the raw test data ("The prevalence of this disease is 1/1000, but the test has a false positive rate of 5%") and then misestimates the probability of having the disease at 95% while professing his statistical shortcomings?

Each of these three scenarios strikes me as precluding informed consent under the battery theory. While the doctor spoke without knowledge that the information conveyed was incorrect, knowledge is not an element of misrepresentation. The most problematic version is where the doctor provides the proper raw data and then, with cautionary language, misestimates the probability of having the disease. This also, in my view, should give rise to liability. In light of the difficulty most doctors have with Bayesian reasoning, it is most certain that patients generally have even a harder time. It is entirely unrealistic to expect the patient to check whether, based on the given raw data, the doctor's estimation of actually having the disease is correct, especially when the patient has every reason to believe that the doctor has greater expertise on the subject, cautionary language notwithstanding. For most patients, and many doctors, discussing statistics in Bayesian terms is like conversing in a foreign language. Information does not sufficiently inform patients unless it can be reasonably understood by the ordinary prudent person.[51]

51. "The principal goals of informed consent doctrine . . . cannot be achieved unless the information about the risks associated with various treatment (and non-treatment) alternatives is reliable and is communicated in a fashion that is intelligible and meaningful to patients." Schuck, *supra* note 43, at 948 (footnote omitted). "Nevertheless, . . . the studies and commentary on informed consent in action suggest that it often fails even this minimal test. Many physicians discuss risk in a more or less perfunctory manner and without much regard to how well the patient comprehends the information." *Id.* "While many factors contribute to this failure, an important one is the language and concepts that physicians use to characterize the risks to patients." *Id.* Schuck then considers a solution that will not work: "[T]he physician might attempt to use more specific language, employing more exact quantitative measures (expressing risk, for example, as a numerical percentage or statistical probability)." *Id.* (questioning whether such precise language "may create a spurious and misleading impression of precision"). But seeing the weakness of this and other proposals, Schuck suggests that physicians "characterize risks . . . in explicitly *comparative* terms—that is, in terms that encourage the patient to assess the medical risk in light of other risks that are more familiar to her, risks that she has some basis for, and experience in, evaluating." *Id.* at 949.

An even more complicated scenario is where the doctor provides only the raw test data: "The prevalence of this disease is 1/1000, but the test has a false positive rate of 5%." The doctor says nothing more. Instead, it is the patient rather than the doctor who, based on this information, misestimates the chances of having the disease as very high, rather than the truer 2%. When the patient, rather than the doctor, makes the misestimation, is the ensuing consent informed? Much can be said for the proposition that even here the disclosure is insufficient, though in a real sense accurate. It is as if the doctor is speaking in technical language that cannot reasonably be expected to inform a patient adequately.[52] Similarly, under the duty to warn in products liability, the warning must be in language "'comprehensible to the average user and . . . convey[ing] a fair indication of the nature and extent of the danger to the mind of a reasonably prudent person.'"[53] Raw Bayesian data hardly meets this standard. For the sake of efficiency, to say nothing of autonomy interests, health care providers should be required to convey risk estimations in comprehensible terms, that is, raw natural frequencies at worst, and accurate bottom-line likelihoods at best.

2. The Negligence Theory

In most jurisdictions, liability under the informed consent doctrine is based on the negligent nondisclosure of material facts, not on a battery theory.[54] The standard elements of the patient's claim under this negligence theory are:

52. *See Canterbury*, 464 F.2d at 783 n.36 ("Physicians and hospitals have patients of widely divergent socio-economic backgrounds, and a rule which presumes a degree of sophistication which many members of society lack is likely to breed gross inequities.").

53. MacDonald v. Ortho Pharm. Corp., 475 N.E.2d 65, 71 (Mass. 1985) (citing Ortho Pharm. Corp. v. Chapman, 388 N.E.2d 541, 552 (Ind. Ct. App. 1979) (quoting Bituminous Cas. Corp. v. Black & Decker Mfg. Co., 518 S.W.2d 868, 872-73 (Tex. App. 1974))). In *MacDonald*, the plaintiff suffered a stroke after using the defendant-manufacturer's birth control pills. 475 N.E.2d at 67. The manufacturer's warnings, pursuant to FDA regulations and common law requirements that they be in "lay language," stated that "[t]he most serious known side effect is abnormal blood clotting which can be fatal," and included other comparable language, but did not use the term "stroke." *Id.* at 66-67. The court held for the plaintiff on her claim that she would not have used the pills if she had known of the associated risk of stroke. *Id.* at 72.

54. "Discomfort with treating doctors under a doctrine aimed at antisocial conduct has prompted most jurisdictions to limit the battery action to those relatively unusual

> (1) nondisclosure of required information; (2) actual damages such as loss of a leg; (3) resulting from the risks of which the patient was not informed; (4) cause in fact, which is to say that the plaintiff would have rejected the medical treatment if she had known the risk; and (5) that reasonable persons, if properly informed, would have rejected the proposed treatment.[55]

About half the states base the negligence standard of required disclosure on medical custom, that is, what a reasonable doctor would provide under the circumstances.[56] Pursuant to this standard, a doctor must divulge the information that other doctors in the relevant community usually reveal for the particular medical procedure. But even under this standard, it is not acceptable medical custom for the doctors in the community to routinely convey misestimated risk probabilities to their patients. The medical community standard of customary disclosure relates to the amount of information to be imparted, not to its accuracy.[57] For the principle of protecting the patient's autonomy to have any significant meaning at all, divulged information must be reasonably accurate.

The more difficult questions under the medical custom standard are whether there is adequate informed consent when: (1) doctors uniformly qualify their risk estimations with precautionary language about their deficient statistical skills; (2) provide both the raw test data and misestimated risk probabilities; or (3) simply provide the raw test data and let the patient arrive at the common misestimation of risk.[58] When confronted with these first two scenarios, the courts may well

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situations where a medical procedure has been carried out without *any* consent, rather than where the consent has merely been insufficiently informed." Shultz, *supra* note 40, at 226. "Most litigation about patient autonomy now occurs over doctors' nondisclosure of information, analyzed as an issue of professional negligence." *Id.*

55. DOBBS, *supra* note 40, § 250, at 654 (footnote omitted); *see* ROZOVSKY, *supra* note 44, § 1.3.2.

56. *See, e.g.*, Fuller v. Starnes, 268 Ark. 476, 479, 597 S.W.2d 88, 90 (1980); Natanson v. Kline, 350 P.2d 1093, 1106 (Kan. 1960); Largey v. Rothman, 540 A.2d 504, 509 (N.J. 1988); Rizzo v. Schiller, 445 S.E.2d 153, 155 (Va. 1994); *see also* DOBBS, *supra* note 40, § 250, at 655.

57. *See* ROZOVSKY, *supra* note 44, § 1.13.1 (Under the medical community standard, "[t]he *amount* of disclosure is largely a matter of medical judgment.") (emphasis added).

58. One may be skeptical that any such customs may arise. *Canterbury*, 464 F.2d at 783 ("[T]he reality of any discernible custom reflecting a professional consensus on communication of option and risk information to patients is open to serious doubt.").

decide that the information as understood by the typical patient is inaccurate. Precautionary language or raw test data notwithstanding, the patient's attention will be drawn to the doctor's bottom-line, misestimated risk assessment. Because only the most sophisticated patient may perceive an inconsistency in the risk assessments, ensuing consent should not be considered sufficiently informed. The most difficult scenario, again, is the third one in which doctors customarily convey only the raw test data and let the patients routinely draw the inaccurate conclusion as to risk probabilities. In a strong sense, the information conveyed by this medical custom is accurate,[59] though misleading. Courts could simply declare that the misleading overtones trump the underlying accuracy, concluding that ensuing consent is not informed. Or the courts could overrule this medical custom as unreasonable.[60] Patients need transparent data to truly give informed consent, especially in these emotionally charged situations. At some point the courts must consider whether the medical custom adequately protects the patient's autonomy.

The other half of the states embrace a patient or materiality standard of disclosure for negligence.[61] This turns the focus on the patient rather than the doctor. The doctor must disclose all material information—that is, the information that a reasonable doctor would expect to be material to a patient who is considering whether to undergo the proposed medical procedure.[62] This standard requires broader disclosure than

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59. *See* ROZOVSKY, *supra* note 44, § 1.13.1 ("There is no hard and fast rule regarding what type of information should or should not be disclosed under the medical community standard.").

60. The most famous opinion disapproving custom when it is found to be unreasonable comes from the pen of Learned Hand. *The T.J. Hooper*, 60 F.2d 737, 740 (2d Cir. 1932) (rejecting the custom among tug boat operators not to have radio receivers on board to obtain weather forecasts).

61. *See, e.g.*, *Canterbury*, 464 F.2d at 786; Cobbs v. Grant, 502 P.2d 1, 11 (Cal. 1972); Cowman v. Hornaday, 329 N.W.2d 422, 425-27 (Iowa 1983); Wilkinson v. Vesey, 295 A.2d 676, 688 (R.I. 1972); DOBBS, *supra* note 40, § 250, at 655; *see also* ROZOVSKY, *supra* note 44, § 1.13.2.

62. *See, e.g.*, Logan v. Greenwich Hosp. Ass'n, 465 A.2d 294, 299-300 (Conn. 1983); *Cowman*, 329 N.W.2d at 425; Wheeldon v. Madison, 374 N.W.2d 367, 374 (S.D. 1985). In the words of one court, a surgeon must "explain the procedure to the patient and . . . warn him of any material risks or dangers inherent in or collateral to the therapy, so as to enable the patient to make an intelligent and informed choice about whether or not to undergo such treatment." Sard v. Hardy, 379 A.2d 1014, 1020 (Md. 1977). Similarly, in

does the medical custom standard.[63] Among the required information that may have a probabilistic form are the test results that suggest the proposed medical procedure is needed, the likelihood of its success, the patient's prognosis if the procedure is declined, and the risks of alternatives. Indeed, probability inheres in much of the material information. For example, "[t]he materiality of information about a potential injury is a function not only of the severity of the injury, but also of the likelihood that it will occur."[64]

The patient or materiality standard of disclosure quickly points toward the inadequacy of conveying probabilistic data in Bayesian terms, even if entirely accurate. A reasonable patient certainly wants to base her consent to a medical procedure on a realistic assessment of the risks. Reasonable doctors should know that the Bayesian approach is unlikely to facilitate this for most of their patients, just as it often fails for them.

Under either the battery or the negligence theory of informed consent, the patient has an uphill battle. The track record of patients claiming only the lack of informed consent is weak. As one commentator puts it, "[a] complete cause of action under an informed consent theory is not easy to prove, and the general consensus in the profession is that these cases are rarely winners without some independent evidence of physician malpractice."[65] In situations relating to diagnostic test results, perhaps the highly misleading information about risks often provided by doctors will get the patient over the litigation hurdle. Or perhaps the patient should look to another theory of recovery, such as the negligent infliction of emotional harm.[66]

determining the materiality of a misrepresentation, "[t]he matter is material if . . . a reasonable man would attach importance to its existence or nonexistence in determining his choice of action in the transaction in question . . . ." RESTATEMENT (SECOND) OF TORTS § 538(2)(a) (1977).

63. *See* Twerski & Cohen, *Decision Making*, *supra* note 23, at 614 n.27.

64. Precourt v. Frederick, 481 N.E.2d 1144, 1148 (Mass. 1985).

65. RICHARD A. EPSTEIN, TORTS § 6.3, at 146 (1999).

66. For cases involving claims of lack of informed consent as well as negligent or intentional infliction of emotional harm, see Jones v. Howard Univ., Inc., 589 A.2d 419, 420 (D.C. 1991); Faya v. Almaraz, 620 A.2d 327, 330 (Md. 1993). For brief discussion of these cases, see ROZOVSKY, *supra* note 44, § 1.15.6.

B. Negligent Infliction of Emotional Harm

Under the cause of action for the negligent infliction of emotional harm, most courts today grant recovery for foreseeable emotional harm alone, such as mental anguish, nervous shock, or emotional distress.[67] But courts are exceedingly careful to keep this theory of recovery from unduly expanding, particularly for fear of fraudulent claims and the slippery slope.[68] They have thus adopted various limitations. Among them, from more to less restrictive, are: (1) an impact rule whereby the defendant must inflict physical contact on the plaintiff;[69] (2) the rule that, in the absence of impact, the plaintiff must be in the "zone of danger" when she apprehends the risk,[70] or that her emotional distress must have physical manifestations; and (3) the rule that when physical symptoms of harm are not present, the emotional distress must be serious or severe.[71] Furthermore, some courts impose restrictions when the emotional harm does not follow from an abrupt occurrence,

67. *See* DOBBS, *supra* note 40, § 308, at 836; *see also* Shultz, *supra* note 40, at 278 & nn.254-55 ("The interest in freedom from emotional distress also has much in common with the interest in medical choice. Both interests protect aspects of personal sanctuary.").

The Arkansas Supreme Court, however, is not one of the majority of courts. *See, e.g.*, Dalrymple v. Fields, 276 Ark. 185, 190, 633 S.W.2d 362, 364 (1982). Arkansas does not recognize a cause of action for negligent infliction of emotional distress; instead, some type of attendant physical injury must be present in order to recover for emotional harm in Arkansas. HOWARD W. BRILL, ARKANSAS LAW OF DAMAGES § 33:12 (5th ed. 2004) ("Damages for emotional harm are considered parasitic damages in that recovery is allowed only if they are attached to the host of physical impact."); *see also* Margaret A. Egan, Note, *Tort Law—Spoliators Beware, but Fear Not an Independent Civil Suit:* Goff v. Harold Ives Trucking Co., 24 U. ARK. LITTLE ROCK L. REV. 233, 253 & n.167 (2001) (explaining that Arkansas courts have generally been reluctant to recognize new torts).

68. Consequently, development of this tort has been in fits and starts. For example, in reviewing the case law, Epstein states: "Once again the courts that open the door to new distress cases are only barely willing to keep it ajar." EPSTEIN, *supra* note 65, § 10.16, at 280. Indeed, the Discussion Draft of the Restatement (Third) of Torts: General Principles "goes further than relegating emotional harm to the margins. It excludes it altogether, at least in those portions of the *Restatement* relating to basic principles." Martha Chamallas, *Removing Emotional Harm from the Core of Tort Law*, 54 VAND. L. REV. 751, 753 (2001). One way it does this is by excluding "cases of negligent infliction of mental distress [because] they are not classified as within 'the core of tort law.'" *Id.*

69. The Restatement adopts this hard line. *See* 2 RESTATEMENT (SECOND) OF TORTS § 436A (1965).

70. The Restatement advances the "zone of danger" rule for liability for physical harm resulting from emotional disturbance. *See id.* § 436, illus. 2.

71. DOBBS, *supra* note 40, § 308, at 836-38; *see generally* EPSTEIN, *supra* note 65, §§ 10.14-10.17.

threat of an impact, or contemporary knowledge of a risk of immediate physical harm.[72] Nevertheless, courts are generally more generous to the plaintiff when the defendant has assumed a duty to her or such a duty is ordained by law.[73]

Although the courts have vacillated in recognizing negligence claims for emotional distress alone,[74] in several cases akin to our problem recovery was allowed despite the limiting rules. In one, the defendant negligently misread a pap smear test as negative. When the mistake was found much later, and proper treatment begun, the plaintiff sued and recovered for her emotional distress from the increased risk of cancer.[75] Dobbs sees two crucial factors warranting relief in this case, both of which are present in our problem. "First, . . . the parties are not strangers; on the contrary, the defendant has undertaken to care for the plaintiff professionally and failed to do so. Second, the fear arises from a specific incident rather than, say, gradual environmental exposure."[76] In other cases related to our problem, where the plaintiff is reasonably put in fear of an

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72. *See* DOBBS, *supra* note 40, §§ 309, 311.

73. *See id.* § 312, at 848-50. For example, a doctor who negligently injured a baby during delivery has been held liable to the mother for her emotional harm even though she may not have been aware of the newborn's injury until later. *See, e.g.*, Burgess v. Superior Ct., 831 P.2d 1197, 1209 (Cal. 1992); Carey v. Lovett, 622 A.2d 1279, 1287 (N.J. 1993). Under the doctor-patient relationship, the doctor owes a direct duty of care to the mother. *See Burgess*, 831 P.2d at 1201; *see also* Chizmar v. Mackie, 896 P.2d 196, 203-05 (Alaska 1995) (holding that despite the lack of physical injury, doctor-patient relationship establishes duty to avoid negligent misdiagnosis of HIV). *But see* Heiner v. Moretuzzo, 652 N.E.2d 664, 670 (Ohio 1995) (explaining that the doctor-patient relationship does not itself establish the duty to avoid emotional harm in the absence of actual physical danger). "When the defendant owes an independent duty of care to the plaintiff, there is no risk of unlimited liability to an unlimited number of people." DOBBS, *supra* note 40, § 312, at 849. "An assumed duty or a special relationship with a duty imposed by law might arguably eliminate other restrictive rules, for example, those requiring a physical manifestation or symptom of harm and those requiring a sudden event, but courts have not yet developed the logic of assumed duty." *Id.*

74. EPSTEIN, *supra* note 65, § 10.17, at 280.

75. Gilliam v. Roche Biomedical Labs., Inc., 989 F.2d 278, 279 (8th Cir. 1993) (applying Arkansas law). In *Gilliam*, the Eighth Circuit held that an Arkansas plaintiff may recover for reasonable mental anguish attributable to the possibility of disease irrespective of whether the negligent act creates an increased risk of disease. 989 F.2d at 280 & n.3 (noting that the issue was one of first impression in Arkansas); *see also* BRILL, *supra* note 67, §§ 4:7 n.21, 29:2; Mark A. Koppel, Note, Gilliam v. Roche Biomedical Laboratories: *An Introduction to Fear-of-Disease Damages in Arkansas*, 48 ARK. L. REV. 555 (1995). No Arkansas court has since discussed the *Gilliam* case. For Dobbs's discussion of the *Gilliam* case, see DOBBS, *supra* note 40, § 311, at 844-45.

76. DOBBS, *supra* note 40, § 311.

egregious disease which fails to develop, some courts have recognized a cause of action even though no "actual exposure" was demonstrated,[77] as in those cases which allowed recovery for fear of AIDS following a negligent prick from a needle that was not tested for the HIV virus.[78] As in our problem, during the "window of anxiety" before the patient discovers the risk was misestimated, assuming it was discovered before a medical procedure was performed, the plaintiff's emotional distress can be expected to be substantial.[79] Finally, in a fact pattern even closer to our problem, some courts grant recovery when the defendant negligently misdiagnoses the plaintiff as having AIDS,[80] though others deny recovery, pointing out that the misdiagnosis does not physically endanger the plaintiff.[81] None of these cases go as far as some of the scenarios we have contemplated, such as where the doctor uses cautionary language disavowing her statistical abilities or where the doctor

77. *See, e.g.*, *Faya*, 620 A.2d at 330, 339 (Md. 1993) (reversing trial court's dismissal of plaintiff's negligence, fraud, and intentional infliction of emotional distress claims against a surgeon who failed to inform patients of his HIV infection prior to operating on them). *But see* Burk v. Sage Prods., Inc., 747 F. Supp. 285, 287-88 (E.D. Pa. 1990) (requiring proof of actual exposure to AIDS); Pendergist v. Pendergrass, 961 S.W.2d 919, 926 (Mo. Ct. App. 1998) (same). *See generally* Ivan Yip, Note, *AIDSphobia and the "Window of Anxiety": Enlightened Reasoning or Concession to Irrational Fear?*, 60 BROOK. L. REV. 461 (1994).

78. *See, e.g.*, Hartwig v. Oregon Trail Eye Clinic, 580 N.W.2d 86, 94 (Neb. 1998) (declaring that proof of actual exposure is not required when the identity of the patient on whom the contaminated needle is used is unknown); Williamson v. Waldman, 696 A.2d 14, 19, 22 (N.J. 1997) (same); Madrid v. Lincoln County Med. Ctr., 923 P.2d 1154, 1163 (N.M. 1996) (same under the tort of intentional infliction of emotional harm).

79. In *Chizmar*, where the doctor misdiagnosed an HIV test result, the court allowed recovery for the long-term emotional injury that extended beyond the period of the "window of anxiety." 896 P.2d at 205-06.

80. *See, e.g.*, *Chizmar*, 896 P.2d 196; Bramer v. Dotson, 437 S.E.2d 773 (W. Va. 1993); *see generally* Ellen L. Luepke, Note, *HIV Misdiagnosis: Negligent Infliction of Emotional Distress and the False-Positive*, 81 IOWA L. REV. 1229 (1996); Kenneth C. Robling, Note, *Negligent HIV Testing and False-Positive Plaintiffs: Pardoning the Traditional Prerequisites for Emotional Distress Recovery*, 43 CLEV. ST. L. REV. 655 (1995); Schmid, *supra* note 6. The leading "misinformation" case is *Molien v. Kaiser Foundation Hospitals*, in which the plaintiff stated a cause of action for incorrect diagnosis of syphilis that lead to the breakup with her husband whom she inferred had been having an extramarital affair. 616 P.2d 813, 821 (Cal. 1980).

81. *See* R.J. v. Humana of Fla., Inc., 652 So. 2d 360, 363-64 (Fla. 1995); *Heiner*, 652 N.E.2d at 670. This limitation and others, such as the requirement that there be a special duty to the plaintiff, assumed or legally imposed, create a high hurdle for members of the patient's family who claim damages for the negligent infliction of emotional harm.

simply offers the raw test data and lets the patient reasonably and foreseeably misestimate the risk.

IV. CONCLUSION

Improved education is a solution to the problems arising from the misunderstandings of probabilistic data. While it would be beneficial for everyone to better understand probabilities in this scientific age, the deep nature of the underlying difficulty may make it unrealistic to expect the average citizen to become sufficiently sophisticated on such crucial statistical matters. But one can expect more from the medical profession. For one, many of a doctor's professional duties turn on statistically-based decisions. Further, doctors go through intensive and extensive training that provides an apt opportunity for the additional education. Finally, medical professionals are highly intelligent and motivated to master those concepts that will benefit their patients and themselves.

Yet training doctors to put statistics in terms of frequencies may not be enough to convey the full import of the information. In the face of risk and uncertainty, humans are simply bad reckoners in many ways.[82] The conveyance of probabilistic information should take this into account. For example, one advocacy group represented the statistics on prostate cancer this way: "In 2002, an estimated 189,000 men will be diagnosed with prostate cancer. This represents one new case every three minutes."[83] But some experts believe that even data expressed in this simple and accurate manner may lead people to exaggerate their own risks.[84] Hence, it has been urged that such statistics be contextualized by comparing them to other risks more familiar to the average person, as where one compares the chances of having a particular ailment to having a car accident.

I do not have the expertise to advise medical professionals on methods of improving their discussions of risks with patients. But one needs no expertise to come to the sound conclusion that inaccurate risk assessments are likely to be injurious to patients. Before the judiciary brandishes its stick of liability to bring this

82. *See supra* notes 23-24 and accompanying text.

83. Gina Kolata, *Experts Strive to Put Diseases in Proper Perspective*, N.Y. TIMES, July 2, 2002, at F5.

84. *Id.*

problem to their attention, the medical profession should consider the demands of the Hippocratic Oath: "Above all, do no harm."[85]

85. *See* TOM L. BEAUCHAMP & JAMES F. CHILDRESS, PRINCIPLES OF BIOMEDICAL ETHICS 113 (5th ed. 2001) ("Above all . . . do no harm.").