

Screening of asymptomatic women using Mammograms Bayes Law and a cost/benefit analysis

There are many misconceptions about the usefulness of mammograms, as well as a considerable amount of misleading information that has been propagated by advocates of mammography.

Misconceptions: The following facts are not in dispute.

- a) Mammograms are used for early diagnosis of breast cancer. They do not reduce the risk of contracting breast cancer, nor do they cure breast cancer. In fact, exposure to X-rays has been shown to cause cancer, so the procedure can induce cancer in some previously healthy women. The exact risk of contracting cancer in this way is small and not well quantified. However, it is believed that of every 10,000 women who begin routine mammography screening at age 40, between 2 and 4 will develop radiation-induced breast cancer, and 1 will die.
- b) Breast cancer is not the leading cause of death for women. Cardiovascular disease is. Even among cancers, lung cancer kills more women than breast cancer.
- c) The media and National Alliance of Breast Cancer Organizations often quote the statistic (to quote from a sheet I obtained this morning from the UVA hospital) that “One out of nine women in the United States will develop breast cancer in her lifetime – a risk that was one out of 14 in 1960.” This is very misleading assessment of the risk. The figure one out of nine is for women who live to be 85 years old, an age most women do not attain. Ductal carcinoma in situ, a particular variety of breast cancer commonly found in younger women, often does not progress. In cases where there is no progression, the carcinoma may be harmless. Many dangerous breast cancers developed by elderly women (and breast cancer incidence increases substantially with age) will advance so slowly as not to be the cause of death. It is believed the main reason the breast cancer rate has increased since 1960 is that mammograms have revealed breast cancers that might have otherwise gone undetected because the cancers were benign or because women died before the cancer could progress to the point of being detected by older technology. Only about 3 in every 100 women will die of breast cancer by age 85, a substantial number, but considerably smaller than the oft-quoted 1 in 9.
- d) No organization currently recommends mammograms for women before age 40.

Results of ten randomized clinical trials – a summary

- a) There is no evidence that screening asymptomatic women in their 40s reduces the mortality from breast cancer, or that biennial screening is less effective than annual screening. Despite the absence of any proven benefit from an aggressive screening protocol, the UVA health clinic, as well as a number of cancer organizations, continue to recommend that women obtain mammograms *annually*, beginning at age 40.
- b) For women over 50, the benefit of biennial screening is real, although still more modest than one might have been led to believe. Consider women who begin screening at age 50 and are screened every two years for twenty years. For every 270 women who undergo this procedure, one life is saved. Biennial screening of older women for the 20 years

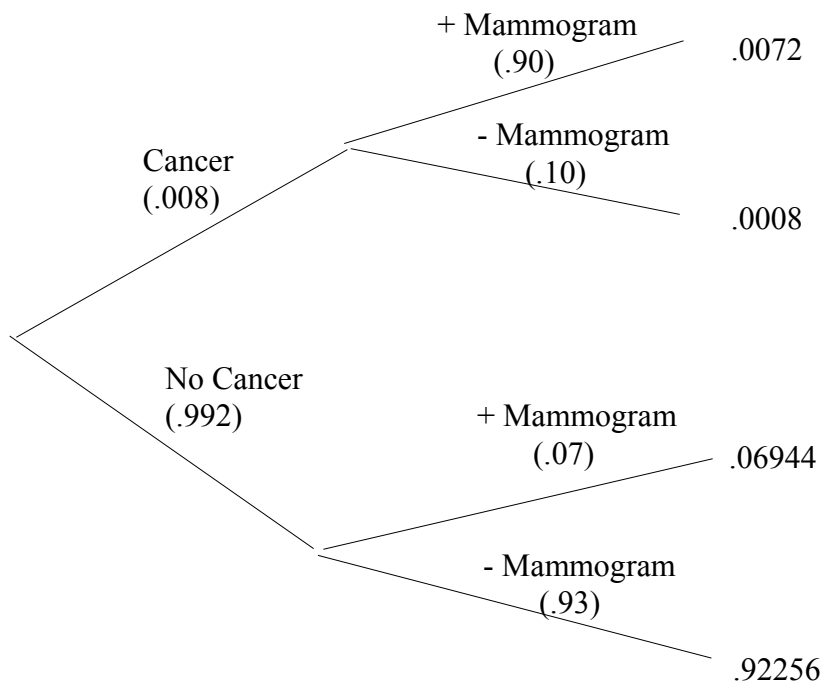
between ages 50 and 70 is the most cost-effective procedure, and even in this group, the cost is \$21,000 *per year* of life saved . Annual exams, beginning at age 40, roughly triple the cost without increasing the benefit. While \$21,000 *per year* of life saved is arguably worth paying, there are medical procedures with a more attractive cost/benefit ratio that are much less actively promoted than mammography screening. Also, the high cost clearly puts the procedure out of reach for much of the world's population.

False Positives.

The following information pertains to the screening of *asymptomatic* women aged 40 to 50. It is presented here as a Bayes Law problem.¹

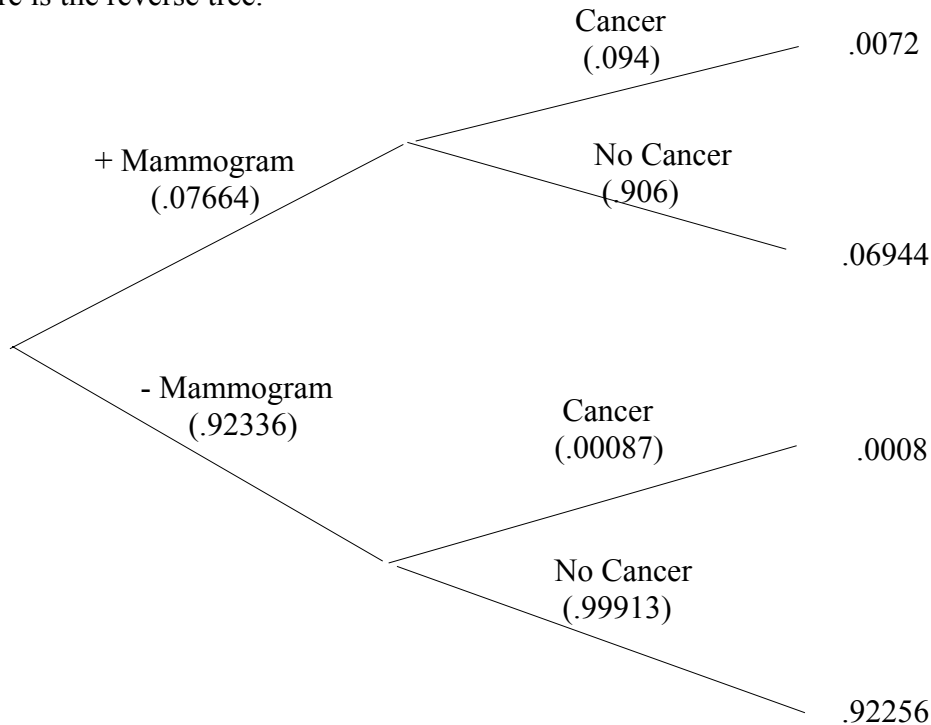
The probability that a women in this age group has breast cancer is 0.8 percent. If a woman has breast cancer, the probability is 90 percent she will have a positive mammogram. If a woman does not have breast cancer, the probability is 7 percent that she will still have a positive mammogram. Imagine a woman with a positive mammogram. What is the probability she actually has breast cancer?

Here is the forward tree.



¹Gerd Gigerenzer, *Calculated Risks*, p. 41.

And here is the reverse tree.



Therefore, if you are asymptomatic and under 50 years of age, the probability of your having cancer, given that you have a positive mammogram, is about 9%! The reason it works out this way is that mammograms give so many false negatives, and the incidence of breast cancer in younger women is small.² Unfortunately, many people, even *physicians*, find the correct interpretation of probabilities difficult. In Gigerenzer's book, *Calculated Risks*, he argues strongly that risk information is most clearly communicated through natural frequencies. Here is the same question, presented in terms of natural frequencies.³

Eight out of every 1000 women have breast cancer. Of these 8 women with breast cancer, 7 will have a positive mammogram. Of the remaining 992 women who don't have breast cancer, some 70 will still have a positive mammogram. Imagine a sample of women who have positive mammograms in screening. How many of these women actually have breast cancer?

In an experiment, a group of 48 physicians, with an average of 14 years professional experience, were given the Bayes law problem above. Half were given the problem in terms of conditional probabilities, half in terms of natural frequencies. The estimates of these physicians were almost always wildly incorrect when given conditional probabilities, but when given natural

²If a woman has 10 mammograms done (one a year for 10 years, or one every two years for 20 years) the probability of a false positive at some point during those 10 years is 1/2.

³Ibid, page 42

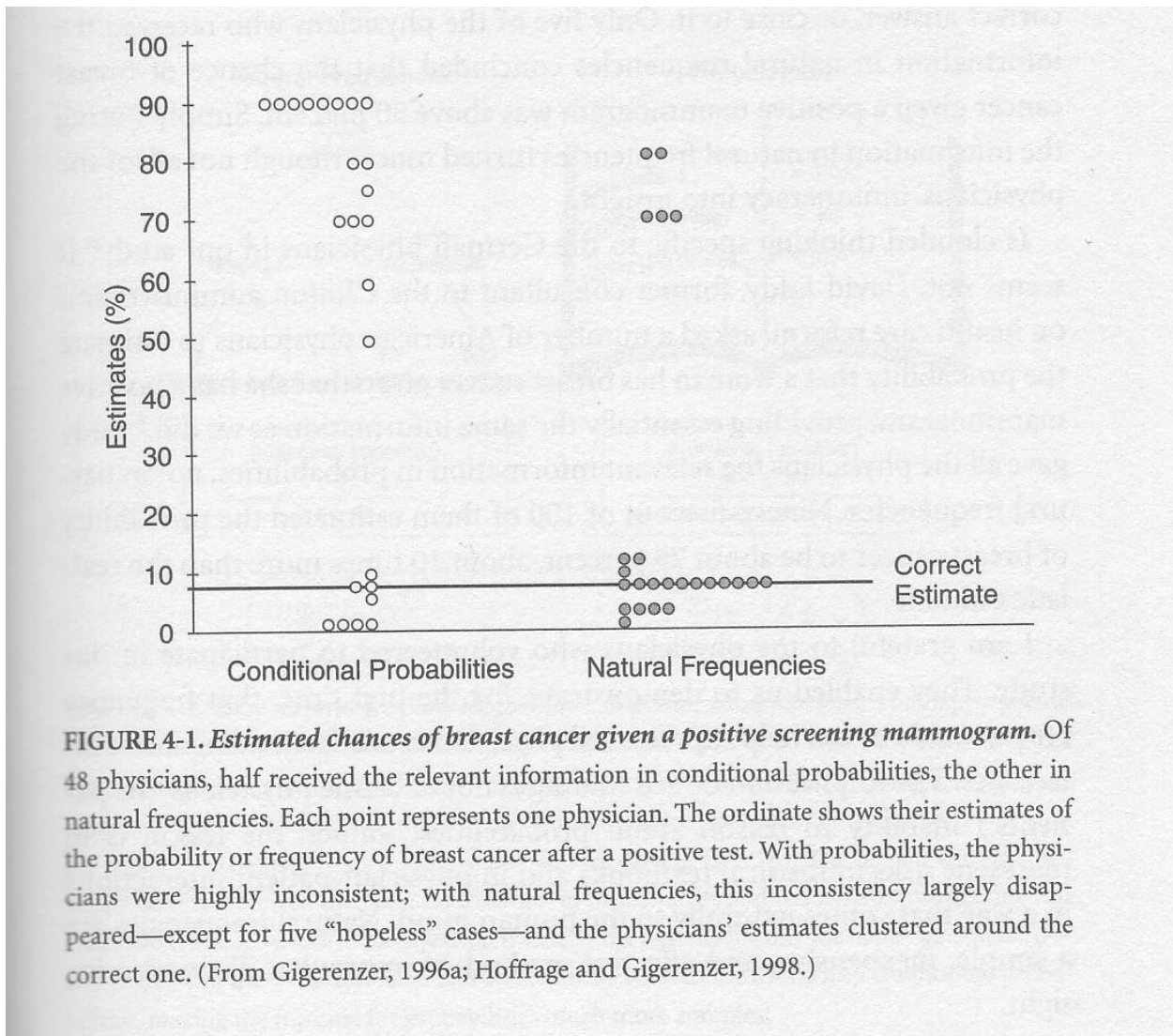


FIGURE 4-1. Estimated chances of breast cancer given a positive screening mammogram. Of 48 physicians, half received the relevant information in conditional probabilities, the other in natural frequencies. Each point represents one physician. The ordinate shows their estimates of the probability or frequency of breast cancer after a positive test. With probabilities, the physicians were highly inconsistent; with natural frequencies, this inconsistency largely disappeared—except for five “hopeless” cases—and the physicians’ estimates clustered around the correct one. (From Gigerenzer, 1996a; Hoffrage and Gigerenzer, 1998.)

frequencies, they did better. The diagram above shows the result of this experiment.⁴ Based on this and many similar experiments, Gigerenzer argues persuasively that physicians and lawyers – and those who train physicians and lawyers - should present information using natural frequencies, rather than conditional probabilities.

Why are mammograms so popular?

First, one must recognize that there is some benefit, which partly accounts for it. However, the actual costs and benefits of mammography are poorly understood by the public, and even by many physicians. Some of this confusion is intentional: self-interested groups tout irrelevant and misleading numbers, such as the 1 in 9 figure, and withhold information less favorable to mammography, such as the large number of people who undergo unnecessary operations as a

⁴Ibid, p. 43

result of false positives. Some feminist groups have made support of mammography a political issue, so that anyone raising questions about it is likely to be accused of prejudice against women. Fear of litigation also plays a role. Physicians aren't sued by women who undergo needless surgery and are relieved to discover they did not have cancer; they are more likely to be sued by women who discover they have breast cancer and were never screened. Also, one should not ignore self-interested motives. Mammography screening is a big business, and quite profitable to the physicians engaged in it. Since screening is not without benefit to patients, and is profitable for health care providers, most physicians feel comfortable recommending it. Why those physicians who do understand the costs and benefits fail to discuss this information with their patients is another issue. The primary reason seems to be that physicians perceive that their patients want reassurance delivered with an air of certainty, rather than a discussion of the messy facts of the matter.

For most of the information in this handout, I have drawn on *Calculated Risks*.⁵ This book explores this and other examples drawn primarily from law and medicine. It would be worthwhile reading if you were considering a career as a criminal lawyer or as a practicing physician.

⁵ISBN 0-7432-0556-1