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Junk Science in the Courtroom

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JUNK SCIENCE IN THE COURTROOM*

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I. INTRODUCTION

Tort law approaches the question of risk quite differently from science. A store owner defending himself against a claim that a slip and fall caused breast cancer need not prove generally that trauma does not cause breast cancer; he need only show that *this* trauma probably did not cause *that* cancer, not whether other traumas cause other cancers elsewhere. Conversely, the plaintiff needs only to sell a diagnosis: *this* breast cancer was caused by *that* fall. The jury is supposed to decide in favor of the side that has established the "preponderance of the evidence." In practice, the plaintiff needs only to persuade the jurors that the risk should be taken seriously. At one level, the legal system is more symmetric than science in its approach to risk. In an individual trial, one side affirms, the other denies, and the matter is resolved in favor of one side or the other by the jury. Each side can hire its own expert witnesses, and in theory (and quite often in practice) the jury's decision will reflect the strengths of the scientific arguments that are presented.

But in a larger sense the legal system is highly asymmetric in its handling of technological risk. The problem is associated with the avalanche of litigation that might be filed because of a real or presumed risk. So much litigation arose because the Dalkon Shield led to pelvic infection in some of its users, and asbestos led to lung disease in some workers, that A. H. Robins and the Johns-Manville Company were both driven into bankruptcy. These were real problems, although one might question whether more effective means of compensating the victims might have been devised. Ending baseless claims -- that trauma causes cancer, or Bendectin causes birth defects -- is far more difficult. The individual claimant may lose, and his case will then be closed. But for legal purposes the issue remains open, to be raised again any number of times by others elsewhere. Everyone is entitled to at least one day in court, and the same question can be litigated indefinitely. In a mass market, a manufacturer is potentially exposed to many lawsuits if something goes wrong, and even questionable claims might result in endless litigation. If thirty million women used Bendectin, and 300,000 of them bore children with birth defects (as

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expected from the one percent incidence of major birth defects in the population at large), then 300,000 different juries could (in principle) be asked to determine whether Bendectin causes birth defects. The legal rule of "collateral estoppel," which sometimes bars a defendant from relitigating an issue it has already lost, does not stop a new plaintiff from relitigating *an issue* that other plaintiffs have lost elsewhere. Class actions -- the main procedural device courts use to resolve common questions of law or fact -- have not been invoked with any consistent success in personal injury litigation. In court, scientific facts can remain perpetually in play. Tort lawyers suggest that this makes the legal system more faithful to the scientific ideal. Science issues no final judgments; since the time of Galileo, the scientist's most cherished freedom has been his freedom to doubt, to disagree, to question anew, and to reconsider. But this analogy between an open-ended legal process and open-ended science is incomplete. While science respects the individual's freedom to keep an open mind, science also depends on the sifting and winnowing process. Science converges. Tort law does not, at least not over a time scale that is sufficiently short to prevent catastrophic losses to its victims.

II. SCIENTIFIC AMBIGUITY AND LITIGATION

Litigation is often triggered by tentative scientific results. Lawyers might seize upon a researcher's first expression of concern, and give it much import, even as later developments fail to support the concern. For example, several Boston investigators published a paper entitled *Vaginal Spermicides and Congenital Disorders* in the April 1981 issue of the *Journal of the American Medical Association*.[1] The paper suggested that spermicides might be associated with certain types of birth defects. But the authors cautioned: "[s]ince a well-defined syndrome among babies with congenital disorders whose mothers used spermicides was not present, these results should be considered tentative until confirmed by other data."[2] In 1985, however, in large part justified by this study, a federal judge awarded $5.1 million against the Ortho Pharmaceutical Corporation for congenital injuries to Katie Wells said to have been caused by a spermicide.[3] In affirming the verdict, a court of appeals stated: "[I]t does not matter in terms of deciding the case that the medical community might require more research and evidence before conclusively resolving the question."[4] A year after the verdict the authors of the original

1. Jick H. Walker AM et al., *Vaginal Spermicides and Congenital Disorders*, 245 JAMA 1329-32 (1981).

2. *Id.*

3. Wells v. Ortho Pharm. Corp., 615 F. Supp. 262, 266-67 (N.D. Ga. 1985), *aff'd*, 788 F.2d 741 (11th Cir. 1986), *reh'g denied en banc*, 795 F.2d 89 (11th Cir. 1986), *cert. denied*, Ortho Pharm. Corp. v. Wells, 479 U.S. 950 (1986).

4. *Wells*, 788 F.2d at 745.

study spoke out again. One acknowledged in 1986 that their work "was not corroborated by subsequent studies." Another conceded: "I believe our article should never have been published. In our present litigious environment, the reservations and qualifications written into a published report are often ignored, and the article is used as 'proof' of a causal relationship." Two physicians from the National Institute of Child Health and Human Development noted "the overwhelming body of evidence indicates that spermicides are not teratogenic.[5]

Litigation over the pertussis (whooping cough) vaccine developed along similar lines. No one disputes that the vaccine has virtually ended the disease, of which 265,000 cases and 7,500 pertussis-related deaths were recorded in the years before 1949 when the vaccine was first licensed.[6] But a 1984 English study, serious and cautiously phrased, suggested that the vaccine might cause twenty-five cases a year of serious brain damage in the United States.[7] An avalanche of litigation followed,[8] blaming the vaccine for brain damage, unexplained coma, Reyes' syndrome, epilepsy, sudden infant death, and other afflictions. Concerned about liability, several pharmaceutical companies abandoned the market, and at one time it seemed that the last United States manufacturer of the product would be leaving too. Later more reassuring evidence on the vaccine's safety began to accumulate.[9] In March 1990, a report of a huge study of 230,000 children and 713,000 immunizations concluded that the vaccine had caused *no* serious neurological complications of any kind, and no deaths.[10] "It is time for the myth of pertussis vaccine encephalopathy to end," declared an editorial in the *Journal of the American Medical Association*.[11] "Unfortunately, because of the sensationalistic media, the organization of a group of parents who attribute their children's illnesses and deaths to the pertussis vaccine, and the unique destructive force of personal injury lawyers, we now have a national problem that shouldn't be. . . . We

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5. James L. Mills & Duane Alexander, *Occasional Notes: Teratogens and "Litogens"*, 315 NEW ENG. J. MED. 1234-35 (1986).

6. Alan R. Hinman & Jeffrey P. Koplan, *Pertussis and Pertussis Vaccine: Re-Analysis of Benefits, Risks and Costs*, 251 JAMA 3109 (1984).

7. *See id.* at 3112, table 5; *see also* Loveday v. Renton, No. 1982 L 1812 (Q.B. Mar. 31, 1988).

8. Stephen Engelberg, *Official Explains Gaffe on Vaccine Shortage*, N.Y. TIMES, Dec. 19, 1984, at C1, col. 5.

9. *See generally* INSTITUTE OF MEDICINE, ADVERSE EFFECTS OF PERTUSSIS AND RUBELLA VACCINES (National Academy Press, Washington, D.C. 1991).

10. Marie R. Griffin et al., *Risk of Seizures and Encephalopathy After Immunization With the Diphtheria-Tetanus-Pertussis Vaccine*, 263 JAMA 1641-45 (1990). *See also* Gina Kolata, *Whooping Cough Vaccine Found Not to be Linked to Brain Damage*, N.Y. TIMES, Mar. 23, 1990, at A19, col. 1.

11. James D. Cherry, *"Pertussis Vaccine Encephalopathy": It is Time to Recognize It as the Myth that It is*, 263 JAMA 1679-80 (1990).

need to end this national nonsense."[12]

Litigation also has resulted from expectations raised by a new technology. Physicians, for example, were long mystified by cerebral palsy, but usually attributed its cause to either trauma or oxygen deprivation during labor. Doctors needed, some believed, a better way to detect signs of trouble during delivery, before trouble became disaster. In 1972, the electronic fetal monitor (EFM) arrived on the scene. A sensor was attached to the baby's scalp in the early stages of labor, and was used to record the infant's heartbeat and the mother's contractions. Many doctors enthusiastically welcomed EFM as "a medical breakthrough that could reduce the incidence of cerebral palsy, stillbirth and infant death."[13] EFM would flag fetal "distress," allowing doctors to prevent trauma or hypoxia by performing Caesarean sections. Then, in the 1970s, obstetricians who delivered babies with cerebral palsy began to be sued in record numbers. EFM and aggressive surgical intervention quickly became the legally established standards for prudent care. The medical consensus then began to move in the opposite direction. A major report of the Institute of Medicine recently concluded that "overwhelming evidence" shows that EFM "does not improve neonatal mortality and morbidity rates."[14]

Still other litigation develops at the periphery of real hazards, for example, in the emotional issues of intrauterine contraceptive devices (IUDs) and asbestos. The first half of the IUD story is very familiar. Soon after Robins placed the Dalkon Shield on the market in 1971, doctors began observing pelvic inflammatory disease (PID) among its users. The U.S. Food and Drug Administration then lacked strong enforcement powers over medical "devices," but it nevertheless asked Robins to halt sales. Robins complied in June 1974. Several years of intensive scientific study followed,[15] which confirmed that the Shield increased risks of PID in sexually active women by six to ten times. An outpouring of IUD litigation followed that quickly enfolded other IUDs as well, including the Lippes Loop, the Saf T Coil, and the Copper 7. The IUD market folded.

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12. *Id.*

13. Tamar Lewin, *Despite Criticism, Fetal Monitors are Likely to Remain in Wide Use*, N.Y. TIMES, Mar. 27, 1988, § 1, Part 1, at 24, col. 3.

14. Committee to Study Medical Professional Liability and the Delivery of Obstetrical Care, Division of Health Promotion and Disease Prevention, Institute of Medicine in I MEDICAL PROFESSIONAL LIABILITY AND THE DELIVERY OF OBSTETRICAL CARE 81 (Washington, D.C.: Nat'l Academy Press ed. 1989); *see also* K.K. Shy et al., *Effect of Electronic Fetal-Heart-Rate Monitoring, as Compared With Periodic Auscultation, on the Neurologic Development of Premature Infants*, 322 NEW ENG. J. MED. 592 (1990); Stephen A. Myers & Norbert Gleicher, *A Successful Program to Lower Cesarean-Section Rates*, 319 NEW ENG. J. MED. 1515 (1988).

15. Nancy C. Lee et al., *Type of Intrauterine Device and the Risk of Pelvic Inflammatory Disease*, 62 OBSTETRICS & GYNECOLOGY 1-6 (1983).

Scientists eventually traced the problems with the Dalkon Shield to its nylon multi-filament tail, which served as a wick for bacteria, especially after prolonged exposure to body fluids. Other IUDs lacked this flaw. An initial epidemiologic study by several researchers at the Centers for Disease Control confirmed the high PID rates for Dalkon Shield users.[16] Two large studies followed, in Boston and Seattle,[17] that confirmed that the Dalkon Shield posed a sharply higher risk than other IUDs. However, epidemiologic studies have failed to implicate other IUDs. In 1988, Lee reported a study[18] that took careful account of the sexual habits of its subjects. These investigators concluded that stably monogamous users of any IUD other than the Dalkon Shield faced no significantly increased risk of PID, except for a very modest increase in risk in the month or two following the insertion of the device.[19] Other studies showed that oral contraceptives also increase risks of PID by two- to three-fold, apparently because sexually transmitted pathogens grow in a region of the cervix that is enlarged by sex hormones. Lee concluded: "the IUD is a good contraceptive choice for women who are in mutually monogamous relationships and, therefore, at low risk of acquiring sexually transmitted infections."[20] A major 1987 review of the literature reached a similar conclusion,[21] and concluded that most IUD's has been "guilty by association." A year earlier, however, the legal system had delivered its verdict to the contrary. A headline in the *New York Times* summarized it: "No more IUD's in U.S."[22]

The asbestos story similarly unfolded, and again the legal system had trouble keeping pace with the science. From the start of World War II through the 1970s, some ten million people were exposed to high levels of asbestos in the shipyards and other industries. Epidemiologic studies clearly showed that such exposure multiplies risk of lung cancer by five to seven times.

An avalanche of litigation followed. The notion developed that asbestos is a uniquely potent poison, that produces lung disease whenever it is on the scene.

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16. *Id.*; *see also* Ronald T. Burkman and the Women's Health Study, *Association Between Intrauterine Device and Pelvic Inflammatory Disease*, 57 JAMA 269-76 (1981).

17. Janet R. Daling et al., *Primary Tubal Infertility in Relation to the Use of an Intrauterine Device*, 312 NEW ENG. J. MED. 937-41 (1985); Daniel W. Cramer et al., *Tubal Infertility and the Intrauterine Device*, 312 NEW ENG. J. MED. 941-47 (1985).

18. Nancy C. Lee et al., *The Intrauterine Device and Pelvic Inflammatory Disease Revisited: New Results from the Women's Health Study*, 72 OBSTETRICS & GYNECOLOGY 1-6 (1988).

19. *Id.* at 5-6.

20. *Id.* at 1-6.

21. David A. Grimes, *Intrauterine Devices and Pelvic Inflammatory Disease: Recent Developments*, 36 CONTRACEPTION 97-107 (1987).

22. Katherine Roberts, *Searle Settles it: No More IUD's in U.S.*, N.Y. TIMES, Feb. 2, 1986, § 4, p. 6, col. 1.

Lawyers then unleashed a second wave of lawsuits, against suppliers of asbestos in building materials, car brakes, and home hair dryers.

Present scientific knowledge suggests that many concerns about asbestos are exaggerated. The risks from occupational exposure to high levels of asbestos are grave. But risks from low-level exposure (as, for example, in buildings with intact asbestos insulation) are much smaller and apparently insignificant. Typical asbestos levels in U.S. schools and buildings are "minuscule" -- typically 10,000 to 100,000 times lower than occupational levels known to cause disease.[23] Moreover, there are two major forms of asbestos with greatly different hazards. The form usually found in buildings is probably much less hazardous than that used so cavalierly in World War II shipyards.

PHANTOM RISK AS SURROGATE

Concerns about risk are often surrogates for other concerns such as environmental protection or aesthetic preservation.[24] Many people view with distaste the sight of a high voltage power line near a school or running through pristine wilderness. Chemical pollution is disagreeable whether or not it poses any real risk of disease. In a notable display of candor, one jury in a dioxin case returned a verdict of $1 for compensation, and $16 million in punishment.[25]

The jury called the science correctly -- it found no credible evidence of physical harm to the plaintiffs. But a spill had occurred, and this jury concluded that the responsible company should pay heavily, notwithstanding the absence of injury. Edward J. Burger in his 1990 essay "Health as a Surrogate for the Environment," describes a similar phenomenon in the regulatory arena: efforts to keep the municipal incinerator away are often more likely to succeed if based on health claims, rather than increased traffic density or noxious smells or other more pressing concerns of the citizens.[26]

PHANTOM RISK AND THE MEDIA

Phantom risk is a favorite topic of the media. The first shot in Bendectin

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23. B. T. Mossman et al., *Asbestos: Scientific Developments and Implications for Public Policy*, 247 SCI. 294 (1990). *See also* Kenneth M. Block & Neil Marantz, *Recent Scientific Evidence Questions Perception of Asbestos Exposure Risks*, N.Y. L.J., 39 (Mar. 14, 1990).

24. MARY DOUGLAS & AARON WILDAVSKY, RISK AND CULTURE (1983).

25. Kemner v. Monsanto, No. 80-L-970 (Cir. Ct., St. Clair Cty., Ill. 1987); *see also* E. R. Shipp, *Marathon Trial on Dioxin Spill Nears End in Illinois After 3.5 Years*, N.Y. TIMES, Aug. 19, 1987, at A15; *Monsanto Liable in '79 Dioxin Spill*, N.Y. TIMES, Oct. 23, 1987, at A12, col. 6.

26. *See generally* Edward J. Burger, Jr., *Health as a Surrogate for the Environment*, 133 DAEDALUS (Fall 1990).

litigation was accompanied by a story in the *National Enquirer* published in October, 1979.[27] In the next five years, leading up to Merrell-Dow's $120 million offer to settle all outstanding claims, the media played a critical role in mobilizing Bendectin lawyers and their clients. Media attention to asbestos, Agent Orange, and the accident at Three Mile Island, likewise fueled public concern, mobilized claimants, and triggered lawsuits seeking compensation for fear of cancer, anxiety, declining property values, and so on.

. . . AND POLITICS

Political pressures are often important as well. In 1970, Senator Gaylord Nelson held widely publicized hearings and publicized the supposed risks of oral contraceptives. The dramatic testimony, based on preliminary scientific evidence and studies that have since been largely repudiated, was extensively covered by the press. Millions of young women began searching for a safer contraceptive options. At Nelson's hearings, a persuasive critic of the pill's risks and advocate of safer alternatives was Dr. Hugh J. Davis of Johns Hopkins University. Four years earlier he had developed one such alternative, the Dalkon Shield.

The interplay between politics and science is a contentious issue but one to which our authors frequently return. The Bendectin controversy was sharpened by publicity and demands for FDA action by the Health Research Group. Other political pressures are apparent in behavior of government agencies, which often become advocates for their constituencies.

. . . AND FEAR

Litigation often turns on fear. A legal theory now held by some academics and jurists links legal rights not just to the actuality of risk but also to the public's widely shared fears. Some courts permit recovery only if a claimant's anxiety about rabies or cancer (say) is scientifically reasonable, and would be shared by a knowledgeable doctor or scientist in the same position. But others ask only whether the public at large shares the fear; the factual basis for the fear is irrelevant. Public anxiety is far easier to prove than real hazard. For example, a lawsuit was recently filed by New York landowners against a power company, claiming that fear of cancer from the lines depressed their property

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27. *Experts Reveal . . . Common Drug Causing Deformed Babies*, NAT'L ENQUIRER, Oct. 9, 1979, at 20.

values.[28]

FINANCIAL INCENTIVES

Sometimes, financial incentives sustain a scientific controversy that would not exist but for litigation. An example is the theory of traumatic cancer. The theory originated in the 17th Century, but was in decline by the Nineteenth. Then, quite abruptly, many doctors became believers once again. The rapid shift in medical attitudes began in Germany in 1884, and swept across the American continent in the first decades of this century. By 1897, one writer blamed trauma for half of all bone cancers.

These changes were motivated by legal, and not scientific developments. Germany introduced the world's first worker's compensation program in 1884, and by the early 1920s all but eight American states had enacted similar programs. As one observer noted in 1959, the carcinogenic properties of trauma "increase[d] in potency each year and in direct proportion to the broadening of insurance coverage."[29] "The cancerigenic potentialities of mechanical trauma would probably have long since ceased to stimulate any significant amount of scientific interest," wrote one commentator in 1954, "were it not for the fact that so many claims for compensation are filed each year."[30] Traumatic cancer would have been "relegated to limbo" far sooner, declared a Mayo Clinic review twenty years later, but for "lawyers constantly keeping the question alive."[31]

More recently, the prospect of insurance benefits has promoted "clinical ecology." This controversial medical theory blames trace environmental pollutants on a host of ailments, including one with the inflammatory name of "chemically induced AIDS." Clinical ecology is viewed skeptically by the mainstream medical community,[32] but is vociferously defended by a small number of clinicians and patients. One survey of fifty consecutive patients

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28. Zappavigna v. New York, No. 74085 (N.Y. Ct. Cl. Sept. 21, 1989), *cited in N.Y. Judge Rejects "Cancerphobia" Damages Against NYPA in Line Case*, ELECTRIC UTIL. WK., Oct. 23, 1989, at 11. *See also* San Diego Gas & Elec. Co. v. Daley, 253 Cal. Rptr. 144 (Ct. App. 1988); Houston Lighting & Power Co. v. Klein Indep. School Dist., 739 S.W.2d 508 (Tex. Ct. App. 1987).

29. R. CRANE, THE RELATIONSHIP OF A SINGLE ACT OF TRAUMA TO SUBSEQUENT MALIGNANCY, *reprinted in* ALAN R. MORITZ & DAVID S. HELBERG, TRAUMA AND DISEASE 147 (1959), *quoted in* Darrell W. Johnson, *Sufficiency of Proof in Traumatic Cancer: A Medico-Legal Quandary*, 16 ARK. L. REV. 243, 267 (1962).

30. ALAN R. MORITZ, PATHOLOGY OF TRAUMA 116 (2d ed. 1954); Curphey, *Trauma & Tumors*, 1 J. FOR. SCI. 27 (1956).

31. G. Orwoll, Monkman et al., *Trauma and Oncogenesis*, *in* Mayo Clinic Proceedings, Mar. 1974, at 162.

32. *See* Eliot Marshall, *Immune System Theories on Trial*, 234 SCI. 1490 (1986).

referred for re-evaluation of a clinical-ecology diagnosis found that forty-three were pressing worker's compensation claims and two others were pursuing tort claims against chemical manufacturers.[33] Only five, apparently, had no direct financial interest in being sick, and one of those was involved in child custody litigation.

Finally, there are the financial incentives to litigators. Phantom risk has proved very profitable in court. Most juries decide cases in a way that is consistent with mainstream science. But some do not, delivering substantial payoffs for questionable claims. With Bendectin, the first thousand claims in the giant class action suit were resolved in line with mainstream science, though not before Merrell was impelled to offer $120 million to buy its way out of the legal quagmire.[34] Merrell ultimately won most of the individual trials too. Most juries made no award; but some returned verdicts ranging from $20,000 to $95 million.[35] Most of these verdicts were overturned on appeal; but some survived even that additional test. The average award (i.e. the total awarded in all the trials, divided by the number of trials) was close to $100,000. To a tort lawyer, a single million-dollar verdict that survives all appeals can more than offset a long string of losses. To the company that has to defend itself against these many claims, the process itself can be a disaster, despite many wins and only occasional losses.

EXPERT WITNESSES: THE LEGAL RULES

Until the mid-1970s, the admission of scientific evidence in court was governed largely by the *Frye* rule, named after a 1923 federal court decision in a criminal case.[36] Expert testimony was to be admitted only when it had received "general acceptance" in the relevant scientific community.[37]

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33. Abba I. Terr, *Environmental Illness: A Clinical Review of 50 Cases*, 146 ARCH. INTERN. MED. 145 (1986).

34. *In re* Richardson-Merrell, Inc. "Bendectin" Product Litigation, 614 F. Supp. 1212 (S.D. Ohio 1985), *aff'd*, 857 F.2d 823 (6th Cir. 1988), *cert. denied*, Hoffman v. Merrell Dow Pharm., 488 U.S. 1006 (1989); *see also In re* Bendectin Products Liability Litigation, 749 F.2d 300 (6th Cir. 1984).

35. Ealy v. Richardson-Merrell, Inc., No. 83-3504, 1987 WL 18743 (D. D.C. Oct. 1, 1987) The trial judge cut the verdict to $20 million. *Id.* at *5. A court of appeals overturned the entire award (without even remanding for a new trial) in March, 1990. Ealy v. Richardson-Merrell, 897 F.2d 1159, 1160 (D.C. Cir. 1990).

36. Frye v. United States, 293 F. 1013 (D.C. Cir. 1923).

37. *Id.* at 1014. The full test reads as follows:

> Just when a scientific principle or discovery crosses the line between the experimental and demonstrable states is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established

For half a century, *Frye* served reasonably to exclude exotic, unreliable evidence from the courtroom. The rule came under attack, however, in the 1960s and '70s. The consumer and environmental movements were gathering momentum at this time. The prevailing intellectual mood was anti-establishment, and *Frye* was seen as elitist and unhelpful, particularly in cases involving new pollutants, and unfamiliar hazards. In the legal world, meanwhile, theories of liability were evolving to give plaintiffs the advantage at trial. *Frye* critics felt that an alleged victim of chemical poisoning or some other toxic tort should not be denied compensation just because his offer of proof could not meet the exacting standards of "acceptance" in a broader scientific community.[38]

Opponents of *Frye* seized their opportunity when the Federal Rules of Evidence went into effect in 1975. The Rules are used in all federal trials and had also been adopted in various forms by thirty-one states as of 1988.[39] The *Frye* general acceptance standard was given no mention in the Rules or in the Advisory Committee notes that accompanied them. The anti-Frye forces seized this opportunity to advocate the abandonment of the "general acceptance" test in favor of a "relevancy" test, which would admit any expert testimony deemed helpful and germane to the scientific issue before the court.[40] Other commentators agreed that *Frye* itself was no longer viable,[41] but argued that general acceptance may "still have a bearing on reliability and consequent probative value of the evidence."[42] Still other scholars have interpreted the absence of *Frye* from the Federal Rules as evidence that the *Frye* test has survived the enactment of the Rules.[43]

The commentators who believe that *Frye* was superseded by the new Rules point to Rule 702 to support their case. It provides that expert testimony is

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to have gained general acceptance in the particular field in which it belongs.

Id.

38. The spirit of the sixties has apparently not yet disappeared. *See, e.g.*, Robert L. Schwartz, *There is No Archbishop of Science*, 69 B.U. L. REV. 517 (1989) (arguing that judges should not screen scientific evidence because scientific truth is relative and culturally determined).

39. Bert Black, *Evolving Legal Standards for the Admissibility of Scientific Evidence*, 239 SCI. 1508, 1512 n.1 (1988).

40. *See* EDWARD W. CLEARY, MCCORMICK ON EVIDENCE § 203, at 608 (3d ed. 1984), *quoted in* Black, *supra* note 39, at 628 n.1 ("Any relevant conclusions supported by a qualified expert witness should be received unless there are distinct reasons for exclusion."). Scientific evidence would thus be treated like any other evidence.

41. *See* JACK WEINSTEIN & MARGARET BERGER, WEINSTEIN'S EVIDENCE § 703(03) [hereinafter WEINSTEIN] ("[t]he silence of the rule and its drafters should be regarded as tantamount to an abandonment of the general acceptance standard.").

42. *Id.*

43. Paul C. Gianelli, *The Admissibility of Novel Scientific Evidence:* Frye v. United States *a Half-Century Later*, 80 COLUM. L. REV. 1197, 1199 (1980).

admissible "[i]f scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue a witness qualified as an expert by knowledge, skill, experience, training or education may testify thereto in the form of an opinion or otherwise."[44] This seems fairly close to the relevancy standard advocated by critics of *Frye*.[45]

While the survival or demise of *Frye* continues to be debated,[46] the rule did, for a period at least, seem to lose much of its conviction even in jurisdictions that still nominally enforced it.[47] Though *Frye* remained officially on the books in a majority of jurisdictions,[48] a growing number of courts in fact applied much more liberal standards for scrutinizing expert scientific testimony.[49] In one 1984 case, for example, the plaintiff claimed injuries resulting from his exposure to paraquat.[50] The expert who testified for the plaintiff presented views not generally accepted in the scientific community. The trial judge admitted the testimony, and the jury found for the plaintiff. A panel of the D.C. Circuit Court of Appeals affirmed. "[Judges], both trial and appellate, have no special competence to resolve the complex and refractory causal issues raised by the attempt to link low-level exposure to toxic chemicals with human disease," the appellate court wrote. "On questions such as these, which stand at the frontier of current medical and epidemiological inquiry, if experts are willing to testify that such a link exists, it is for the jury to decide whether to credit such testimony."[51] In 1988, the Eighth Circuit Court

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44. FED. R. EVID. 702.

45. *See, e.g.*, CLEARY, *supra* note 40.

46. As late as the March, 1990 issue of the TEXAS LAW REVIEW Professor Jonakait gives this debate substantial coverage. Randolph Jonakait, *The Supreme Court, Plain Meaning and the Changed Rules of Evidence*, 68 TEXAS L. REV. 745, 765-67 (1990).

47. Historically, many scientific evidence issues have been resolved by courts without any reference to *Frye*. Black, *supra* note 39. In general, *Frye* seems to be cited far less often in civil cases than in criminal cases – not surprising, considering that *Frye* itself was a criminal case. The author of this chapter recently researched dozens of cases spanning many decades involving claims that physical trauma caused cancer without seeing even one reference to *Frye*.

48. Edward Imwinkelreid, *The Bases of Expert Testimony: The Syllogistic Structure of Scientific Testimony*, 67 N.C. L. REV. 1, 6 (1988).

49. WEINSTEIN, *supra* note 41, at 477-48.

50. Ferebee v. Chevron, 736 F.2d 1529 (D.C. Cir. 1984), *cert. denied*, 469 U.S. 1062 (1984).

51. *Id.* at 1534. The court added: "If reasonable jurors *could* conclude from the expert testimony that paraquat more likely than not caused Ferebee's injury, the fact that another jury might reach the opposite conclusion or that science would require more evidence before conclusively considering the causation question resolved is irrelevant." *Id.* at 1535. Allowing the jury to decide the issue does not always benefit plaintiffs.

In a recent case involving PCBs, the jury found for the defendants, but the judge ordered a new trial in order to prevent what he saw as a "miscarriage of justice." The appeals court overturned his decision, ruling: "We would not expect disagreement between judge and jury upon the integrity of multiple witnesses to be a sound basis for a new trial." Scott v. Monsanto, 868 F.2d 786, 791 (5th Cir. 1989).

likewise reaffirmed the "relevancy" standard: "The relative skill or knowledge of an expert," the appellate court wrote, "goes to the weight of that witness' testimony, not its admissibility" and is therefore for the jury to weigh.[52]

More recently, however, a growing number of courts began to apply a somewhat stricter "balancing" test.[53] A major turning point in judicial attitude was an opinion by Judge Patrick Higginbotham. While adhering to an appellate court's "deferential standard for review" of decisions regarding the admission of expert testimony, Judge Higginbotham declared that the court would keep a "sharp eye" on instances where "the decision to receive expert testimony was simply tossed off to the jury under a 'let it all in' philosophy."[54]

In one leading "strict scrutiny" case that followed,[55] a federal jury awarded a plaintiff $1.16 million for birth defects allegedly caused by Bendectin. Judge Thomas Penfield Jackson overturned the award, and a unanimous panel[56]

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52. Loudermill v. Dow Chem. Co., 863 F.2d 566, 569 (8th Cir. 1988); *see also* Osburn v. Anchor Lab., Inc., 825 F.2d 908 (5th Cir. 1987), *cert. denied sub. nom.* Rachelle Labs. v. Osburn, 485 U.S. 1009 (1988) ("medical expert opinion testimony that is controversial can support a jury finding of causation as long as the doctor's conclusory opinion is based upon well-founded methodologies." *Id.* at 915).

53. *See generally* Black, *supra* note 39, at 1511 ("[a] growing number of courts now delve into the reasoning behind an expert's conclusion and require that this reasoning reflect accepted scientific practice."); Rothstein & Crew, *When Should the Judge Keep Expert Testimony From the Jury*, INSIDE LIT., Apr. 1987, at 19 (discussing strict and lenient trends in judicial scrutiny of expert testimony).

By 1985, a popular and relatively strict formulation of the balancing test said that district courts should conduct a preliminary inquiry focusing on (1) the soundness and reliability of the process or technique used in generating the evidence, (2) the possibility that admitting the evidence would overwhelm, confuse, or mislead the jury, and (3) the proffered connection between the scientific research or test result to be presented, and particular disputed factual issues in the case. United States v. Downing, 753 F.2d 1224, 1237 (3d Cir. 1985). While that case explicitly rejected Frye's general acceptance test, in a later case, Sterling v. Velsicol, 855 F.2d 1188 (6th Cir. 1988), a court applied a balancing test in a way that incorporated the general acceptance test and added more conditions. *Id.* at 1237. The court said that Rule 702 requires: "(1) a qualified expert (2) testifying on a proper subject (3) which is in conformity to a *generally accepted* explanatory theory (4) the probative value of which outweighs it prejudicial effect." *Id.* at 1208. (emphasis added) *Cf.* Boggess v. Monsanto, No. 86-3081 slip op. at 9 (4th Cir. 1987) (exclusion of flawed evidence "clearly within the discretion of the trial court.")

54. *In re* Air Crash Disaster at New Orleans, 795 F.2d 1230, 1234 (5th Cir. 1986).

55. Richardson v. Richardson-Merrell Inc., 649 F. Supp. 799 (D.D.C. 1986), *aff'd*, 857 F.2d 823 (D.C. Cir. 1988), *cert. denied*, 493 U.S. 882 (1989); *accord* Ealy v. Richardson-Merrell, Inc., 897 F.2d 1159 (1990).

56. Richardson v. Richardson-Merrell, Inc., 857 F.2d 823 (D.C. Cir. 1988), *cert. denied*, 493 U.S. 882 (1989).

of the D.C. Federal Court of Appeals affirmed.[57] Other judges have begun to take a somewhat harder line on expert credentials and qualifications.[58] Still others have attempted to give new weight to Federal Rule of Evidence 403, which requires that testimony must be more probative than prejudicial,[59] and Rule 703, which demands that the facts or data used by experts must be of the type "reasonably relied upon by experts in the particular field in forming opinions or inferences on the subject."[60] In litigation over the effects of Agent Orange on Vietnam veterans,[61] for example, Judge Jack Weinstein excluded plaintiffs' expert's testimony because the expert's opinions were based on

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57. The court explicitly refused to follow *Oxendine*. *Id.* at 825. *But see* Osburn v. Anchor Lab., Inc., 825 F.2d 908, 915 (5th Cir. 1987) (expert's opinion need not be generally accepted in the scientific community before it can be sufficiently reliable and probative to support a jury finding) (citations omitted), *cert. denied sub nom.* Rachelle Lab. v. Osburn, 485 U.S. 1009 (1988).

58. *See, e.g.*, Apostol v. United States, 838 F.2d 595 (1st Cir. 1988); *see also* Will v. Richardson-Merrell, 647 F. Supp. 544 (S.D. Ga. 1986); Mallory v. Monsanto Co., No. 29843 (Cal. Super. Ct. 1988); *In re* Paoli R.R. Yard PCB Litig., 706 F. Supp. 358, 370, 374 (E.D. Pa. 1988); Warden v. Taylor, No. 81-28711 (Harris County Ct. Aug. 10, 1987).

59. *See* Jackson v. Johns-Manville Sales Corp, 750 F.2d 1314, 1321 (5th Cir. 1985). *See also* Nachtsheim v. Beech Aircraft Corp., 847 F.2d 1261 (7th Cir. 1988).

60. FED. R. EVID. 703. *See, e.g.*, Richardson v. Richardson-Merrell, Inc., 857 F.2d 823, 830 (D.C. Cir. 1988) (dismissing expert's opinion as not satisfying Rule 703). As Professor Edward Imwinkelreid points out, Rule 703 seems to be targeted towards an expert's "minor premise," not his overall testimony, and seems designed to actually liberalize the admission of expert testimony. Imwinkelreid, *supra* note 48, at 9. *See also Advisory Committee's Note*, 56 F.R.D. 183, 283 (recognizing fears that "enlargement of permissible data may tend to break down the rules of exclusion unduly"). Certainly, nothing in Rule 703 would seem to give a judge power to exclude testimony as whole.

The full text of Rule 703 is as follows:

> The facts or data in the particular case upon which an expert bases an opinion or inference may be those perceived by or made known to an expert before the hearing. If of a type relied upon by experts in the particular field in forming opinions or inferences upon the subject, the facts or data need not be admissible in evidence.

FED. R. EVID. 703. *But see* Jack Weinstein, Role of Expert Testimony and Novel Scientific Evidence in Proof of Causation, Address Before the ABA Annual Meeting 30-31 (Aug. 9, 1987) (footnotes omitted). Weinstein said:

> Under the Federal Rules of Evidence, a judge can exclude expert testimony . . . . [through] Rule 703, which allows an expert to base his opinion on the type of evidence reasonably relied upon by experts in his field. In some cases examination of the basis of an expert's opinion reveals that it is supported by no reliable evidence at all. In such cases exclusion of the expert's opinion under Rule 703 and a grant of summary judgment to the opposing party might be appropriate.

See also Mateer v. U.S. Aluminum, No. 88-2147, 1989 Lexis 6323 (E.D. Pa. June 6, 1989) (summary judgment granted in Trichlorethylene exposure case on grounds that plaintiff's experts' "ultimate conclusions are not supported by the type of evidence reasonably relied upon in the scientific community to determine the health effects of exposure to toxic substances" thus violating Rule 703. *Id.* at 7).

61. *In re* Agent Orange, 611 F. Supp. 1223, 1243-48 (D.C.N.Y. 1985), *aff'd on other grounds*, 818 F.2d 187 (2d Cir. 1987).

"facts" and "data" not "reasonably relied" upon by experts in the field.[62] Another federal appellate court affirmed a trial judge's decision to exclude expert testimony regarding the causal relationship between illness and exposure to a herbicide.[63]

The more recent trend appears to be toward reaffirming stricter standards against evidence from the fringes of the scientific community. One slowly evolving consensus, for example, is truly scientific studies are subject to peer review.[64] In one oft-cited case,[65] Federal District Judge Patrick F. Kelly, rejected the testimony of plaintiffs' experts in a radiation case. "This court is disappointed with the apparent fact that these so-called experts can take such license from the witness stand," Judge Kelly wrote.[66] "[T]hese witnesses say and conclude things that, in the Court's view, they would not dare report in a peer reviewed journal."[67] A year later, the Eleventh Circuit affirmed the exclusion of an epidemiological study offered on the swine flu vaccine, in part because it had not been peer reviewed.[68] Both the First and the Ninth Circuits

62. Weinstein added that expert testimony on a particular subject must meet "minimum standards of reliability" in order to be put before a jury. *Id.* at 1245.

63. Viterbo v. Dow Chemical Co., 826 F.2d 420 (5th Cir. 1987).

64. Judge Higginbotham wrote:

> Many experts are members of the academic community who supplement their teaching salaries with consulting work. We know from our judicial experience that many such able persons present studies and express opinions that they might not be willing to express in an article submitted to a refereed journal of their discipline or in other contexts subject to peer review. We think that is one important signal, along with many others, that ought to be considered in deciding whether to accept expert testimony.

In re Air Crash Disaster at New Orleans, 795 F.2d 1230 (5th Cir. 1986).

65. Johnston v. United States, 597 F. Supp. 374 (D. Kan. 1984). That same year, in Ellis v. International Playtex, Inc., 745 F.2d 292 (4th Cir. 1984), the court noted the importance of peer review of epidemiological studies: "publication and survival of peer review . . . is one further indication that the reliability of the contested data far exceeds that normally accorded 'preliminary data' and 'speculation.'" *Id.* at 302 (footnote omitted).

66. *Johnston*, 597 F. Supp. at 415.

67. *Id.* at 415. The plaintiffs had already gained a $1.6 million settlement from other defendants who were afraid that the court would not be able to see through plaintiffs' experts' testimony. *See* Allen v. United States, 588 F. Supp. 247, 419-23 (D. Utah 1984) (court admits testimony from same experts rejected in *Johnston*), *rev'd on other grounds*, 816 F.2d 1417 (10th Cir. 1987), *cert. denied*, 484 U.S. 1004 (1988).

68. Perry v. United States, 755 F.2d 888 (11th Cir. 1985) ("[d]espite appellant's protestations, the examination of a scientific study by a cadre of lawyers is not the same as its examination by others trained in the field of science or medicine." *Id.* at 892). *See also* Zeck v. United States, 559 F. Supp. 1345, 1349 n.3 (D.S.D. 1983) (letters to the editor of medical journals have no probative value in swine flue case because they are anecdotal and have not been peer-reviewed); Kubs v. United States, 537 F. Supp. 560, 562 (E.D. Wis. 1982) (non-peer reviewed testimony rejected in another swine flue case).

have taken similar positions in Bendectin cases.[69] And in a 1988 ruling involving PCBs,[70] a New Jersey state court rejected an expert's testimony as "having not been previously recognized by any recognized tribunal, having no substantial minority acceptance, and having no support in the scientific literature."[71] Judicial insistence on peer review is still by no means unanimous, however.[72]

Other judges have taken steps to discount "hired gun" experts who earn much of their income by testifying.[73] As one federal trial judge wrote, some experts have "become advocates for a cause and have therefore departed from the ranks of objective expert witnesses."[74] Other rejected testimony from witnesses who undertook to testify, "not as detached scholars in the area of birth malformations motivated by the sole purpose of assisting the fact-finder with an objective evaluation of the relevant data but as partisans. When expert witnesses become partisans, objectivity is sacrificed to the need to win."[75] As discussed later in this article, a growing number of state legislatures have also undertaken similar initiatives.

The qualification of experts plays a particularly crucial role in the early stages of litigation. In scientifically complex cases, experts are often, for all practical purposes, the entire case. If the plaintiffs' proffered expert testimony is excluded there will be no trial at all; the case will be decided summarily for the defense. In practice, this is often the only way the defense can come close to "winning" a case, because the costs of litigation (which the defense must shoulder for itself, win or lose) will often be very substantial. An important breakthrough for summary judgment motions in toxic tort cases came in Judge

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69. Lynch v. Merrell-Nat'l Laboratories, 830 F.2d 1190 (1st Cir. 1987); Daubert v. Merrell Dow Pharmaceuticals, 951 F.2d 1128 (9th Cir. 1991).

70. Rubanick v. Witco Chem. Corp., 542 A.2d 975 (N.J. Super. 1988), *rev'd*, 576 A.2d 4 (1990).

71. *Id.* at 23 (Decision of Apr. 29, 1988); for further discussion of motions *in limine*, see Richard A. Rothman & Arvin Maskin, *Defending Immunotoxicity Claims*, 3 TOXICS L. REP. (BNA) 1219, 1228 (Mar. 1, 1989).

72. *See, e.g.*, Rudell v. Merrell Dow Pharm., Inc., No. 85-0115-CV-W-5 (W.D. Mo. Feb. 19, 1987), in which the court refused to exclude a suspect study, holding that "[t]he jury can decide how much credence should be given to any or all . . . reports."

73. Judge Higginbotham wrote:

> [T]he professional expert is now commonplace. That a person spends substantially all of his time consulting with attorneys and testifying is not a disqualification, but experts whose opinions are available to the highest bidder have no place testifying in a court of law, before a jury, and with the imprimatur of the trial judge's decision that he is an "expert."

In re Air Crash Disaster at New Orleans, 795 F.2d 1230, 1234 (5th Cir. 1986).

74. Allen v. United States, 597 F. Supp. 374, 411 (D. Kan. 1984).

75. Rubinstein v. Marsh, No. CV-80-0177, 1987 WL 30608, at *7 (E.D.N.Y. Dec. 10, 1987).

Weinstein's opinion in the Agent Orange litigation.[76] Having ruled that the plaintiffs' proffered expert testimony was inadmissible, Weinstein was then able to grant summary judgment on the ground that the plaintiffs had presented no material issue of fact in dispute. The Supreme Court has since liberalized the standards for granting summary judgment.[77]

Finally, most judges faced with conflicting scientific evidence have the power to appoint their own experts,[78] special "masters" to rule on evidentiary motions, or (in non-jury trials) even an "advisory jury" composed entirely of experts. These techniques can reduce the number of scientific issues left for the judge or jury to cope with at the trial.[79] But while court-appointed experts are widely favored in theory,[80] they are rarely used in practice,[81] perhaps because judges fear their choice of expert might unduly influence the jury.[82]

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76. *In re* Agent Orange, 611 F. Supp. 1223 (E.D.N.Y. 1985).

77. *See* Celotex Corp. v. Catrett, 477 U.S. 317 (1986) ("one of the principle purposes of the summary judgment rule is to isolate and dispose of factually unsupported claims or defenses, and we think it should be interpreted in a way that allows it to accomplish this purpose." *Id.* at 423); Anderson v. Liberty Lobby, Inc., 477 U.S. 242, 252 (1986) (the standard for summary judgment is whether a "fair minded jury could return a verdict for the plaintiff on the evidence presented. . . . A scintilla of evidence in support of the plaintiff's position will be insufficient."); Matshushita Elec. Indus. Co. v. Zenith Radio Corp., 475 U.S. 574 (1986) (summary judgment pierces the pleadings and assesses the proof in order to see whether there is a need for trial); *see also* Knight v. United States Fire Ins. Co., 804 F.2d 9 (2d Cir. 1987) (hostility to summary judgment based on "misconception"), *cert. denied*, 480 U.S. 932 (1987).

78. They get this power from FED. R. EVID. 706.

79. Some commentators have called for one or another version of science courts, usually on the model of the patent court system but thus far this idea has not resulted in any experiments. E. Donald Elliott, Issues of Science and Technology Facing the Federal Courts 20 (Apr. 4, 1988) (unpublished manuscript, on file with author). *See also* Tahirih V. Lee, *Court-Appointed Experts and Judicial Reluctance: A Proposal to Amend Rule 706 of the Federal Rules of Evidence*, 6 YALE L. & POL'Y REV. 480, 496-97 (1988). Other commentators have called for requiring or encouraging judges to take basic science course. *See generally* Elliott, *supra*.

80. According to a 1987 Harris Poll of two hundred federal judges, seventy-six percent of those surveyed said they favored the use of independent expert witnesses in cases "involving technical or scientific issues," with twenty percent opposed. Louis Harris & Assoc., Judges' Opinions on Procedural Issues 45, Table 6.1 (Study No. 874017) (Oct.-Dec., 1987), *cited in* Elliott, *supra* note 79, at 11.

81. Constance Holden, *Science in Court*, 243 SCI. 1658 (1989).

82. *Id.*; Lee, *supra* note 79, at 495-96. One proposal that would relieve some of Higginbotham's worries would modify Rule 706 to require parties to negotiate for the appointment of a single expert witness for each subject area which requires expert testimony. The court would remain involved in the negotiations and could appoint the expert if the negotiations failed to produce an agreed-upon expert. Johnson, *Court-Appointed Scientific Expert Witnesses: Unfettering Expertise*, 2 HIGH TECH. L.J. 249 (1988).

SCIENCE AS CONSENSUS

What is good science? How can we identify it? The trial lawyer and his acolytes will never tire of telling stories about how high priests of science have been proved badly wrong by "cranks" and "mavericks" in times past. Galileo, the patron saint of all heretics, figures often in such stories. Let's not ostracize the "mini Galileo," pleads a plaintiff's lawyer; the legal system must be "capable of advancing."[83] Honor the expert "at the edges of the bell curve," advises the chemical-AIDS maven Alan Levin, "as was Galileo and as are other people at the frontiers of medicine or science."[84]

No doubt about it: the views of the establishment *are* sometimes wrong, in science and medicine as in law. Galileo gained fame by challenging one orthodoxy but eventually became part of another: he refused to believe that the moon caused tides, or that planets moved in ellipses, as the upstart Johannes Kepler maintained. Eighteenth-century astronomers stubbornly refused to believe that stones fell from the sky. Darwin's theory was dismissed initially by physicists who calculated (correctly) that ordinary combustion could never have kept the sun burning over the Darwinian millennia. Ernest Rutherford's views on the radioactive transmutation of elements were attacked for sounding too much like alchemy. Albert Einstein never was reconciled to quantum mechanics. When the great Hungarian clinician Ignaz Philipp Semmelweis discovered the antiseptic properties of chlorinated lime in 1850, his findings were met with deep skepticism from many in the medical establishment. True enough, the isolated scientist, the iconoclast, the maverick, crank, or congenital rebel has sometimes been proved right.

But science has changed profoundly since the days of Galileo and Semmelweis. This is most particularly true of medical science. Until the late seventeenth century, as the historian James Burke recounts, a medical career "flourished or foundered according to the relationship the doctor managed to strike up at the bedside." The doctor would emphasize his "heroic and secret" insights into disease and its cure. Each individual's illness was thought to be a unique condition. Each doctor "would claim that all other doctors were quacks and their remedies ill-advised or dangerous."[85] Doctors believed that every

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83. Roisman, *Law and Science: Partners or Protagonists? in* ICET Symposium III Immunotoxicology: From Lab to Law, 105, 132 (1987).

84. Alan Levin, *Environmental Illness a Scientific Reality, a Legal Boondoggle, a Potential American Tragedy, in* ICET Symposium III Immunotoxicology: From Lab to Law, p. 88 (1987).

85. My discussion here and later, on the evolution of medical science, draws from JAMES BURKE, THE DAY THE UNIVERSE CHANGED 195-237 (1985). Epigraph quoted in BURKE, *supra*, at 226; *see also* JOHN M. EYLER, VICTORIAN SOCIAL MEDICINE: THE IDEAS AND METHODS OF WILLIAM FARR 9 (1979).

disease could exhibit every symptom. Therapies were correspondingly quirky. The patient's own view of what kind of treatment he needed was often the main basis for recommending a cure.

In 1800, the French surgeon Xavier Bichat demonstrated that disease is a specific phenomenon peculiar to certain lesions or tissues. Doctors began to recognize that disease itself presents a specific and concrete target that transcends individual patients. As medicine raised its sights from the idiosyncratic and particular to the regular and general, it converged with statistics, a new branch of mathematics that was evolving during the same period. The foremost French physicist of the age, Pierre-Simon Laplace, would show how statistics could systematically improve observation, establish the reliability of experimental results, and reveal hidden regularities. The center of medical learning shifted to the hospital, where patients could be studied in still larger numbers. As Burke recounts, "[B]edside secrets gave way to a desire among doctors to share techniques and information."[86] Medical journals proliferated.

When cholera struck Europe in 1829, the hospital was overtaken by the city. William Farr, appointed Controller of the General Register Office, set out to conquer cholera with a radically new medical instrument: the biometer. The biometer was pencil and paper – a life-table that insurance company actuaries had been using for years. Farr systematically analyzed who was dying and where. The most important things he discovered were negative. Wealth did not protect you from cholera. Nor did occupation, or residential proximity to the sea. What mattered was how high above the Thames you lived. Farr concluded that cholera was caused by the river's awesome stench. He was wrong, but only in this single, last step of the analysis. It was left to another English physician, John Snow, to make the right connection in 1853. The key was not dirty air but dirty water; the London sewers emptied into the Thames, so the farther down-sewer you lived, the more likely you were to drink foul water. A few years later Parliament passed legislation to rebuild the sewers, and cholera disappeared from the city forever.

The story of cholera is the story of how medicine was transformed from black art to science, from a pseudoscience of the individual to a science of groups. The difference between the clinician who cures and the clinician who quacks is the difference between the intellectual hermit and the member-in-good-standing of a community of scientists. For the one, medicine is shaped by an endless series of peculiar and individual cases; for the other, by broad perspective and consensus conclusions. One espouses fictions as

86. BURKE, *supra* note 85, at 213.

changeable as the individual patient and doctor; the other, truths that apply to many people, not just to one. The rise of modern medical science, with its astonishing capacity to diagnose and cure, can be traced to the decline of individual eccentricity on both sides of the stethoscope.

Medical science is not unique; all modern science has similar origins. Many Renaissance scientists lacked any cohesive social structure or professional journals; Galileo had limited opportunity to belong to a larger community of scientists, though one should not forget that his heresy was to agree with Copernicus. But in 1660, there was established the "College for the Promoting of Physico-Mathematical Experimental Learning," which became London's Royal Society.[87] The original Royal Society boasted such luminaries as Charles II, Christopher Wren (who gave the society's first lecture), Samuel Pepys, Robert Hooke, and Sir Isaac Newton (president of the Society for twenty-four years). Since that time, all science in the West has been built up through collegiality and consensus -- and a concomitant decline in the role of the hermit scientist.

Modern science is thus a far cry from the science of centuries ago. It is no longer linked to any single theory or result; it is a process of replication and verification, a search for consensus. This is not to say that the new ideas are shunned; the truth is quite the opposite. As Gardner points out, "[t]he prevailing spirit among scientists, outside of totalitarian countries, is one of eagerness for fresh ideas. . . . If anything, scientific journals err on the side of permitting questionable theses to be published, so they may be discussed and checked in the hope of finding something of value."[88] But science centers on objective fact, and the only reliable test for objectivity is to determine what many different people can see in common, from different vantage points, in their waking hours. What individuals see alone, awake or in their dreams, is not science. A solitary white coat, test tube, and resume are not science. Modern science is not a solitary undertaking.

Litigation is. Real science is the study of facts that are regular, of things that recur in patterns, but a courtroom trial is quintessentially singular. Science depends on placing facts in an orderly context, but a trial frames facts in isolation. Good science transcends the here and now, the individual and idiosyncratic, the single laboratory, the single nation, the single planet, even the single galaxy, but a trial typically examines a singular datum, and demands that scientific truths be rediscovered anew every time. Scientific facts emerge from many isolated observations, as data are accumulated, vetted for error, tested for

87. *See* T. E. ALLIBONE, THE ROYAL SOCIETY AND ITS DINING CLUBS (1976).
88. MARTIN GARDNER, FADS AND FALLACIES IN THE NAME OF SCIENCE 10 (1957).

significance, correlated, regressed, and reanalyzed, but trials are conducted retail. Good science is open, collegial, and cumulative, but the courtroom setting is discrete, insular, and closed -- a one-shot decision.

The methods of science are so fundamentally different from those of litigation that scientific anarchy in court is inevitable if rules of evidence are not strictly maintained. Absent such rules, scientific facts remain perpetually in play. Each patient, each injury, each illness becomes unique once again -- or so says the eighteenth-century doctor, on the payroll of the twentieth-century lawyer. Trials are not connected; the same question about Bendectin, the Audi, or clinical ecology can be litigated again and again. In the worst cases, courts drift through the degenerative sequence described by the historian Jerome Ravetz,[89] and thereafter elaborated by W. C. Clark. Tentative outlooks are often suppressed, views are quickly polarized, and a "great confidence game" replaces serious science. Recognition and money flow "to those making the first, loudest, and most frightening noises." The careful skeptic is rewarded with "accusations of corruption, cowardice, or insensitivity." There will be "an accretion of cranks and congenital rebels whose reforming zeal is not matched by their scientific skill."[90]

HOLDING WITNESSES TO A COMMON STANDARD

An accretion of cranks in court follows inevitably from the great paradox of modern liability science: in attempting to control quackery outside the courtroom, we invite quacks to the witness stand. If this degenerative process is to be halted, or better still reversed, judges must rediscover rules of evidence consonant with the essential collegiality of modern science. Such rules are not self-evident, nor can they be implemented mechanically, nor will they work their intended effect in the hands of jurists who hold science itself in no real respect. But rules can be formulated, and even modest rules, if enforced with evenhanded conviction and some measure of faith in the scientific method, will make a positive difference.

Whatever his credentials, publications, or affiliations, a scientist who becomes the alter ego of a lawyer is no longer a scientist. At the very least, rules to maintain some minimum separation of egos are thus urgently needed. They are not difficult to devise.

"Training is everything," Mark Twain once suggested. "The peach was once a bitter almond; the cauliflower is nothing but cabbage with a college

89. JEROME R. RAVETZ, SCIENTIFIC KNOWLEDGE AND ITS SOCIAL PROBLEMS (1971).
90. *Id.* at 427.

education."[91] Many, like Twain, will suppose that the cure to junk science litigation is to have judges scrutinize professional credentials more carefully. It isn't; Twain was only half right. Strings of letters appended to last names do provide a useful initial screen against professional incompetence, but only a very coarse one. Even yesterday's stellar achievement offers little assurance that today's opinion is correct: many a great scientist takes off sooner or later on some foolish frolic. Isaac Newton, for example, ended up in alchemy. Johannes Baptiste van Helmont, the seventeenth-century scientist who invented both the term and the concept of a "gas," later extolled the curative powers of magnetic forces. David Starr Jordan, one-time president of Stanford University, who coined the term *sciosophy* ("shadow wisdom") to describe the junk science of his day, was a dyed-in-the-wool eugenicist. The modern patron of clinical ecology is a Harvard-trained, board-certified allergist. Individuals change; yesterday's competent medical student or even Nobel-caliber chemist can become tomorrow's crank.

So while a resume may be a necessary condition of expert competence, it is never a sufficient one. Twain's views notwithstanding, what defines a cauliflower is not its resume but the views it shares with other cauliflowers. A cabbage with an M.D. is a still a cabbage. Science is likewise defined by a community, not by the individual, still less by a resume. Lawyers already know this. Credentials are all but irrelevant when a doctor sits at the defense table rather than in the witness box, and so they should be. *Cucullus non facit monachum*: the cowl does not make a monk.

This was, indeed, the key insight in the old *Frye* rule. *Frye* directed the focus away from the individual, whatever his credentials might be, and toward the scientific consensus. Define the relevant community whose consensus views should prevail. Then require expert witnesses to report not their own, personal views, but the consensus views of that community.

Applying the test is not always simple; there will always be room for quibbling. Any definition of "the relevant scientific community" will be somewhat arbitrary. But despite what some lawyers maintain, it isn't terribly difficult to decide which community of scientists to consult on Bendectin, cerebral palsy, or sudden acceleration. Lawyers in fact define similar communities all the time. A long-standing principle of negligence law is that doctors are held to the standards of the medical community in which they practice; one standard for an urban specialist, another for a rural generalist. Class actions -- a great favorite among many legal scholars who disdain Frye -- operate on the theory that a few individual claimants can be identified as

91. MARK TWAIN, PUDD'NHEAD WILSON (1894).

"typical" of many others; a few from the mainstream, the reasoning runs, will represent the interests of the rest quite adequately. Most of the time, common sense serves well enough in identifying a relevant scientific community, far better than it does in ascertaining the science itself.

The second step in applying Frye -- determining just where the mainstream scientific consensus lies -- is usually not all that hard either. Careful reviews of current learning on one subject or another are published in top-notch scientific journals all the time. Such journals have long track records of accuracy and insight. They are backed by established scientific institutions. What they publish is reviewed by other scientists. A judge need not know the slightest thing about traumatic cancer or electronic cruise controls to make sensible calls about who speaks for mainstream science on such issues and who does not. Even a person who knows nothing about hydrology can distinguish the mainstream of the Mississippi from stagnant pools near its banks.

As the legal scholar Bert Black has lucidly discussed, a sophisticated, modern application of *Frye* looks to the methods behind a scientific report, not to its finely detailed conclusions.[92] An epidemiological study will easily survive *Frye* even if it is the very first to report, for example, a link between Bendectin and birth defects, so long as standard protocols for conducting such studies have been observed and the data are reported with error bands, significance tests, and similar statements of caution suitable for a refereed professional journal. What should not survive, however, is a crude imitation of science, the unpublished hunch, the letter to the editor, the impressionistic "mosaic theory," in which the lawyer's science of harmonious coupling substitutes for systematic observation and analysis.

Lawyers should be the last to suggest that any of these ideas is radical or unreasonable, because lawyers apply every one of them to defendants, though not to witnesses. If the laws of negligence and strict liability can condemn doctors, chemists, pharmacologists, and car manufacturers for their ineptitude, it is because we believe that there *is* such a thing as ineptitude, that competence is ascertainably different from incompetence, that there are objective standards worth enforcing. But if people who really design cars or deliver babies are to be judged by professional standards in court, those who accuse them must be held to similar account. If the law is capable of holding defendants to professional standards, it is capable of holding witnesses to the same.

Judges, too, certainly live by *Frye* when their own, personal interests are at stake. The judge who currently sits back and allows the general practitioner's

92. Bert Black, *A Unified Theory of Scientific Evidence*, 56 FORDHAM L. REV. 595 (1988).

testimony on esoteric problems of pharmacology is the same judge who jumps on the next plane to the Mayo Clinic when he himself needs treatment.[93] If he is wise, he will also trust the Mayo Clinic doctors when they tell him which therapies *won't* work, and which treatments are *not* worth trying. He trusts the Mayo clinic -- for both positive and negative advice -- not because he knows the individual doctors, or is impressed by their resumes, and still less because he really knows what ails him or what cure to accept. What he trusts is the institution, the process, the collegiality, the experience, and the track record. And this, of course, is just where he should place his trust when administering a legal process that establishes standards and prescribes therapies for everyone else in the world.

The consensus scientific community supplies stopping points in abundance for those who care to find them. An authoritative scientific pronouncement on Bendectin by the Food and Drug Administration might be one. Or a report by the National Institutes of Health on electronic fetal monitors. Or one by the Centers for Disease Control on the pertussis vaccine, or the causes of pelvic infection. Or the Surgeon General's office on tobacco. Such institutions, established and funded to make difficult scientific calls, draw on the best and broadest scientific resources. This is not to suggest that they are infallible; of course they aren't. They are just less fallible -- much less fallible -- than a thousand juries scattered across the country grappling with the complexities of immune system impairment after being educated by fringe scientists peddling iconoclastic theories about "chemically induced AIDS." Judges therefore have abundant reason to promote the former and to be far more cautious about admitting the latter.

Half the time, ironically, that is precisely what judges already do. If the FDA declares that thalidomide causes limb defects in the womb, there will not be a very long or complex trial if a drug company nonetheless sells the product and a child is born without arms. The case is easy not because the science is easy -- it isn't -- but because a much larger community has already thrashed out the questions and reached some consensus. But there is consensus with Bendectin too, yet Bendectin trials have lumbered forward, one by one. If the FDA says the drug is a teratogen, liability will follow almost automatically. If the FDA says it isn't, ask a jury. And then another, and another, as many times in succession as the trial bar may deem to be justified by either visceral conviction or speculative greed. We find, once again, that our modern liability system is all accelerator and no brake.

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93. *Cf.* Hubert W. Smith, *Scientific Proof in Relations of Law and Medicine*, 23 B.U. L. REV. 143 (1943).

When definitive pronouncements of the FDA, CDC, or Surgeon General are not at hand, the next best place to look for the consensus views of mainstream science is in the peer-reviewed scientific literature. There is, indeed, a straightforward test for judges to determine which methods, procedures, and theories have *not* been "generally accepted" by other scientists: the absence of peer-reviewed publication. Writing is the medium of science. As lawyers well know, writing imposes discipline and precision; it clarifies both the strengths and weaknesses of a claim. Modern science simply does not exist without it. Only a much firmer emphasis on the written word can bridge the wide gulf between oral testimony in court and the only medium accepted by scientists themselves for communicating important findings and theories. A witness whose views have survived peer review in a professional journal will already have been forced into a candid disclosure of cautions and qualifications; good journals won't publish without them. If the published claim is of any importance, publication will also mobilize other scientists to repeat, verify, contradict, or confirm. By requiring professional publication as a basis for expert opinion, judges will help line up the larger community of scientists to shadow the necessarily smaller community of expert witnesses.

One might expect judges to be very comfortable with such a write-it-down rule of scientific evidence, for they apply similar rules elsewhere. The "parol evidence" rule, for example, declares that a written contract trumps the verbal discussions that lead up to it; writing is likewise required by the law to make binding a will or a contract for the sale of land. If the law already recognizes that only a written document can be trusted to determine who gets Aunt Agatha's prized collection of china dogs, it is hardly excessive to require formal writing by anyone who claims to have identified the causes of cerebral palsy or chemically induced AIDS.

There is one final test of expert competence, one more difficult to articulate but of great importance nonetheless. Scientific study of the causes of injury and disease, like scientific study of anything else, looks for regularities, patterns, and recurrences. Modern science uses rigorous, systematic methods to locate such regularities, methods that are rooted in statistics and significance tests, blinded trials and especially epidemiology. Each human spirit may be individual and unique, but the frailties of human flesh are shared by many. Medical science has recognized this fundamental fact for the better part of two centuries.

Thus, any truly scientific claim about the causes of disease will be based on systematic observation of many patients or test subjects, not on off-the-cuff impressions developed in the course of clinical treatment. The skills required to diagnose cerebral palsy, or perform infant surgery, or treat leukemia, are not the same skills required to determine the afflictions in question. The difference between the clinician and the scientist is one that courts must learn to understand

and affirm.

For there to be real science, the subjects of scientific study, like scientists themselves, must connect up with a broader community. Peer review places the clinician in the larger context of the community of clinicians; epidemiology and systematic clinical trials place the patient in the larger context of the populace at large. Both are enemies of bedside medicine. They force conviviality on the hermit scientist. They elevate learning from the specific to the general, from the singular to the plural -- and thus from the idiosyncratic impression to something we call science. As solutions to a pressing legal problem, they may appear undramatic. But by systematically emphasizing such well-recognized instruments of mainstream science, judges can do much to reconcile science in court with science in the real world.

THE PRIVILEGED INTERLOPER

To hold experts to serious scientific standards is not to abandon venerable legal principle but to reaffirm it. The expert witness is the only kind of witness who is permitted to reflect, opine, and pontificate, in language as conclusory as he may wish. We give him the considerable license he enjoys because some facts are meaningful only in the context of those larger patterns of facts we call science. It's useless for a pathologist to describe in fine detail what he saw when the reagent was added to the blood sample, if he may not also explain blood types, genetic rules, and why harmonious coupling between Charlie Chaplin (group O) and Joan Berry (group A) could not have produced Carol Ann (group B).[94] The expert, in other words, is there to provide a bridge between the particular facts of a case and patterns of facts that can be observed and understood only through much wider study.

Once we recognize the expert witness for what he is, an unusually privileged interloper, it becomes apparent why we must limit just how far the interloping may go. A witness cut loose from time-tested rules of evidence to engage in purely personal, idiosyncratic speculation offends legal tradition quite as much as the tradition of science. Unleashing such an expert in court is not just unfair, it is inimical to the pursuit of truth. The expert whose testimony is not firmly anchored in some broader body of objective learning is just another lawyer, masquerading as a pundit.

The challenge, then, is to determine when the anchor is secure. The only possible test is to confirm that other boats have favored similar moorings. The only way to tell that expertise is based on objective experience is to see whether

94. *But see* Berry v. Chaplin, 169 P.2d 442, 452, 453 (Cal. Ct. App. 1946).

others with similar experience favor similar methods, adopt similar procedures, embrace similar theories, and reach similar conclusions. This is pretty much the standard articulated decades ago by *Frye*.

It is heartening to record that at least some judges have arrived at some of these conclusions in recent years. Something of a turning point in judicial attitudes came in 1986, in the much-cited opinion by federal appellate Judge Patrick Higginbotham. "Our message to our able trial colleagues: it is time to take hold of expert testimony in federal trials," he wrote.[95] A slowly growing number of able colleagues have taken these sentiments to heart.[96] Some have begun to emphasize that radical London novelty of 1660 -- the professional society -- and that radical Paris novelty of the 1820s -- the professional journal and peer review.[97] Others have begun to emphasize the importance of solid epidemiological data.[98] Still others have concluded that medicine, too, is a part of science, and that medical experts can be screened along the same lines as all others.[99] Some have expressed mounting impatience with experts who wander far from their specialties, such as the plastic surgeon who wanted to testify on Bendectin although he admitted he had no knowledge of studies that had been conducted on that drug.[100] (The witness was confined to making mountains out of molehills outside the courtroom). Others have revised rules to allow experts to be questioned about how much they are paid, how often they testify, and for whom.[101] Others have rejected testimony from witnesses who actually solicited their own employment.[102] Still others have refused to enforce contingency-fee arrangements made with expert referral agencies.[103] But, as we have seen, many judges still reject any such limits, or equivocate so much that defendants settle baseless claims rather than risk going to trial.

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95. *In re* Air Crash Disaster at New Orleans, 795 F.2d 1230, 1234 (5th Cir. 1986).

96. *See, e.g.*, Richardson v. Richardson-Merrell, Inc., 857 F.2d 823 (D.C. Cir. 1988); Will v. Richardson-Merrell, 647 F. Supp. 544 (S.D. Ga. 1986); Brock v. Merrell Dow Pharm., Inc., 874 F.2d 307, 316 (5th Cir. 1989), *petition for reh'g denied*, 884 F.2d 166 (5th Cir. 1989), *reh'g en banc denied*, 886 F.2d 1314 (5th Cir. 1989), *cert. denied*, 494 U.S. 1046 (1990); Lynch v. Merrell-National Lab., 830 F.2d 1190, 1195 (1st Cir. 1987).

97. *See* Thomas S. Burack, Note, *Of Reliable Science: Scientific Peer Review, Federal Regulatory Agencies, and the Courts*, 7 VA. J. NAT. RESOURCES L. 27, 30-31 (1987); Lynch v. Merrell-National Labs., Inc., 830 F.2d 1190 (1st Cir. 1987); Johnston v. United States, 597 F. Supp. 374 (D. Kan. 1984); Perry v. United States, 755 F.2d 888 (11th Cir. 1985).

98. *See* Bert Black & David Lilienfeld, *Epidemiologic Proof in Toxic Tort Litigation*, 52 FORDHAM L. REV. 732 (1984); *In re* Agent Orange, 611 F. Supp. 1223 (E.D.N.Y. 1985); Brock v. Merrell Dow Pharm., Inc. 874 F.2d 307 (5th Cir. 1989).

99. *See, e.g.*, Kubs v. United States, 537 F. Supp. 560 (E.D. Wis. 1982).

100. Will v. Richardson-Merrell Inc., 647 F. Supp. 544 (S.D. Ga. 1986).

101. Trower v. Jones, 520 N.E.2d 297 (Ill. 1988).

102. Viterbo v. Dow Chemical Co., 646 F. Supp. 1420 (E.D. Tex. 1986), *aff'd*, 826 F.2d 420 (5th Cir. 1987).

103. Polo v. Gotchel, 542 A.2d 947 (N.J. 1987).

If judges will not screen witnesses retail, state legislatures can screen wholesale; it is encouraging to note once again that a few have recently done so.[104] In 1987, for example, Alabama passed a law requiring expert witnesses to have practiced recently in the same specialty as the doctor they charge with medical malpractice.[105] Colorado passed a law in 1988 restricting malpractice expert testimony to licensed physicians who can demonstrate "substantial familiarity" with the applicable standard of care and the procedure being litigated.[106] A recent Maryland law bars testimony from any malpractice expert who spends more than 20 percent of his time in court.[107] Kansas, Michigan, Maryland, Rhode Island, and West Virginia have developed similar requirements. Most of these states also bar from the witness stand academics who do not practice at all.

The strongest antidote to bad science in court remains one that most American judges are still regrettably reluctant to use. European judges routinely summon their own experts. Our judges have similar powers,[108] but few choose to exercise them.[109] Most trial lawyers vehemently oppose court-appointed experts, perceiving (correctly, no doubt) that consensus cannot be good for a conflict-centered livelihood. Lawyers will therefore assure you that there is no such thing as a neutral expert. But it is obviously possible to find knowledgeable scientists of high principle, and having a nonpartisan judge do the finding considerably improves the prospect of locating a less partisan expert.

None of these ideas is the least bit radical. What they all come down to is biblical wisdom on the punishment of harlots. If not certifiably free of sin, the expert witness who casts the first stone should -- at the very least -- not be a notorious patron of the local scientific bordello.

PUBLISH AND BE DAMNED

It has gradually dawned on professional societies that they too should be

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104. *See* David Holthaus, *States Judge Expert Witnesses Before They Testify*, 62 HOSP. 60 (Mar. 5, 1988).

105. Act of June 11, 1987, No. 87-189, § 9(E), 1987 Ala. Laws.

106. COLO. REV. STAT. ANN. § 13-64-401 (West 1991).

107. *See Engineers Draft Witness Code*, 217 ENGINEERING NEWS-RECORD 40 (1986).

108. *See* Tahirih Lee, *Court-Appointed Experts and Judicial Reluctance: A Proposal to Amend Rule 706 of the Federal Rules of Evidence*, 6 YALE L. & POL'Y REV. 480 (1988).

109. *See In re* Swine Flu Immunization Products Liability Litigation, 495 F. Supp. 1185 (W.D. 1980), *aff'd*, Gates v. U.S., 707 F.2d 1141 (10th Cir. 1983); *Science in Court*, 243 SCI. 1658 (1989); Louis Harris & Assoc., *Judges' Opinions on Procedural Issues*, 45, table 6.1 (Study No. 874017) (Oct.-Dec. 1987), *cited in* E. Donald Elliott, *Issues of Science and Technology Facing the Federal Courts* 11 (Apr. 4, 1988) (unpublished manuscript, on file with author).

concerned about a legal system in which the worst doctors, engineers, or toxicologists are given a better than fair shot at prescribing standards of conduct for the rest. If X rays, CAT scans, and cesarean sections are proliferating in unnecessary (and even perhaps dangerous) excess, it is because too much obstetrics, oncology, and emergency-room surgery is conducted a second time in court, by second-rank doctors who understand law better than medicine. Witnessing can have far-reaching professional consequences. It is therefore a form of professional practice. Or malpractice, as the case may be.

While lawyers are uncharacteristically tolerant about this one form of malpractice among all others, professional societies need not be. The American Medical Association, joined by the American College of Obstetricians and Gynecologists and the American Academy of Pediatrics, recognizes the doctor's "ethical obligation to assist in the administration of justice," but insists that "[t]he medical witness must not become an advocate in the legal proceeding." Contingent fees for witnesses are flatly labeled "unethical."[110] Several engineering societies have taken similar initiatives. However much lawyers may wish otherwise, professional societies have a major role to play in maintaining sharp lines between the practice of litigation and the practice of medicine, engineering, or pharmacology.

Another, even more important challenge for professional societies is to maintain scientific candor. We can all sense that truth is in peril when witnesses say things in court they would never dare say elsewhere. Sins of omission are less obvious, but no less common. Bad scientists routinely engage in "data dredging," a process by which observations that coincide with initial beliefs are carefully saved and recorded, while others somehow get lost.

The law grandly insists that individual witnesses swear to tell the *whole* truth, but modern rules of evidence in fact encourage dredging of an even more brazen kind. The lawyer dredges not for congenial data points, but for congenial scientists themselves. The upshot of this degenerate process is an expert-witness referral bureau that promises lawyers: "[I]f the first doctor we refer doesn't agree with your legal theory, we will provide you with the name of a second."[111] This sort of thing corrupts not only the legal process but its scientific participants. As Nobel physicist Richard Feynman once noted, this too is a form of scientific corruption, and perhaps an even more "If your answer happens to come out in the direction [those who solicited it] like, they can use

110. American Medical Association, Current Opinion op.07 (1986 Edition), *quoted in* AMA Report of the Board of Trustees, Medical Expert Witness Qualifications (Resolution 22, I-88), Report SS (A-89) 2.

111. *Quoted in* Bill Richards, *Doctors Seek Crackdown on Colleagues Paid for Testimony in Malpractice Suits*, WALL ST. J., Jan. 7, 1988, § 2, at 1.

it as an argument in their favor; if it comes out the other way, they don't publish it at all. That's not giving scientific advice." Good science, Feynman pointed out, demands "utter honesty," a "leaning over backwards" to be open and frank. "[T]he idea is to try to give all of the information to help others to judge the value of your contribution; not just the information that leads to judgment in one particular direction or another."[112]

Half the time, the legal system shares this view, but half the time is not enough. The sober scientist or doctor who works calmly day by day, meticulously recording all her observations and speculations, tentative, final, or otherwise, will end up seeing her every marginal note scrutinized in open court if something goes wrong. When Audi's engineers or Merrell's pharmacologists are summoned for trial, they will find the law to be limitlessly enthusiastic about candor and complete disclosure. Every doctor, druggist, or corporate defendant can be forced to empty all files and disclose every opinion and musing he ever recorded on the hazard now being litigated.

But once litigation begins, scientific inquiry suddenly becomes altogether private and confidential. Experts rounded up purely for the purpose of litigation are carefully sifted and sanitized, primed and primped. And these experts, the ones on the lawyers' payroll, are completely sheltered by a circus-tent privilege of confidentiality. Lawyers, it turns out, believe in complete candor for every scientist but their own. This, of course, allows them to shop around for divergent views, and then rehearse the one or two most perfectly congenial to the case at hand. But as Feynman points out, such shopping is just a sophisticated way of subverting integrity and objectivity through a sort of Darwinian selection. Lawyers will insist that the selection must be performed in complete secrecy to protect their confidential relationship with their clients. But a lawyer out angling for expert witnesses is not doing anything that deserves to be protected from public scrutiny, especially when protection has such antisocial consequences.

Feynman once suggested a pellucidly simple rule to protect against the subversion-by-selection that lawyers routinely practice. The honest scientist approached for his expert opinion must resolve at the outset to publish or at least disclose his conclusion, regardless of whose side it will benefit in the forthcoming trial. "If you don't publish such a result, it seems to me you're not giving scientific advice," Feynman wrote. "You're being used."[113]

The very thought that their own, duly hired and solemnly signed experts

112. RICHARD P. FEYNMAN, SURELY YOU'RE JOKING MR. FEYNMAN! 311, 312 (1986).
113. *Id.* at 314.

might feel free to publish findings beneficial to the other side would of course send trial lawyers into fits of blustery protest. But this should not deter professional societies from policing malpractice by their members wherever it may occur. Societies could accomplish wonders by requiring every member approached as potential witnesses to make a Feynman declaration at the outset: "[I]n keeping with my professional responsibilities, I will promptly publish anything of scientific note that I may learn in our consultations, regardless of whose legal interests my findings may favor." Judges might achieve much the same result by forbidding lawyers to do what they now do, which is to conceal all but the most favorable of the fistful of expert opinions they may solicit. Or better still, by announcing that only experts solemnly Feynmanized on first contact would be allowed to testify at all. The ultimate test of a scientist's competence is her ability to publish in peer-reviewed journals. The ultimate test of her scientific integrity is her readiness to publish and be damned. *That* is one real lesson judges should have learned from Galileo.

GAVAGING THE RATS

Real science, science outside the courtroom, is an evenly balanced process of proposal and disposal. Science does, of course, require a steady supply of the new and different, the bold, the shocking, even the outrageous. But it requires even more a steady supply of replication, verification, and peer review, the patient development of consensus, the systematic weeding, pruning, and uprooting of spurious data and erroneous theory. Starting promising new lines of inquiry is important; no less important is stopping unpromising old ones. Beginning speculation may be more exciting than ending it. But good science depends quite as much on the patient, plodding rejection and elimination of bad data and mistaken theory.

Judges have understood this well enough when addressing unfounded prejudice against victims of AIDS. But when the targets of junk science are less sympathetic, and their pockets deeper, the legal record has been dismal. Let-it-all-in rules of scientific evidence have made it trivially easy to begin pseudoscientific speculation in court and almost impossible to end it. Courtroom science has come to revolve around the opinionated eccentric, the go-it-alone maverick. It is heavily biased in favor of the impresario who begins speculation, and against the plodders who end it.

The vindication of good science in court requires precisely the opposite. Judges, like scientists themselves, will never pen a final opinion on the laws of nature, nor should they try. What they can do, however, is realign courtroom science with the science of scientists. This means giving much less attention to the self-proclaimed new Galileos, and far more to the reticent stalwarts of the mainstream scientific community. No doubt, trials will always depend on

individual witnesses and personal credibility. But just who those witnesses are and what they testify to can be controlled. Lawyers and judges who claim so much aptitude in deterring incompetence and preventing accidents everywhere else can surely find the rules to deter and prevent them in court -- if they can ever find the will. Until they do, courts will maintain their current renown for quixotic, pseudoscientific crusades, begun in haste and repented at leisure. Until they do, what passes for science in court won't be.

All science -- all *real* science -- contains what Karl Popper called "stopping rules." Statements of scientific fact are statements that could be systematically shown to be false (if they are false) after some finite, circumscribed inquiry.[114] Questions that are forever open, questions that can be answered only one way or not at all, are the domain of philosophy and religion, not of science. "Dioxin may be a human carcinogen" is not a statement of scientific fact, nor is "AIDS might be transmitted by flies." No finite number of tests and experiments could ever refute a statement of general fact couched in "mays" or "mights." No matter how far one searches, a weaker, as yet undetected effect may still be lurking just over the statistical horizon. The language of *could*, *possible*, *may*, *might*, and *maybe* that so often litters fringe testimony in court is not the language of science. Nor is science a business of completely open-ended speculation, where any idea can be floated but none can ever be finally brought back to earth.

W. C. Clark pursued the point in his scathing commentary on what often passes for risk assessment, but he might equally well have been speaking about legal process:

> If rats cope with the heaviest dose of a chemical that can be soaked into their food and water, you can always gavage them. Or try mice or rabbits. . . . [T]he only stopping rule is discovery of the sought-for effect, or exhaustion of the investigator (or his funds). Many of the risk assessment procedures used today are logically indistinguishable from those used by the Inquisition . . . . Since neither is advancing falsifiable propositions, neither is capable of producing anything more than propaganda in support of its own prejudices.[115]

It is only in the most naive and uninformed views of science that every question is perpetually unresolved, that every theory is as good as every other, that every fact is forever in doubt. Real science has stopping points. Real scientists

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114. KARL POPPER, CONJECTURES AND REFUTATIONS (1963).

115. W. C. CLARK, WITCHES, FLOODS, AND WONDER DRUGS: HISTORICAL PERSPECTIVES ON RISK MANAGEMENT 291 (1981).

respect them.

Is this to say that their minds are closed? Yes. Closing the mind, selectively and carefully, of course, is the essence of most good science. Science is defined as much by what it rejects as by what it accepts. Indeed, much of good science, especially in the early stages of new inquiries, consists of proving negatives, of closing the mind to plausible but erroneous possibilities. Good science has closed the modern mind to perpetual motion, polywater, and N rays, and to the curative powers of Krebiozen, Radiothor, Galvanic batteries, and Laetrile. When a new disease like AIDS arrives on the scene, much of the critical early research is a process of elimination: the cause is *not* traumatic, *not* bacterial, *not* autoimmune, and so on. By knowing what it is not, one eventually converges on what it is. Although the point can easily be misinterpreted, closing the mind -- to demonstrably incorrect claims and theories -- is much of what science is about. If we no longer burn witches at the stake, it is because science has closed most modern minds to the possibility that certain women cause plague, pestilence, and crop blight.

If courts are to assimilate good science in their proceedings, legal process must be equally symmetric. Judges must discover ways to cut off junk science as resolutely and reliably as they can affirm science that spotlights real hazards. If the only thing certain to stop Bendectin litigation is the disappearance of Bendectin itself, legal process has failed science miserably. If the law acts decisively (and remuneratively) against real hazards, and with perpetual indecision against fake ones, the upshot will be a corruption of science in court, a gradual, inexorable slide toward ignorance and paranoia.

Stopping the slide toward ignorance requires, at the very least, that incompetence not be unleashed against competence. The paranoia possibilities of junk science must be resisted more firmly still. Junk science's one very real power is to stir up fear. As a wise trial judge in Washington State recognized eighty years ago, there must therefore be cases of damnum absque injuria -- harm without a legally recognized injury, harm without a right to recover from the person who caused it.[116] The miscreant in that case, we may recall, was Benjamin Paschall, and the harm he had caused was frightening his neighbors by opening his home to victims of tuberculosis. The harm was real enough, but only because the neighbors held fears out of line with scientific reality. Today, many judges confronted with similar AIDS cases have performed much more courageously than did the Washington Supreme Court in the Paschall litigation. When it comes to junk fear, a court either affirms good science or ends up

116. *See* Everett v. Paschall, 111 P. 879 (Wash. 1910); *see also* Stratton v. Conway, 301 S.W.2d 332 (Tenn. 1957).

increasing the very injury it seeks to redress.

Yes, the pained judge too often responds, but if only we had better science, more certainty, firmer answers. All these suggestive studies -- with traumatic cancer, Bendectin, Audis, fetal monitors, and chemical AIDS -- yet never anything absolutely, finally, completely positive. The scientists themselves refuse to speak in absolutes. How vexing for the nonscientific bystander, especially the one seated at the bench or in the jury box. Do another study! Still inconclusive? Then a major research program is in order. The problem isn't really too much bad science -- it's too little good science. Until the balance is corrected, the courts just have to muddle along, resolving the uncertainty one way or the other, as the jury may see fit.

In fact, what is most desperately needed is almost the opposite of more research: not less research across the board, but reliable ways of saying that enough is enough when great and costly towers of litigation are being erected on the soft, ever-shifting sands of junk science. In law, as in science, not all frontiers are worth exploring forever. Not when exploration is so socially disruptive and expensive, and when there are other, manifestly more productive territories to be settled.

It is perhaps comforting to declare that we need more research. But that statement is always trite and often wrong. Worse still, calls for more research provide great comfort to junk scientists, who will find there subtle support for their own idiosyncratic crusades. Such calls legitimize and dignify the concerns that have been raised. Believers in Martian spaceships and astrology undoubtedly would welcome calls for more research in those fields, too. What takes more courage is to put an end to what, given a fair test of time, has proved to be fruitless, wasteful speculation.