

Berry vs. CSX Transp.

Case Details:

Experts Challenged:

Name	Discipline	Area of Expertise	Disposition
W. Lynn Augenstein	Medicine;Emergency Medicine, Medicine;Medical Toxicology	toxic encephalopathy	Court reversed lower court's ruling and admitted testimony.
Edward L. Baker	Medicine;Internal Medicine, Medicine;Occupational Medicine, Public Health (NEC)	Toxic encephalopathy.	Court reversed lower court's ruling and admitted testimony.
Douglas H. Linz	Medicine;Internal Medicine, Medicine;Occupational Medicine	Chronic overexposure to chemicals and solvents	Court reversed lower court's ruling and admitted testimony.
R. Michael Kelly	Medicine;Internal Medicine, Medicine;Occupational Medicine	Diagnosing and treating solvent-exposed workers	Court reversed lower court's ruling and admitted testimony.
Robert James	Pharmacology, Toxicology		Expert not challenged under Daubert.

Raymond Harbison	Toxicology		Expert not challenged under Daubert.
Richard L. Lipsey	Toxicology	Pesticide environmental toxicology.	Court reversed lower court's ruling and admitted testimony.

Date of Decision: 03/03/1998

Jurisdiction: State

Court: Florida, Court of Appeal

Plaintiff(s): CAROL BERRY, as personal representative of the Estate of Roy Lee Berry, Jr., deceased, Appellant JAMES CHRISCO, Appellant

Defendant(s): CSX TRANSPORTATION, INC., Appellee

Docket No(s): 95-3131

Citations: 709 So. 2d 552

Area of Law: Toxic Torts

Counsel:

Judges:

Opinion By:

Opinion:
OPINION:

VAN NORTWICK, J.

In these consolidated appeals, James Chrisco and Carol Berry, as personal representatives of the Estate of Roy Lee Berry, Jr., deceased, appeal from a final judgment and a partial final summary judgment, n1 respectively, which were entered after the trial court excluded the testimony of appellants' expert witnesses. In their actions brought pursuant to the Federal Employers' Liability Act, 45 U.S.C. § 51, et. seq. (FELA), appellants allege that appellee, CSX Transportation, Inc., exposed Berry and Chrisco, railroad employees of CSX, to excessive levels of organic solvents causing them to suffer from toxic encephalopathy. n2 In both cases, asserting that the expert opinions were not generally accepted in the scientific community and relying upon *Frye v. United States*, 54 App. D.C. 46, 293 F. 1013 (D.C. Cir. 1923), and its Florida progeny, CSX objected to the proposed expert testimony that long-term exposure to excessive levels of organic solvents can and did cause appellants' toxic encephalopathy. The record reflects that appellants' proposed expert testimony was grounded upon numerous peer-reviewed and published epidemiological studies demonstrating an association between exposure to organic solvents and toxic encephalopathy. n3 The trial court nevertheless found that the proposed expert opinions were not based on a "scientific principle or discovery" that has been sufficiently established to have gained general acceptance in the particular field to which it belongs. Accordingly, by separate orders, the trial court disqualified all of the appellants' experts.

This is the first time a Florida appellate court has been asked to decide the issue of what evidence must be *Frye* tested in the context of toxic tort litigation. We commend the trial court for its thorough and exhaustive review of the proposed expert testimony. We believe, however, that the trial court went beyond addressing the threshold question of admissibility of expert testimony under *Frye*, which was the issue before it, and in effect engaged in an analysis of the weight to be assigned to the expert testimony or the sufficiency of the evidence. As a result, even though appellants adequately demonstrated the reliability of their experts' proposed testimony, the trial court erroneously ruled that testimony inadmissible. Thus, we reverse the final judgment and partial final judgment and remand these actions for proceedings consistent with this opinion.

Procedural Background

Roy Lee Berry, Jr., deceased, worked as an electrician for CSX for over 20 years. James Chrisco worked as a machinist for CSX for over 10 years. Their suits alleged exposure to unreasonably hazardous levels of organic solvents in their workplace at CSX. The four organic solvents at issue in this case are trichloroethane (TCA), trichloroethylene (TCE), perchloroethylene (PCE), and mineral spirits. The trial court conducted a lengthy evidentiary hearing in Berry's suit in connection with CSX's motion to disqualify the opinion testimony of Berry's treating physician, Michael Kelly, M.D. In support of Dr. Kelly's proposed testimony, Berry proffered the supporting testimony of several other expert witnesses. CSX also filed a similar motion in the Chrisco suit. Although the trial court entered separate orders disqualifying the expert testimony in each case, the court considered essentially the same evidence in both cases. Thus, for purposes of this appeal, the evidence and cases will be considered together.

The Frye Reliability Standard

The issue of the admissibility of expert testimony is governed by the Florida Evidence Code, section 90.702, Florida Statutes (1995). That section provides:

Testimony by experts. - If scientific, technical, or other specialized knowledge will assist the trier of fact in understanding the evidence or in determining a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education may testify about it in the form of an opinion; however, the opinion is admissible only if it can be applied to evidence at trial.

Like its federal counterpart, Federal Rule of Evidence 702, section 90.702 is "silent as to any requirement that there be general acceptance of a newly developed scientific technique or principle in the particular field in which it belongs." *Hawthorne v. State*, 470 So. 2d 770, 783 (Fla. 1st DCA 1985)(Ervin, J., concurring and dissenting). This "general acceptance" test applied to scientific evidence had been espoused decades earlier in the case of *Frye v. United States*, 54 App. D.C. 46, 293 F. 1013 (D.C. Cir. 1923). The Frye court succinctly stated the test as follows:

Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages 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 to have gained general acceptance in the particular field in which it belongs.

293 F. at 1014.

After the adoption of the Florida Evidence Code, of which section 90.702 is part, disagreement arose among the district courts of appeal as to whether (i) the relevancy test under section 90.702 combined with the so-called balancing test of section 90.403 or (ii) the Frye test was to be applied to determine the admissibility of novel scientific evidence. See *Hawthorne*, 470 So. 2d at 783-787 (Ervin, J., concurring and dissenting; see also Ehrhardt, *Florida Evidence*, § 702.3 at 526 & 528 n.18 (1997)). This debate ended when the Florida Supreme Court decided *Stokes v. State*, 548 So. 2d 188 (Fla. 1989).

In *Stokes*, the Florida Supreme Court held that posthypnotic testimony may not be admitted unless it meets the Frye test. *Stokes*, 548 So. 2d at 194-95. "This test requires that the scientific principles undergirding this evidence be found by the trial court to be generally accepted by the relevant members of its particular field." *Hadden v. State*, 690 So. 2d 573, 576 (Fla. 1997). In reaching its conclusion in *Stokes*, the Court explained its rationale for continuing the application of the Frye test:

The underlying theory for this rule [Frye] is that a courtroom is not a laboratory, and as such it is not the place to conduct scientific experiments. If the scientific community considers a procedure or process unreliable for its own purposes, then the procedure must be considered less reliable for courtroom use.

Stokes, 548 So. 2d at 193-94.

Later, in Hadden, the court further amplified the reasons supporting its allegiance to the Frye reliability test:

We firmly hold to the principle that it is the function of the court to not permit cases to be resolved on the basis of evidence for which a predicate of reliability has not been established. Reliability is fundamental to issues involved in the admissibility of evidence. It is this fundamental concept which similarly forms the rules dealing with the admissibility of hearsay evidence. . . . Novel scientific evidence must also be shown to be reliable on some basis other than simply that it is the opinion of the witness who seeks to offer the opinion.

Hadden, 690 So. 2d at 578.

At the same time, a similar debate was ongoing in the federal courts concerning whether Frye or Federal Rule of Evidence 702 should govern the admissibility of scientific evidence. The United States Supreme Court answered this question in *Daubert v. Merrell Dow Pharm., Inc.*, 509 U.S. 579, 113 S. Ct. 2786, 125 L. Ed. 2d 469 (1993). In what has become known as the "scientific validity" test, the Daubert court set forth four non-exclusive factors that courts should consider in determining the admissibility of such evidence: "(1) testability (or falsifiability), (2) error rate, (3) peer review and publication and (4) general acceptance." David L. Faigman, David H. Kaye, Michael J. Saks & Joseph Sanders, *Modern Scientific Evidence: The Law and Science of Expert Testimony* § 1-3.3 (1997)(herein *Modern Scientific Evidence*). n4

As might be expected, the Florida Supreme Court was faced with the decision whether to continue following Frye or to adopt Daubert. In *Flanagan v. State*, 625 So. 2d 827 (Fla. 1993), the court noted the United States Supreme Court's decision in *Daubert*, but "reaffirmed the applicability of Frye." Ehrhardt, *Florida Evidence* § 702.4 (1997 Edition).

Flanagan was followed by the court's decision in *Ramirez v. State*, 651 So. 2d 1164 (Fla. 1995), wherein the court emphasized that the burden is on the proponent of the evidence to prove the general acceptance of both the underlying scientific principle and the testing procedures used to apply that principle to the facts of the case at hand . . . The general acceptance under the Frye test must be established by a preponderance of the evidence.

Id. at 1168. In *Ramirez*, the court delineated a four-step process for applying Frye in passing on the admissibility of expert opinion testimony concerning a new or novel scientific principle:

First, the trial judge must determine whether such expert testimony will assist the jury in understanding the evidence or in determining a fact in issue. . . . Second, the trial judge must decide whether the expert's testimony is based on a scientific principle or discovery that is "sufficiently established to have gained general acceptance in the particular field in which it belongs."

Frye v. United States, 54 App. D.C. 46, 293 F. 1013, 1014 (D.C. Cir. 1923) . . . The third step in the process is for the trial judge to determine whether a particular witness is qualified as an expert to present opinion testimony on the subject in issue. . . . Fourth, the judge may then allow the expert to render an opinion on the subject of his or her expertise, and it is then up to the jury to determine the credibility of the expert's opinion, which it may either accept or reject. . . .

Ramirez, 651 So. 2d at 1167.

Finally, we note that the appropriate standard for our review of a Frye issue is de novo. *Brim v. State*, 695 So. 2d 268, 274 (Fla. 1997); *Hadden*, 690 So. 2d at 579. n5 Thus, we review the trial court's ruling on the admissibility of expert opinion testimony, which is purportedly based on an underlying novel scientific principle or technique, as a matter of law, rather than under an abuse of discretion standard. *Id.*; see also *Vargas v. State*, 640 So. 2d 1139, 1144 (Fla. 1st DCA 1994), quashed on other grounds, 667 So. 2d 175 (Fla. 1995). Our de novo review of the Frye issue in these cases includes an examination of three methods of proof: (1) expert testimony, (2) scientific and legal writings, and (3) judicial opinions. *Flanagan v. State*, 586 So. 2d 1085, 1112 (Fla. 1st DCA 1991)(Ervin, J., concurring and dissenting).

Scientific Background

The evidence and testimony in these cases span several fields, most notably epidemiology and toxicology. As recognized by the trial court, the epidemiological research upon which the numerous experts relied related to studies of subjects ranging from "Danish painters to Venezuelan gluemakers and from Silicon Valley chipmakers to Michigan autoworkers." Because of the highly technical nature of this epidemiological evidence, to facilitate understanding of these cases and the arguments of the parties, it is necessary for us to provide a brief, but by no means exhaustive, discussion of certain scientific terms and concepts employed by the parties.

"Epidemiology" is a branch of science and medicine which uses studies to "observe the effect of exposure to a single factor upon the incidence of disease in two otherwise identical populations." *DeLuca v. Merrell Dow Pharm., Inc.*, 911 F.2d 941, 945 (3d Cir. 1980), quoting Bert Black & David E. Lilienfeld, *Epidemiological Proof in Toxic Tort Litig.*, 52 *Fordham L. Rev.* 732, 755 (1984). Epidemiology focuses on the question of general causation, that is, whether a substance is capable of causing a particular disease, rather than specific causation, that is, whether the substance did cause the disease in a specific individual. Federal Judicial Center, *Reference Manual on Scientific Evidence*, 126 (1994)(herein the Reference Manual).

To establish that a given substance was a necessary causal link to the development of an individual's disease, in theory a scientist might obtain reliable information by engaging in experimental studies with human beings. For example, to determine whether exposure to a certain level of a suspected toxin is associated with a particular disease, the scientist might compare two randomly selected groups of people. One of the groups would be exposed to certain doses of the toxin over a prescribed length of time and the other group would not. For obvious ethical reasons, however, experimental studies with human beings are proscribed where the subject chemical agent is known or thought to be toxic. See *Ethyl Corp. v. United States Env'tl. Protection Agency*, 176 U.S. App. D.C. 373, 541 F.2d 1, 26 (D.C. Cir.), cert. denied, 426 U.S. 941, 96 S. Ct. 2663, 49 L. Ed. 2d 394, 96 S. Ct. 2662 (1976); *Reference Manual* at 129.

Because of these ethical proscriptions, rather than experimental methods, epidemiologists use observational methods to study persons exposed to a suspected toxic substance to determine whether an association exists between exposure to the chemical and the development of a disease. These epidemiological studies use "statistical methods to detect abnormally high incidences of disease in a

study population and to associate these incidences with unusual exposures to suspect environmental factors." (emphasis supplied). In re "Agent Orange" Prod. Liab. Litig., 611 F. Supp. 1223, 1231 (E.D.N.Y. 1985) quoting Michael Dore, A Commentary on the Use of Epidemiological Evidence in Demonstrating Cause-in-Fact, 7 Harv. Envtl. L. Rev. 429, 431 (1983); In re Swine Flu Immunization Prods. Liab. Litig., 508 F. Supp. 897, 907 (D. Colo. 1981), *aff'd sub nom.*, Lima v. U.S., 708 F.2d 502 (10th Cir. 1983)("Where . . . the exact organic cause of a disease cannot be scientifically isolated, epidemiologic data becomes highly persuasive.").

Through epidemiological studies, scientists can assess the existence (and strength) or absence of an association between an agent and the disease. But "association is not causation." Reference Manual at 126. Association is a term used to describe the relationship between exposure to a chemical agent and disease that occurs more frequently together than one would expect by chance. *Id.* at n.7. Establishing an association does not necessarily mean that there is a causal effect between the exposure and the disease. *Id.* Causation, by comparison, constitutes an association between two events in which one event is a necessary link in a chain of events that results in the effect. *Id.* Nevertheless, while "epidemiological methods cannot prove causation . . .," epidemiological studies can provide a basis on which an epidemiologist can infer and opine that a certain agent causes a disease. *Id.*

In the event an epidemiological study finds an association between exposure to a substance and a disease, scientists can analyze the study to consider whether the reported association reflects a cause-and-effect relationship or, alternatively, is a spurious finding. *Id.* at 157. "Researchers first look for alternative explanations for the association, such as bias or confounding factors. . . ." *Id.* The primary types of biases are selection bias and information bias. "Selection bias occurs when the exposed group is selected in a way that makes it more or less susceptible to disease for reasons independent of exposure." Michael D. Green, Expert Witnesses and Sufficiency of Evidence in Toxic Substance Litigation: The Legacy of Agent Orange and Bendectin Litigation, 86 Nw. U. L. Rev. 643, 649 (1992). Similarly, information bias exists where the participants incorrectly give information about either exposure or health effects. This may exist where an interviewer whose "awareness of the identity of cases and controls . . . may influence the structure of the questions and the interviewer's manner, which in turn may influence the response." David E. Lilienfeld & Paul D. Stolley, *Foundations of Epidemiology* 237 (1994).

Although epidemiologists cannot totally control such variables as the genetic background or lifestyle choices of their human subjects or the amount and duration of their exposure to the studied substance, Reference Manual at 129, the researchers have systematic methods for assessing the characteristics of the people in the study and their risk of disease to rule out known sources of bias and errors. *Id.* at 127. For example, to eliminate information bias, whenever possible an interviewer should conduct "blind" interviews without prior knowledge of the cases and controls. *Foundations of Epidemiology* at 237.

Further, even when a statistical association exists and no bias is present, the association may be the result of some other confounding factor, or a so-called "confounder." A confounding factor may be itself a risk factor for the disease or associated with the exposure of interest. Reference Manual at 158. As an example, assume a study finds that individuals with grey hair have a higher rate of death than those with another hair color. Instead of hair color impacting on death, however, the test results might be explained by the confounding factor of advanced age. Thus, when a researcher finds an

association between an agent and disease, he or she must determine whether the association is causal or the result of confounding. *Id.*

After the researcher has analyzed the epidemiological study for alternative explanations for an association, researchers then consider generally accepted guidelines for determining whether the association between exposure to a substance and a disease is causal. See *Smith v. Ortho Pharm. Corp.*, 770 F. Supp. 1561, 1575-76 (N.D. Ga. 1991). Although the guidelines are composed of various criteria, in the instant cases the factors of strength of association, consistency with other research, and biological plausibility are raised in the arguments of the appellee.

Strength of Association. Epidemiologists commonly use "relative risk" to measure the strength of the association between exposure and disease. Reference Manual at 126. Relative risk is the ratio of the risk of disease among the group exposed to the chemical agent compared to the risk of disease among the unexposed group. *Id.* at 176. For example, a relative risk of 2.0 indicates that the risk of developing a disease in the exposed group is two times higher than the risk of developing that disease in the unexposed group. A relative risk of 1.0 indicates no association. The higher the relative risk, the stronger or more powerful is the association between exposure to the substance and development of the disease. *n*7

Scientists use the concept of a "confidence interval" as the means by which an epidemiologist can express confidence in a specific finding of relevant risk. For instance, if relative risk in a study is found to be 2.0, the epidemiologist can estimate the range of numeric values above and below 2.0 in which the relationship of a study sample would be likely to fall if the same study were repeated numerous times. *Id.* at 173. "The width of the confidence interval provides an indication of the precision of the point estimate or relative risk found in the study . . ." *Id.* In this appeal, citing *Black & Lilienfeld*, *supra*, 52 *Fordham L. Rev.* at 757, the railroad urges that the confidence interval should be expressed with estimated 95% accuracy, that is, as a range in which relative risk will predictably fall 95 times out of 100 replications of the study.

Consistency with Other Research. The validity of scientific conclusions is often based upon the replication of research findings, and consistency in these findings is an important factor in making a judgment about causation. See *Kehm v. Procter & Gamble Co.*, 580 F. Supp. 890, 901 (N.D. Iowa 1982), *aff'd*, 724 F.2d 613 (8th Cir. 1983) (noting the persuasive power of multiple independent studies, each of which reached the same finding of an association between the toxic shock syndrome and tampon use); *Cadarian v. Merrell Dow Pharm., Inc.*, 745 F. Supp. 409, 412 (E.D. Mich. 1989) (holding a single Bendectin study insufficient to support an expert's opinion, because "the study's authors themselves concluded that the results could not be interpreted without independent confirmatory evidence").

Biological Plausibility. Biological plausibility involves the application of the "existing knowledge about human biology and disease pathology to provide a judgment about the plausibility that an agent caused a disease." Reference Manual at 172. Thus, for example, a conclusion that high cholesterol is a cause of coronary heart disease is biologically plausible because cholesterol is found in atherosclerotic plaques. *Id.* at 163.

Briefly, we turn to another scientific discipline, toxicology. Toxicology is defined as "the study of the adverse effects of chemical agents on biological systems." *Id.* at 185. One of the central tenets of

toxicology is that "the dose makes the poison" implying that all chemical agents are harmful - it is only a question of dose. *Id.* Thus, even water if consumed in large enough quantities can be toxic. *Id.* A toxicologist attempts to determine at what doses foreign agents produce their effects, and animal studies are used by toxicologists to predict toxic responses in humans. *Id.* In toxicology, a dose-response relationship is a relationship in which a change in amount, intensity, or duration of exposure is associated with a change - either an increase or decrease - in risk of disease. *Id.* at 173.

The Scientific Evidence Below

The appellants proffered the testimony or affidavits of expert witnesses Dr. W. Lynn Augenstein, Dr. Richard L. Lipsey, Dr. Edward L. Baker, Jr., Dr. Douglas H. Linz, and Dr. Michael Kelly in the Berry case.

Dr. Augenstein. Dr. W. Lynn Augenstein, a medical doctor with a board certification in medical toxicology who teaches at the University of Florida Health Science Center, reviewed approximately 150 journal articles, textbooks, and notes of international conferences. He opined that, of the epidemiological studies which had been performed, the studies correlating long-term exposure to organic solvents and toxic encephalopathy outweigh the negative studies by eight or nine to one. He acknowledged that there were negative studies, but he opined that these studies dealt with short term or low level exposures.

Regarding toxic encephalopathy, he explained that it is usually divided into three categories: minimum, moderate and severe. In the lowest category of toxic encephalopathy, a patient suffers from tiredness, mood problems, irritability, sleep disturbances, possibly some poor memory function, depression, headaches and dizziness. A patient suffering moderate toxic encephalopathy shows more specific neurologic signs that would be detectable on neuropsychological testing: memory problems; slower reaction times; and problems with spacial orientation. The patient has more persistent mood and behavioral problems. In the severe category, there is significant global brain dysfunction. The individual is almost in a vegetative state where he cannot function, has very poor memory, and there are significant findings on x-ray tests showing brain atrophy. Dr. Augenstein opined that it is not necessary for a worker to become unconscious in order to suffer toxic encephalopathy.

He further explained that the dose-response relationship, which is a cornerstone of toxicology, is very difficult to assess in an epidemiological study because epidemiological studies are performed on a retrospective basis.

Dr. Lipsey. Richard Lipsey, Ph.D., who stated his profession as a pesticide environmental toxicologist, concurred that in his review of the literature, there was a general consensus in the scientific community that long-term exposure to excessive levels of organic solvents can and does cause toxic encephalopathy.

Dr. Baker. Edward L. Baker, Jr., M.D., is board-certified in occupational medicine and internal medicine. In addition to his doctor of medicine degree, he has two masters degrees from Harvard University, a Master of Public Health with emphasis on epidemiology and a Master of Science with emphasis on epidemiology and occupational health. He has practiced medicine in the Occupational/Environmental Health Clinic at Emory University; has been employed as a professor

at Harvard, where he directed research into the health effects of organic solvents; has served as Deputy Director of the National Institute for Occupational Safety and Health, the federal agency responsible for research in occupational health; and, at the time of the evidentiary hearing, was the Director of the Public Health Practice Program Office at the federal government's Center for Disease Control and Prevention.

Dr. Baker has authored chapters for at least four medical textbooks which address the subject at issue; he has published 98 journal articles of which approximately 20 are directly related to the subject at issue; and he has served on the editorial boards, as peer reviewer for submitted articles, of several journals and publications, including the American Journal of Industrial Medicine. He was the only United States scientist to participate in an international conference of scientists, convened in Copenhagen in 1985 by the World Health Organization to reach a consensus on the chronic effects of organic solvents on the central nervous system. The report generated from the Copenhagen conference concludes that "epidemiological and experimental data indicate that long-term occupational exposure to organic solvents may cause adverse effects in the central and peripheral nervous systems." Dr. Baker participated in a second international conference which produced the same consensus opinion. As a result of a conference held in 1990, it was agreed that "chronic toxic encephalopathy does occur in workers with excessive exposure to solvents."

Significantly, as can be seen from his credentials, Dr. Baker began studying the effects of solvents well before this litigation arose and arrived at his conclusions independent of his involvement in this lawsuit. n8 As a result of his very considerable study on the subject, he has concluded that long-term excessive exposure to organic solvents can cause toxic encephalopathy.

Specifically, he opined that if an individual is exposed more than ten years to a concentration that is sufficient to cause acute symptomology (intoxication, light-headedness, dizziness, inebriation) on a regular basis, that person is at risk for developing toxic encephalopathy. He said it was a general consensus in the scientific community that there is a risk of toxic encephalopathy in people excessively exposed to solvents. The only real debate at present, according to Dr. Baker, was over the safe levels of exposure and the degree of reversibility of the damage. He disagreed with appellee's experts that, for there to be a causal relationship, a patient must have been rendered unconscious by the exposure.

Dr. Baker testified that the Occupational Safety and Health Administration (OSHA) has published recommended maximum safe exposure levels for the various solvents at issue in this case. OSHA has arrived at a number 350 parts per million as an eight-hour time-weighted exposure for the workplace for TCA that is deemed to be a safe level. Nonetheless, as Dr. Baker recognized, this level does not take into consideration solvent exposure through the skin. He opined that solvents penetrate the skin and can get into the body through percutaneous exposure as well as through inhalation exposure. Thus, even a workplace allegedly below the safe level of 350 parts per million might nonetheless subject a worker to excessive exposure.

Although he was uncertain of the exact biological "mechanism" by which these solvents cause damage, Dr. Baker offered a biologically plausible explanation. He explained that solvents typically accumulate in fat-rich tissues and that the adipose tissues of the brain are tissues that have a high fat content. He postulated that since many organic solvents are highly lipid soluble, they can accumulate in the brain or in the adipose tissue.

Dr. Linz. Douglas H. Linz, M.D., who is board-certified in internal medicine and occupational medicine, submitted an affidavit. His speciality included diagnosing and treating injuries and conditions caused by acute and chronic overexposure to chemicals and solvents. Initially, Dr. Linz had been asked by CSX to examine several of the railroad's employees who, like appellants, worked in the diesel shop. He opined that the employees had suffered neurological and neuropsychological conditions caused by their recurrent exposures to solvents while working for the railroad and that there was a medically significant pattern among the examined diesel shop employees of the railroad who were suffering from solvent-induced brain injury. The employees had described heavy exposures: large amounts of solvents were used at full strength; the solvent was sprayed under pressure which atomized it; respirators were not worn; and employees washed their hands and clothes in solvent. They had the following complaints: headaches; dizziness; nausea; feelings of drunkenness and/or confusion; and acute mucosal complaints. He opined that it was well recognized that repeated exposures such as the kind noted above over a period of years can result in neurological and neuropsychological conditions including organic brain damage.

Dr. Linz came to the conclusion that the diesel employees had suffered solvent induced brain damage only after interviewing the patients and discussing with them their general health, their medical histories, and their occupational histories; reviewing the manufacturer safety data sheets on the solvents which were provided to him by the railroad (which included the solvents that are at issue in this case); reviewing the medical records of the employees; performing physical examinations on the men; reviewing diagnostic studies such as neuropsychological evaluations and balance testing performed on the men; reviewing the scientific literature which has been published with regard to solvents; and after eliminating other causes to a reasonable degree of medical certainty. He opined that the overwhelming epidemiological evidence confirms the relationship between long-term exposure to solvents and brain damage.

Dr. Kelly. Michael Kelly, M.D., is board-certified in internal medicine and occupational medicine. Currently he is the Medical Director of Occupational Health Services and Chief of Medicine at St. Lawrence Hospital in Lansing, Michigan. He has extensive experience in diagnosing and treating solvent-exposed workers from all over the country, including approximately 200 railroad workers. He opined that it was a general consensus in the medical and scientific community that long-term exposure to organic solvents can cause toxic encephalopathy.

In arriving at his conclusion that Mr. Berry suffered from solvent-induced toxic encephalopathy, Dr. Kelly employed a differential diagnosis n9 procedure which he opined was the standard methodology utilized in the field of occupational health. He took a history from both Mr. Berry and his wife concerning his current medical problems. After reviewing Mr. Berry's work history and symptoms, Dr. Kelly opined that Berry had been exposed to very high levels of organic solvents in excess of OSHA standards, which excessive exposure had been confirmed by other railroad employees. Dr. Kelly also conducted a thorough physical examination. He caused various laboratory tests to be performed on Berry, and obtained an MRI and an EEG of Berry. He referred Berry to a neuropsychiatrist for evaluation, which revealed that Berry had severe cognitive defects. A psychiatrist to which Berry was also referred reported back that Berry's cognitive defects were more likely consistent with toxic encephalopathy than with mere depression. Dr. Kelly had a SPECT scan of Berry performed, and the physician who performed the scan reported that it showed that Berry suffered diminished activity and function in several areas of the brain, consistent with neurotoxic

insults. Dr. Kelly asked Berry questions about cigarettes, alcohol and other possible confounders.

Regarding his occupational history, Mr. Berry told Dr. Kelly that he used materials out of a 55 gallon drum hooked up to house air, as he called it, to spray off the locomotives. He worked in the pit area under the locomotive. He would dip his hands in the material, and wash his clothes with it. He described being wet with the solvent material. He developed headaches, and was tired and lethargic. He had to take naps when he came home from work. Dr. Kelly opined that these symptoms indicated Berry had been exposed to "pretty high exposure levels occurring over a fairly long period of time." Berry could not remember names, could not remember directions, and could not remember his assignment at work. He was frequently angry, irritable, and was having some sleep disturbances. His gait was abnormal. When he walked, his feet were wide apart indicating a balance disturbance. Regarding Berry's cognitive difficulties, Dr. Kelly concluded that Berry's ability to interpret visual spacial configurations was at best low average, whereas one would expect an electrician to be able to visualize diagrams and remember them.

Regarding a biologically plausible explanation for the toxic encephalopathy, Dr. Kelly concurred with Dr. Baker that solvents have the ability to dissolve fatty materials. He felt that this characteristic allowed them to damage the body. He added that the fact these solvents are chlorinated probably adds to their toxicity, because the chlorine atom is more difficult for the body to metabolize and prolongs the exposure. He said there was no support for the notion that it is necessary to have an acute exposure causing unconsciousness before a person can suffer toxic encephalopathy.

CSX presented the expert testimony of Dr. Raymond Harbison and Dr. Robert James.

Dr. Harbison. Raymond Harbison, Ph.D., a toxicologist on the faculty of the University of Florida, opined that there was no biologically plausible explanation for a solvent exposure to cause toxic encephalopathy. As an example, he said that TCA is rapidly eliminated from the body and does not damage the nervous system because it cannot be converted to a chemical that interacts with the nervous system to cause damage. His testimony regarding TCE and PCE was similar. According to him, nothing in the molecular structure of the chlorinated hydrocarbon is able to produce any pathology in the nervous system. Contrary to plaintiffs' experts, he opined that TCA cannot "bioaccumulate in the brain." He maintained that it was generally accepted among toxicologists that TCA is not able to cause toxic encephalopathy unless there has been a dose sufficient to impair respiration resulting in lowering of the oxygen level in the body or unconsciousness. However, he admitted no study supports his contention that unconsciousness was required.

He was generally of the opinion that the literature contained insufficient evidence of a real causal connection between long-term exposure to organic solvents and toxic encephalopathy because real exposures could not be determined without making accurate air quality measurements, and because only precisely controlled double blind studies could be expected to establish causation. According to him, one should not use patient history to make the diagnosis but should use analytical data and be able to conduct measurements of the actual exposure received. Contrary to Dr. Kelly, he opined that a patient's symptoms could not be used to measure exposure. Instead, to make the diagnosis of toxic encephalopathy one would have to evaluate such factors as the level of chemicals in the workplace, the available ventilation, the temperature, and the air exchange rates in the work area.

Dr. Harbison opined that, before the toxicological scientific community would acknowledge the validity of an epidemiological study relating exposure to disease, there would have to be a known verified exposure, valid testing that is objective, and this testing methodology must have been subjected to a double blind evaluation where neither the investigator nor the individual who was being evaluated knew what the exposure was or what the potential outcome should be.

Dr. James. Robert James, Ph.D., also a toxicologist on the faculty at the University of Florida, presented an analysis of the studies demonstrating an association between exposure to organic solvents and toxic encephalopathy. Dr. James opined that most of the studies were negative and that of the ones which were positive, when flawed methodology was considered as well as other factors, only a few studies could be considered truly positive. Based upon his reanalysis, he said the studies did not demonstrate that long-term exposure to excessive amounts of organic solvents can cause toxic encephalopathy or that this hypothesis was generally accepted by the scientific community at this time. He advocated his reanalysis of the studies as more credible because it eliminated from the classification of positive studies those studies which failed to provide clear and convincing evidence of strong associations and big differences. The studies he eliminated he characterized as false positive studies which had not controlled for confounders. He conceded that he and Dr. Baker had obviously interpreted the literature differently.

While it was his opinion that epidemiology and toxicology use essentially the same type of analysis, nonetheless, Dr. James testified that toxicologists use a more rigorous standard to evaluate the data before determining whether or not a substance causes a particular disease in any population. He rejected studies that do not show a strong dose-response relationship, commenting that if the response does not change as a result of the dose or there is not a dose-response curve, the chemical agent is not the cause of the disease.

To the extent other scientific evidence is deemed relevant, it is discussed in other parts of this opinion.

Trial Court's Order

In the proceedings below, CSX challenged the admissibility of the appellants' expert testimony, contending that the plaintiffs' theory of general causation was based on "junk science" which did not meet the Frye/Ramirez test of reliability and that Dr. Kelly's specific causation testimony was not credible. The trial court found that the central issue in these cases was the general acceptance of the scientific principles underlying the testimony of appellants' expert witnesses. The appellants argued that Frye does not require that the experts' opinions themselves must be generally accepted; but, rather, that only the scientific techniques or methodology upon which the expert relies must be generally accepted in the scientific community. The trial court rejected this argument, ruling that Frye not only applies to scientific methodology, but that the scientific conclusion of the expert witness itself must be generally accepted in the scientific community to which it pertains.

The trial court concluded that there remains a substantial disagreement within the scientific community as to whether or not organic solvents can cause brain damage. In reaching this conclusion, the court recited the findings of numerous of the epidemiological studies upon which the appellants relied. In these studies, the researchers found an association between exposure and injury, but used the seemingly equivocal term of "association" rather than causation. Moreover, these

studies admitted the controversial nature of this subject, and several called for further investigation. The trial court was plainly troubled by the "qualifying phrases and disclaimers" used in the articles. This led the trial court to the conclusion that there remains a substantial disagreement within the scientific community as to whether or not organic solvents, particularly the ones at issue in the instant case, can cause brain damage, particularly chronic toxic encephalopathy, of the nature allegedly experienced by the plaintiffs in [these] cases. Said another way, the Court concludes that it is not generally accepted that exposure to organic solvents causes the condition of which the plaintiffs complain.

Arguments of the Parties

Appellants argue that the effect of the trial court's admissibility ruling was to decide the causation issue itself - that is, whether exposure to the four solvents causes toxic encephalopathy - which is a jury issue. They contend that the trial court erred as a matter of law in concluding that it was the experts' ultimate opinions, rather than the underlying methodology from which they derived their opinions, that had to be Frye tested. See, e.g., *Ferebee v. Chevron Chem. Co.*, 237 U.S. App. D.C. 164, 736 F.2d 1529, 1535 (D.C. Cir.), cert. denied, 469 U.S. 1062, 105 S. Ct. 545, 83 L. Ed. 2d 432 (1984); accord *Osburn v. Anchor Lab., Inc.*, 825 F.2d 908, 915-16 (5th Cir. 1987), cert. denied, 485 U.S. 1009, 108 S. Ct. 1476, 99 L. Ed. 2d 705 (1988); and *Cella v. United States*, 998 F.2d 418, 425 (7th Cir. 1993). Appellants argue that the "principle or discovery" language in Frye upon which the trial court seized to arrive at its conclusion that an expert's opinion must be generally accepted in the medical community was merely language used by the Frye court to label the novel "systolic blood pressure deception test" at issue in that case. They submit that an expert opinion derived from the generally accepted methodology of the science of epidemiology - where numerous published, peer-reviewed epidemiological studies and medical textbooks provide support for the opinion - is reliable, and therefore admissible.

Regarding the trial court's exclusion of Dr. Kelly's specific opinion on causation, appellants argue that Dr. Kelly followed a "differential diagnosis" methodology which is the standard methodology utilized in the field of occupational health. In *re Paoli R.R. Yard PCB Litig.*, 35 F.3d 717, 758 (3d Cir. 1994), cert. denied sub nom., *General Elec. Co. v. Ingram*, 513 U.S. 1190, 115 S. Ct. 1253, 131 L. Ed. 2d 134 (1995); *Hines v. Consolidated Rail Corp.*, 926 F.2d 262, 274 (3d Cir. 1991). Further, although the trial court was troubled by the fact that Dr. Kelly had merely estimated the levels of exposure to the organic solvents, appellants argue that this was necessary as the railroad had not monitored the work rooms, and therefore verifiable knowledge of the levels of solvents does not exist. Thus, Dr. Kelly could only rely upon an informed estimate derived from the statements of Berry and the other people who worked in the shops everyday to arrive at a diagnosis. If this estimate is erroneous, submit the appellants, CSX will have the opportunity to dispute the claimed levels of exposure at trial.

CSX argues that the causal proposition - that long term exposure to TCA, TCE, PCE and mineral spirits at workplace level sufficient to produce transient irritation, dizziness or disorientation, but not hypoxia or anoxia, n10 can cause irreversible central nervous system damage - must pass the Frye test. Appellee contends that upon a de novo review of this issue, this court will be compelled to conclude that this causal proposition does not pass the Frye test. CSX directs our attention to several publications which show some epidemiologic disagreement about causality between long-term exposure to organic solvents and toxic encephalopathy. Further, CSX criticizes the studies upon

which appellants' experts rely, contending these studies did not sufficiently take into account the presence of confounders or information bias, or involved exposure to much more damaging chemicals than those at issue in the instant cases. Finally, CSX argues that these studies are deficient because they fail to offer a biologically plausible explanation for the stated effects and do not adequately address the dose response relationship.

CSX suggests that for an epidemiological study to show a statistically significant association between a certain risk factor and disease in the exposed group such that causation may be inferred by the scientists, there must be a relative risk greater than 2.0 within a 95% confidence interval greater than 1.0, and that the calculations must adequately guard against selection and information biases and other confounders. After reviewing the studies, CSX argues there are only three positive studies, or at most five positive studies, and of those, four were subject to obvious selection and information bias.

The appellants reply that the microscopic level of critical analysis to which the railroad has resorted belongs only to the experts. They suggest that neither the trial court nor this court can assume the role of an amateur scientist, examine the materials upon which the expert scientists rely, draw its own scientific conclusion as to whether the material support the opinions of the plaintiffs' experts or not and then declare one set of opinions the victor by excluding the other set of opinions from evidence. See *Joiner v. General Elec. Co.*, 78 F.3d 524, 530-33 (11th Cir. 1996), rev'd on other grounds, *U.S.* , 139 L. Ed. 2d 508, 118 S. Ct. 512, 66 U.S.L.W. 4036 (December 15, 1997); *In re Joint E. & S. Dist. Asbestos Litig.*, 52 F.3d 1124, 1137 (2d Cir. 1995).

Frye Analysis

At the outset of our Frye analysis, we must resolve the issue over what must be Frye tested in this case -- the opinion testimony of the witnesses or the underlying scientific principle or methodology utilized by the experts in arriving at their opinions. Frye expressly addressed whether it is the expert opinion or the underlying principle and methodology from which the opinion is deduced which must be generally accepted in the scientific community. The Frye court explained: "the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs." *Frye*, 293 F. at 1014.

Further, the federal cases following Frye have applied the Frye test to the underlying scientific principle or methodology on which the opinion is based. See, e.g., *Cella v. United States*, 998 F.2d 418, 425 (7th Cir. 1993)("the Frye standard requires that the methodology and reasoning used by an expert in reaching a conclusion be generally accepted within the relative scientific community"); *Christophersen v. Allied-Signal Corp.*, 939 F.2d 1106, 1111 (5th Cir. 1991)(in applying Frye test ask whether the expert, in reaching his conclusion, used a well founded methodology or mode of reasoning), cert. denied, 503 U.S. 912, 112 S. Ct. 1280, 117 L. Ed. 2d 506 (1992); *Peteet v. Dow Chem. Co.*, 868 F.2d 1428, 1433 (5th Cir. 1989)(as long as expert's methodology is well-founded, the nature of his conclusion is generally irrelevant, even if it is controversial or unique), cert. denied sub nom., *Dow Chem. Co. v. Greenhill*, 493 U.S. 935, 110 S. Ct. 328, 107 L. Ed. 2d 318 (1989); *Osburn v. Anchor Lab., Inc.*, 825 F.2d 908, 915 (5th Cir. 1987)("an expert's opinion need not be generally accepted in the scientific community before it can be sufficiently reliable and probative in support of a jury finding"), cert. denied, 485 U.S. 1009, 108 S. Ct. 1476, 99 L. Ed. 2d 705 (1988); *Ferebee v. Chevron Chem. Co.*, 237 U.S. App. D.C. 164, 736 F.2d 1529, 1535-36 (DC

Cir.)(rejecting defendant's argument that expert opinion testimony must be generally accepted in the scientific community before it can be introduced as evidence), cert. denied, 469 U.S. 1062, 105 S. Ct. 545, 83 L. Ed. 2d 432 (1984).

The Florida Supreme Court has, until recently, consistently described the Frye test as a standard which "requires a determination, by the judge, that the basic underlying principles of scientific evidence have been sufficiently tested and accepted by the relevant scientific community." *Brim*, 695 So. 2d at 272 (emphasis added). In *Hadden*, however, the court stated that it would "not permit factual issues to be resolved on the basis of opinions which have yet to achieve general acceptance in the relevant scientific community." *Hadden*, 690 So. 2d at 578 (emphasis added). Specifically, the court held in *Hadden* that "a psychologist's opinion that a child exhibits symptoms consistent with . . . 'child sexual abuse accommodation syndrome' . . . has not been proven by a preponderance of scientific evidence to be generally accepted by a majority of experts in psychology" and that such opinion could not be used in a prosecution for child abuse where a proper objection is raised to its introduction. *Id.* at 575. The court distinguished such testimony from pure opinion testimony (testimony which is personally developed through clinical experience) on the grounds that profile and syndrome evidence rely on conclusions based upon studies and tests. "Consequently, the expert's opinion was based upon diagnostic standards which must pass the Frye test." *Id.* at 581.

However, we decline to interpret this language in *Hadden* as meaning that in all cases expert opinion testimony, not otherwise developed through clinical experience, must be Frye tested. Instead, we believe that this language in *Hadden* must be confined to the facts in that case and the psychological syndrome testimony which was being proposed. It is clear that the syndrome testimony in *Hadden* was not based upon scientifically accepted methodology. As Judge Ervin opined in his dissenting opinion in *Hadden v. State*, 670 So. 2d 77, 89 (Fla. 1st DCA 1996)(en banc), approved by the supreme court, the diagnosis of sexual abuse through a syndrome analysis is not a generally accepted method of diagnosing sexual abuse nor is there a consensus among experts that it is useful as substantive evidence of guilt. 690 So. 2d at 579.

In *Hadden*, the expert's opinion testimony was inextricably intertwined with an unacceptable diagnostic methodology. This circumstance is factually and legally distinguishable from the proposed expert opinion causation testimony in the instant toxic tort case. The proposed expert opinions here are based upon peer reviewed published epidemiological studies undertaken independently of the instant action and clearly recognized in the case law as important sources of evidence of toxic causation. As the Third Circuit observed in *DeLuca*, 911 F.2d at 954:

The reliability of expert testimony founded on reasoning from epidemiological data is generally a fit subject for judicial notice; epidemiology is a well-established branch of science and medicine, and epidemiological evidence has been accepted in numerous cases.

Commentators have further explained:

Epidemiological studies have been well received by courts trying mass tort suits. Well conducted studies are universally admitted. The widespread acceptance of epidemiology is based in large part on the belief that the general techniques are valid.

Modern Scientific Evidence at § 28-1.1; see also Green, 86 Nw. U. L. Rev. at 659, 663-64 (1992).

Thus, we hold that, under *Frye* and its Florida progeny, when the expert's opinion is well-founded and based upon generally accepted scientific principles and methodology, it is not necessary that the expert's opinion be generally accepted as well. We find persuasive the rationale of the court in *Christophersen*:

In *Osburn* [*Osburn v. Anchor Lab., Inc.*, 825 F.2d 908 (5th Cir. 1987)] the plaintiff's and the defendant's experts relied on essentially the same diagnostic methodologies but drew opposite conclusions from the available information. We did not attempt to determine which expert's conclusion was more in line with the consensus in the scientific community. Instead we stated, "a jury must be allowed to make credibility determinations and weigh conflicting evidence in order to decide the likely truth of a matter not itself initially resolvable by common knowledge or lay reasoning." *Id.* at 916. "An expert's opinion need not be generally accepted in the scientific community before it can be sufficiently reliable and probative in support of a jury finding." *Osburn*, 825 F.2d at 915.

939 F.2d at 1111 (emphasis added).

Our conclusion is supported by the opinion of the Florida Supreme Court in *Brim*. There, the court recognized that *Frye* allows opposite opinion testimony from experts relying upon the same generally accepted scientific principles and methodologies. In *Brim*, the court was faced with a *Frye* challenge to DNA test results. The *Brim* court held that, for DNA test results to be admissible, both the first step of the testing process (which relies upon principles of molecular biology and chemistry) and the second step (which involves a calculation of population frequency statistics) must satisfy *Frye*. *Brim*, 695 So. 2d at 269. With regard to the second step, the court found that multiple statistical calculations might simultaneously satisfy *Frye*. *Id.* at 272. "It is clear that scientific unanimity is not a precondition to a finding of general acceptance in the scientific community." *Id.* The court explained that although two conflicting scientific principles cannot simultaneously satisfy *Frye*, it would allow multiple reasonable statistical calculations when based upon generally accepted principles of population, genetics and statistics. *Id.*

For all these reasons, we must respectfully disagree with the trial court's conclusion that it was the appellants' expert opinion testimony that was required to be *Frye* tested in these cases.

Turning to the trial court's further reasoning for denying admissibility - that the underlying epidemiological studies were equivocal as to causation - we find that the trial court ultimately misunderstood the nature of epidemiological studies and was unnecessarily concerned that the studies did not prove causation. As discussed above, epidemiological studies are designed to assess the existence and strength or absence of an association between an agent and a disease. *Supra*, page 12. As Dr. Baker explained in his testimony, epidemiological studies do not fix the cause - they merely demonstrate the probabilities of cause. See also *Green*, 86 Nw. U. L. Rev. at 647 ("At best, epidemiology assesses the likelihood that the agent caused a specific individual disease."). From epidemiological studies demonstrating an association, an epidemiologist may or may not infer that a causal relationship exists. However, the epidemiological studies themselves are not designed to demonstrate whether a particular agent did cause the disease, and the trial court erred in concluding that the studies were unreliable because they failed to establish causal relationship. *n12*

Nonetheless, CSX argues that the epidemiological studies upon which appellants' experts rely are infirm because they contain methodological flaws. It is the railroad's position that even if the experts' opinions themselves do not have to be Frye tested, here the underlying methodology upon which the opinions rely, the epidemiological studies, fail the Frye test.

Before turning to a discussion of the critical analysis employed by CSX, we must emphasize at this juncture that the issue in Frye and in the instant cases involves the admissibility of expert testimony, not the sufficiency of that testimony. An inquiry regarding the "sufficiency" of the evidence concerns whether the party has produced sufficient evidence to convince a reasonable juror that the opinion of the party's expert is correct. In *re Paoli R.R. Yard PCB Litig.*, 35 F.3d at 744.

"Admissibility," in contrast, "entails a threshold inquiry over whether a certain piece of evidence ought to be admitted at trial." In *re Joint E. & S. Dist. Asbestos Litig.*, 52 F.3d at 1132 (emphasis in original).

At this admissibility stage of the proceedings, under Frye the court is asked to decide whether the basis of the evidence upon which plaintiffs' experts rely has a sufficient indicia of reliability. "Reliability is fundamental to issues involved in the admission of evidence." Hadden, 690 So. 2d at 578. We agree with the appellants that under Frye they have demonstrated the reliability of the scientific evidence upon which their experts rely. While, as Dr. Baker acknowledged in his proffered testimony, there continues to be scientific debate about the safe levels of exposure with respect to certain toxins and the degree of reversibility of the effect of exposure to the toxins, we find the epidemiological science and methodology underlying his testimony to be established, reliable, and well-founded.

CSX asserts that, in deciding the question of admissibility here, as a part of our de novo review we must engage in a highly detailed level of critical analysis of each epidemiological study. While an analysis of each study for relative risk, confidence interval, biases, confounders, criteria of causality and other numerous factors may be appropriate in considering the sufficiency of the evidence, that is not appropriate or necessary under the circumstances here or at this stage of the litigation. Further, such a detailed analysis would require this court not only to have an appreciation for the methodological errors and inadequacies in the studies, an ability to assess the validity of a reanalysis of those studies, and an understanding of the biological underpinnings associated with the disease in question, but also to possess a firm grounding in the concepts of relative risk, statistical significance and confidence intervals, and their relationship to the preponderance of the evidence standard.

Green, 86 Nw. U. L. Rev. at 681. While certainly courts must become educated on these subjects when necessary to adjudicate issues regarding the sufficiency of the evidence in the toxic torts arena, the record in these cases is lacking the necessary evidence upon which to make these judgments at this stage of the proceeding. See, e.g., *DeLuca*, 911 F.2d at 955 (declining to rule as a matter of law that any expert opinion rooted in a statistical analysis where the results of the underlying studies are not significant at a .05 level would not be allowed where the record contained virtually no relevant help from the parties or from qualified experts); In *re Joint E. & S. Dist. Asbestos Litig.*, 52 F.3d at 1134 (an argument that an epidemiological study must show a relative risk greater than 2.0 is a sufficiency argument not an admissibility argument). n13

Our conclusion is strongly influenced by the fact that the epidemiological studies here were conducted independently of this litigation and were peer-reviewed and accepted by journals that are widely acknowledged in the scientific and medical communities. See generally *Modern Scientific*

Evidence at § 1- 3.3.3 (noting the importance of peer review and publication in highly regarded journals for the purpose of establishing scientific validity under Daubert). Although there is a debate as to whether publication in peer-reviewed journals or other professional literature is necessary to give a study an indicia of reliability, when there exists a mature epidemiological record with numerous peer-reviewed, published studies supporting the expert's analysis, an aura of reliability and validity is accorded those studies. See *Green*, 86 Nw. U. L. Rev. at 694; *Richardson v. Richardson-Merrell, Inc.*, 649 F. Supp. 799, 802-03 (D.D.C. 1986), *aff'd*, 273 U.S. App. D.C. 32, 857 F.2d 823 (D.C. Cir. 1988), *cert. denied*, 493 U.S. 882, 110 S. Ct. 218, 107 L. Ed. 2d 171 (1989). While the existence of numerous peer-reviewed, published, epidemiological studies does not guarantee that the studies are without flaws, such publication here alleviates the necessity of thorough judicial scrutiny of each study at the admissibility stage "to sort out the disputes over methodologic errors in studies." *Green*, 86 Nw. U. L. Rev. at 694. n14 At least until a more refined screening mechanism can be devised, we are satisfied that under *Frye* peer review and publication lends sufficient reliability and validity to these studies to allow an expert's testimony based upon these studies to be admissible. n15

In our ruling here we are not advocating the abdication of the judicial "gate-keeping" role, contemplated by *Frye*, to the editors of scientific and medical journals. In part, our ruling is a recognition that at this stage of these proceedings a sufficient record is not in place which would allow judicial scrutiny of these studies, spanning several scientific and medical disciplines, to determine the existence and seriousness of any methodological errors. While the experts in these cases testified at length, they testified only in a very general way about the qualities of the studies upon which they relied. Although the studies themselves are in the record, there is insufficient expert testimony on the quality of those studies to guide the court in making any legal conclusion about the probity of the studies. Researchers have methods for assessing the characteristics of persons included in the study and the risk of disease which can be used to rule out known sources of biases and error. On the basis of this record, this court cannot say that the researchers involved in these studies failed to employ such methods.

In addition, any such errors in these studies would principally affect the weight to be accorded the opinions based thereon. Our focus at this stage, however, is a more narrow one - whether to exclude expert testimony based on mere speculation or unreliable science. *Joiner v. General Elec. Co.*, 78 F.3d at 532. n16

Finally, we decline to adopt the railroad's suggestion that we reject "statistically insignificant" studies. The use of "statistical significance" to reject an epidemiological study has been roundly criticized by the experts in the field. See, e.g., *Green*, 86 Nw. U. L. Rev. at 681-93. Professor *Green*, for example, concludes that rejecting studies that are not statistically significant would be cursory and foolish. We find his explanation instructive:

The Brock [*Brock v. Merrell Dow Pharm., Inc.*, 874 F.2d 307 (5th Cir. 1989), *cert. denied*, 494 U.S. 1046, 110 S. Ct. 1511, 108 L. Ed. 2d 646 (1990)] decision, in ascribing wondrous powers to the concept of statistical significance, contributes to doubts that these matters are ones that reasonably can be mastered by generalist judges. Statistical significance addresses only random error due to the sampling inherent in any epidemiologic study. It cannot and does not speak to systematic error, which requires an informed review of the methodology employed in conducting the study. Moreover, statistical significance is merely an instrument for assisting in evaluating a study, not a

truth serum that can be simplistically prescribed.

86 Nw. U. L. Rev. at 681-82.

In sum, for the above reasons we decline to accept the railroad's invitation to examine these studies in detail ourselves and conclude without the basis of record evidence that they are deficient for the variety of reasons advanced by the railroad. CSX's claims of bias, lack of biological plausibility, and alleged other defects in these studies go to the weight, rather than the admissibility, of the studies. See *Ellis v. International Playtex, Inc.*, 745 F.2d 292, 303 (4th Cir. 1984). If there are weaknesses or technical deficiencies in the published epidemiological studies supporting the plaintiffs' experts' opinions as the railroad claims, those perceived deficiencies are appropriate matters upon which to examine and cross examine the experts at trial and, then, for consideration by the fact finder. In re Joint E. & S. Dist. Asbestos Litig., 52 F.3d at 1132. In the instant cases, however, the claimed deficiencies are not a valid reason for excluding the experts' opinions.

As argued by the appellants, the trial in the instant cases will be primarily a so-called "battle of the experts." The fact that the experts have all derived their opinions from the same generally-accepted methodology, the epidemiological studies contained in the record, but simply disagree upon how to interpret the scientifically (and legally) reliable data, is not a valid reason for excluding the plaintiffs' experts' opinions altogether. As the court said in *In re Joint E. & S. Dist. Asbestos Litig.*, 52 F.3d at 1135:

For the district court to seize on the putative flaws of studies favorable to plaintiff, and then to privilege certain studies favorable to the defendant, was impermissibly to place a thumb on defendant's side of the scale and to encroach on the jury's prerogative to weigh the relative merits and credibilities of competing studies . . . Thus, to the extent that none of the studies is flawless or dispositive, their relative merits seems to us to be a classic question for the jury. Trial courts should not arrogate the jury's role in "evaluating the evidence and the credibility of expert witnesses" by "simply choos[ing] sides in [the] battle of the experts." *Christophersen v. Allied-Signal Corp.*, 902 F.2d 362, 366 (5th Cir. 1990).

Finally, we must respectfully disagree with the trial court's rejection of Dr. Kelly's testimony on specific causation. Dr. Kelly employed the differential diagnosis method which is scientifically acceptable. In re Paoli R.R. Yard PCB Litig., 35 F.3d at 758; *Hines v. Consolidated Rail Corp.*, 926 F.2d at 274. Using this differential diagnosis, Dr. Kelly attempted to eliminate the other possible causes of Berry's symptoms. Unlike the situation in *In re "Agent Orange" Prod. Liab. Litig.*, 611 F. Supp. 1223, and other cases, Dr. Kelly had physical contact with Berry and personally examined him as well as supervised his treatment by other professionals. Dr. Kelly's opinion was not only based upon Berry's statements of his symptoms, but was based upon Berry's personal history, medical records, physical examinations and medical tests. In short, Dr. Kelly's opinion was based upon sufficient epidemiological data, facts and personal observation, and was therefore reliable.

REVERSED and REMANDED for further proceedings consistent with this opinion.

JOANOS AND PADOVANO, JJ., CONCUR.

APPENDIX

Edward L. Baker, M.D., et al., Neurobehavioral Effects of Solvents in Construction Painters, 30 J. Occup. Med. 116 (1988)

Barbara Bazylewicz-Walczak, et al., The Psychological Effects of
Chronic Exposure to White Spirit in Rubber Industry Workers, 3 Polish J. Occup. Med. 117 (1990)

Stig-Arne Elofsson, Ph.D., et al., Exposure to Organic Solvents,
6 Scand. J. Work Envtl. Health 239 (1980)

Evelin Escalona, M.D., et al., Neurobehavioral Evaluation of
Venezuelan Workers Exposed to Organic Solvent Mixtures, 27
Am. J. Indus. Med. 15 (1995)

Anne T. Fidler, et al., Neurobehavioral Effects of Occupational
Exposure to Organic Solvents Among Construction Painters,
44 Brit. J. Indus. Med. 292 (1987)

Helena Hanninen, et al., Exposure to Organic Solvents and
Neuropsychological Dysfunction: A Study on Monozygotic
Twins, 48 Brit. J. Indus. Med. 18 (1991)

Lisa A. Morrow, Ph.D., et al., Alterations in Cognitive and
Psychological Functioning After Organic Solvent Exposure,
32 J. Occup. Med. 444 (1990)

Lisa A. Morrow, Ph.D., et al., A Distinct Pattern of Personality
Disturbance Following Exposure to Mixtures of Organic
Solvents, 31 J. Occup. Med. 743 (1989)

Andreas Seeber, Neurobehavioral Toxicity of Long-Term Exposure to Tetrachloroethylene, 2
Neurotoxicology and Teratology 579 (1989)

A. Spurgeon, Ph.D., et al., Neurobehavioral Effects of Long-Term

Occupational Exposure to Organic Solvents: Two Comparable

Studies, 22 Am. J. Indus. Med. 325 (1992)

Kurt Rasmussen, M.D., et al., Solvent-Induced Chronic Toxic

Encephalopathy, 23 Am. J. Indus. Med. 779 (1993)

1 There remains pending below a suit on behalf of Roy Lee Berry, Jr., for injuries due to alleged exposure to excessive levels of asbestos.

2 Toxic encephalopathy occurs when there has been an alteration to the brain and central nervous system function due to exposure to various toxins. See generally Neil L. Rosenberg, M.D., Occupational and Environmental Neurology, 116-17 (1995)(herein Occupational and Environmental Neurology). As explained in William N. Rom, M.D. (ed.) Environmental and Occupational Medicine at 849 (1992):

The nonspecific effects of long-term exposure to solvents range from a general negative affective state to a subtle reduction in functional reserve capacity to perform well when fatigued or in a distracting environment, to mild slowing of psycho-motor performance, to memory disturbance, and finally to severe intellectual deficits. The most severe condition, which has been called psycho-organic syndrome, presenile dementia, and severe chronic toxic encephalopathy, is also the most controversial. Although the existence of chronic solvent encephalopathy has been questioned, experts now generally agree that it occurs but not on its prevalence.

(Footnotes deleted).

3 Some, but by no means all, of the studies relied upon by appellants' experts are set forth in "Appendix A."

4 In their recent treatise, Professors Faigman, Kaye, Saks and Sanders have explained the differences between Frye and Daubert thusly:

In fact, if Daubert is a significant break from the past, the departure lies in the changed focus of the admissibility determination. Frye asks judges to decide the admissibility of scientific expert testimony by deferring to the opinions of scientists in the "pertinent field." Thus, under Frye, judges need not have any facility with scientific methods to make the admissibility decision. They must merely have some basis for knowing what scientists believe. Under Daubert, the trial court itself is initially responsible for determining the admissibility of scientific expert testimony by determining that the science supporting that opinion is valid.

Modern Scientific Evidence at § 1-3.0. These authors have further characterized Frye as "easy to apply and requiring little scientific sophistication on the part of judges." Id. at § 1-2.3. "Whereas Frye requires judges to survey the pertinent field to assess the validity of the proffered scientific evidence, Daubert calls upon judges to assess the merit of the scientific research supporting an expert's opinion." Id. at Preface p. viii.

5 Recently in Joiner v. General Elec. Co., U.S. , 139 L. Ed. 2d 508, 118 S. Ct. 512, 66 U.S.L.W. 4036 (December 15, 1997), the United States Supreme Court has held that an abuse of discretion standard of review applies to the review of a trial court's determination of admissibility under Daubert.

6 One generally accepted set of standards for evaluating epidemiological studies is known as the Koch Postulates. Those standards are composed of the following seven factors:

1. strength of association;
2. temporal relationship;
3. consistency of the association in other research;
4. biological plausibility;
5. consideration of alternative explanations;
6. specificity of the association; and
7. dose-response relationship.

Federal Judicial Center, Reference Manual on Scientific Evidence 161 (1994)(herein the Reference Manual); see also Bert Black & David E. Lilienfeld, Epidemiological Proof in Toxic Tort Litigation, 52 Fordham L. Rev. 732, at 762-63 (1984).

7 The "relative risk" concept is sometimes referred to as the "odds ratio" depending upon the type of study involved. However, for ease of reference, we will refer to relative risk only. Reference Manual at 149.

8 As stated by the court in *Daubert v. Merrell Dow Pharm., Inc.*, 43 F.3d 1311, 1317 (9th Cir. 1995): One very significant fact to be considered is whether the experts are proposing to testify about matters growing naturally and directly out of research they have conducted independent of the litigation, or whether they have developed their opinions expressly for purposes of testifying. . . . In determining whether proposed expert testimony amounts to good science, we may not ignore the fact that a scientist's normal workplace is the lab or the field, not the courtroom or the lawyer's office.

That an expert testifies based on research he has conducted independent of the litigation provides important, objective proof that the research comports with the dictates of good science.

9 "Differential diagnosis" is a term used "to describe a process whereby medical doctors experienced in diagnostic techniques provide testimony countering other possible causes . . . of the injuries at issue." *Hines v. Consolidated Rail Corp.*, 926 F.2d 262, 270 n.6 (3d Cir. 1991).

10 Hypoxia is a "decrease below normal levels of oxygen in inspired gases, arterial blood, or tissue, short of anoxia;" anoxia is an "absence or almost complete absence of oxygen." *Stedman's Medical Dictionary*, at 90 and 756 (25th ed. 1989).

11 While the court had already ruled in *Ramirez*, 651 So. 2d at 1168, that general acceptance under *Frye* must be established by a preponderance of the evidence, in *Brim* the court added to the analysis by defining "general acceptance" as meaning acceptance by a clear majority of the members of the relevant scientific community, with consideration by the trial court of both the quality and quantity of those opinions. *Brim*, 695 So. 2d at 272.

12 Further, the fact that a epidemiological study calls for further research does not indicate uncertainty on the part of the researchers. As explained below by expert witness David Hartman, Ph.D., who submitted an affidavit in the *Chrisco* case:

Any research design assessing clinical data in the real world will always be considered incomplete by critical reviewers. By its very nature, the medical researcher cannot control all possible factors in

the human population under study. Therefore, one must distinguish between a truly erroneous study, and the study which is simply an expression of a particular population . . . [and] is correctly constructed and analyzed. . . .

Almost all genres of research articles in the medical and behavioral sciences conclude their discussion with qualifying statements such as "there is still much to be learned." This is not, as might be assumed, an expression of ignorance, but rather an expression that all scientific fields are open-ended and can progress from their present state. . . .

Medical and behavioral statistics is a methodology that seeks to measure degrees of probability, not causality. Uncertainty is never completely abolished in any form of behavioral or medical science statistical manipulation. Therefore, conclusions must be defined in terms of "suggestions" or "associations" rather than causes. This is not due to some inaccuracy or vagueness of the technique or conclusion, but rather is intrinsic to the properties of statistics.

Mr. Hartman's opinion is consistent with other authorities on the subject. See, e.g., Reference Manual at 157 ("Most researchers are conservative when it comes to assessing causal relationships, often calling for stronger evidence and more research before a conclusion of causation is drawn.").

13 Though there are certainly a number of cases that suggest a relative risk greater than 2.0 can permit an inference that an individual's disease was more likely than not caused by exposure to the toxic agent, there are also cases which have recognized that a plaintiff may satisfy his or her burden of production even if a relative risk less than 2.0 emerges from the epidemiological evidence. Reference Manual at 170. See, e.g., *Grassis v. Johns-Manville Corp.*, 248 N.J. Super. 446, 591 A.2d 671, 675 (N.J. Super. Ct. App. Div. 1991):

The physician or other qualified expert may view the epidemiological studies and factor out other known risk factors such as family history, diet, alcohol consumption, smoking . . . or other factors which might enhance the remaining risks, even though the risk in the study fell short of the 2.0 correlation.

14 In an action against CSX factually similar to the instant cases, the Tennessee Supreme Court recently upheld the admission into evidence of expert testimony based upon epidemiological studies showing an association between exposure to certain organic solvents and toxic encephalopathy. *McDaniel v. CSX Transp., Inc.*, 955 S.W.2d 257, 1997 WL 594750 (Tenn., September 29, 1997). We believe that the *McDaniel* court correctly explained the role of the trial court in cases such as this:

Although the trial court must analyze the science and not merely the qualifications, demeanor or conclusions of experts, the court need not weigh or choose between two legitimate but conflicting scientific views. The court instead must assure itself that the opinions are based on relevant scientific methods, processes, and data, and not upon an expert's mere speculation. The trial court should keep in mind that the preliminary question . . . is one of admissibility of the evidence. Once the evidence is admitted, it will thereafter be tested with the crucible of vigorous cross-examination and countervailing proof. After that occurs, a defendant may, of course, challenge the sufficiency of the evidence by moving for a directed verdict at the appropriate times. Yet it is important to emphasize that the weight to be given to stated scientific theories, and the resolution of legitimate but competing scientific views, are matters appropriately entrusted to the trier of fact.

Id. at 265 (citations omitted).

15 A review of case law in the toxic torts area demonstrates that the intensity of the "admissibility" inquiry evolved as a result of Agent Orange and bendictin cases. See *Green*, 86 Nw. U. L. Rev. 643.

But unlike the present situation, the initial published studies involving both of those allegedly toxic agents were negative and the plaintiffs were trying to introduce expert testimony contrary to the published epidemiological studies.

16 Though certain of the federal decisions cited or discussed in this section of the opinion employ a Daubert analysis, rather than a Frye analysis, these opinions are nonetheless focusing on the reliability of the expert's methodology. Florida's Frye test is ultimately concerned with the reliability of the scientific principles or methodology upon which the expert bases his opinion. See generally, C. Ehrhardt, Florida Evidence §§ 702.3, 702.4 (1997). It is yet a matter of debate whether the Daubert test, in requiring that the reasoning or methodology underlying the testimony be scientifically valid, will be more liberal and allow more expert testimony than the Frye requirement that there be general acceptance of the underlying methodology. Modern Scientific Evidence at § 1-3.3.4. But we are satisfied that for the purposes of the analysis here, under the Frye test of general acceptance, that peer-reviewed epidemiological studies conducted independently of the instant litigation are the scientifically accepted means of analyzing human response to exposures to certain substances.