Defining Multiple Chemical Sensitivity

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5. NO BALM IN GILEAD: WHY WORKERS' COMPENSATION FAILS WORKERS IN A TOXIC AGE*

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I am wounded at the sight of my people's wound;
I go like a mourner, overcome with horror.
Is there no balm in Gilead, no physician there?

Jeremiah 8:21–22

The Story

For over a decade, my office had a nook: a leather loveseat with a shelf and bookcase behind it, an oval wood coffee table, and two tall wingback chairs. Its form matched its function nearly perfectly. Intended to provide a safe place for my clients to unburden themselves, it saw a steady stream of women and men doing just that. Many a day I waved a husband and wife towards the loveseat. Without prompting, the wife would describe a pattern of symptoms with which I would come to be all too familiar: crushing headaches, eye irritation, nosebleeds, sore throat, painful and difficult breathing, fatigue, thirst, nausea, increased emotionality, insomnia, impaired

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memory, inability to cope, loss of interest in things usually enjoyed, decreased sexual interest, trouble concentrating, and sensitivity to certain materials.

The symptoms first arose when the client was exposed to certain materials in the workplace. When she worked a long week her symptoms would worsen; after a three-day weekend her symptoms would improve. It took awhile for her to associate her symptoms with the workplace because she had been working overtime consistently for months — and because the company denied knowledge of any ill effects from exposure. Medical records confirmed her having reported these symptoms on numerous occasions. Her fellow workers, mostly women, also felt sick. Everybody assumed it was a flu bug going around. But for some, the symptoms persisted — and worsened. For these workers, symptoms reappeared whenever they were exposed to certain substances present in the everyday environment of modern society: aftershave, gasoline, detergent, toner from photocopiers. For these workers, the path through each day had become a maze in which certain commonplace exposures had to be avoided.

As the wife would start talking about increased emotionality, I would glance over to the husband and receive the expected confirmation. He would look towards his wife with his eyes filling with tears. She needs this job, she would say. Then he would lower his eyes again.

The nook is no longer there. Yet the stream of injured visitors continues.

These people are telling a story, variations of which I have now heard countless times from factory workers, office workers, doctors, teachers, painters, and chemists. Over the years, dozens of working men and women, fearful of losing their jobs, have sat before me telling the story. The insidious onset of the constellation of symptoms. Trooping from doctor to doctor, specialist to specialist, with no explanation, no cure.

- A young man just a month or so before his wedding is unable to work. His fiancee breaks off the engagement because, as he puts it, he doesn't appear to have much of a future anymore.
- A chemist just out of school cannot look forward to the job for which he has trained for years. He learns from co-workers that the woman who sat at his desk just before him also can no longer work. She also told the story. We thought that's just the way she was, you know, having lots of problems, they tell him. But now you. His co-workers are worried.
- A top-flight, high-powered executive can no longer perform his sales job for a television network.
- A physician who once could remember the blood pressures of a full schedule of patients when writing up his office notes now has trouble remembering where he is going between examination rooms.

They all tell their own versions of the story.

I have not been trained to answer their questions. And, theoretically, as a lawyer, I do not have to. But, as a human being, I must try.

Inside the Beltway

On March 6, 1989, at 10:00 A.M., Senator Reid of Nevada, chair of the United States Senate Subcommittee on Toxic Substances, Environmental Oversight, Research and Development, called to order the first hearing on "Worker Exposure to Toxic Materials in the Aerospace Industry."[1] In his opening remarks, the senator stated:

> I intend to set a standard for these hearings. The work place should not be a test tube and the company employees should not be guinea pigs. We cannot tolerate stone-age protections for space-age dangers. At the same time, we must do everything possible to maintain the current high standards of national security that come from extraordinary leaps forward in scientific research and available technology.
>
> Today we begin a dialogue that includes testimony from affected workers, medical experts, representatives of the aerospace industry, union officials and federal regulators. I sincerely appreciate their willingness to appear before our panel and look forward to hearing their remarks.
>
> In World War Two, we glorified Rosie the Riveter. Thirty years later, we buried her because nobody had known about the dangers of asbestos contamination. The employees of the aerospace industry protect us by the work they perform. We owe them the very same high level of protection.[2]

The sentiments expressed by the senator articulate what most Americans would regard as the expected — and appropriate — policy respecting workplace safety: Human beings ought not to be exposed to chemicals whose

effects are unknown. Such a policy is beguiling in its humanity and simplicity. But is it the policy of the United States government?

It is to the dedication of the bureaucrat functioning within the constraints of his agency that we may fairly attribute most of the success of regulatory efforts, however well-conceived the underlying legislation. The testimony before the Senate subcommittee from Leo Carey, director of the Office of Field Programs of the Occupational Safety and Health Administration (OSHA),[3] and Charles Elkins, director of the Office of Toxic Substances of the Environmental Protection Agency (EPA), exemplifies both the dedication and the necessarily circumscribed perspective of the civil servant.

Consider briefly the testimony of Mr. Carey:

> [A]s a young boy I experienced the effects of occupational injuries and illnesses. I come from a small town in the anthracite region of Pennsylvania. I have had relatives killed in the mines, and I have had relatives develop black lung. I have spent the 20 years of my professional life devoted to protecting workers from injuries and illnesses.
>
> OSHA has responsibility for approximately 80 million workers in nearly 6 million work places. We are largely a field organization with an annual budget of approximately $250 million a total staff of 2400, more than 80 percent of whom are located in ten regional and 86 area and district offices throughout the country.
>
> Our mission is to assure, so far as possible, safe and healthful working conditions for every working man and woman in the nation....
>
> In the past fiscal year, federal OSHA and the states, together, have inspected approximately two and a half percent of the six million workplaces covered by OSHA.[4]

As one might expect from the administrators of government agencies, the testimony had two basic thrusts: the efficiency of the agency given existing funding levels and the inadequacy of the present level of appropriations. One would hardly expect OSHA or EPA officials to testify that it is impossible to protect the worker. We can rely upon the proffered data, but any judgment regarding the efficacy of an agency's efforts or the possibility of its attaining its expressed goals is the responsibility of an informed citizenry.

The notion that the workplace ought not to be a "test tube" for experimentation on human "guinea pigs" is so widely held that we are in danger of persuading ourselves that reality conforms with our expectations. It does not.

Too Few White Mice

Ironically, to this observer, the testimony from the OSHA and EPA representatives did not establish justification for additional funding so much as demonstrate the futility of attempting to gain adequate knowledge through testing.

Responsibility for the policing of the Hazard Communication Standard rests with OSHA[5] and its associated agencies at the state level. The standard, first effective in May 1986, requires chemical manufacturers and importers to evaluate the hazards of the chemicals they produce or import. They must then inform their employees, as well as the employers to whom they ship their products, of the hazards. This communication, in the form of a material safety data sheet (MSDS), identifies the product, the risks associated with its use, and the appropriate protective measures. The data sheets must be available to the employees on their shifts.

The employer is required to train employees to understand the information the standard makes available to them. Training is to be provided at the time of an employee's initial assignment and whenever a new hazard is introduced into the work area. Such training must address how to read and interpret information on labels and material safety data sheets and how to detect the presence of hazardous chemicals.

Presently, the standard covers more than 575,000 chemical substances and products. OSHA has established permissible exposure limits for only 600 industrial chemicals and substances. In a written submission to the Senate subcommittee, Mr. Carey stated: "In a recent landmark effort, the agency set limits for 164 substances that had not previously been regulated by OSHA, and adopted more protective limits for 212 chemicals."[6] In the event no specific limits exist, the General Duty Clause of the Occupational Safety and Health Act (Section 5 [a] [1]) authorizes OSHA to issue citations where the employer has failed to furnish employment or place of employment free from recognized health hazards. A penalty of up to $1,000 may be proposed and up to $10,000 for each instance of a willful or repeated violation.

At present, the introduction of new chemicals in the workplace has outstripped all efforts to establish permissible exposure limits. Under the Toxic Substances Control Act (TSCA),[7] manufacturers intending to manufacture or import a new chemical are required to give 90-day advance notification to the EPA. This Premanufacture Notification (PMN) is

intended to permit the EPA to evaluate the new chemical. Section 5 of TSCA requires the submission of toxicity test data that are available, but does not require toxicity testing by the manufacturer. More than 11,600 PMN submissions were received through the end of fiscal year 1988; more than half lacked any test data; fewer than 15 percent of the notices contain information respecting any effects beyond acute lethality or local irritation.[8] The PMN submissions add to the backlog of over 65,000 chemicals already in use for which health risk assessments have yet to be made. As Mr. Elkins noted:

> [T]he *Existing* Chemical Program deals with chemicals that have well-established and often major roles in the economy. To responsibly place significant restrictions on the use or manufacture of chemicals basic to the operation of the American economy requires EPA to perform extensive analyses of options and impacts....
>
> In order to regulate existing chemicals, TSCA requires EPA to make a determination that the manufacture, distribution, processing, use or disposal *will* present an unreasonable risk to health or the environment....[9]
>
> With existing chemicals, we have a much bigger problem. There are almost 65,000 chemicals in commerce. Many of these have production volumes over a billion pounds, and for many others, millions of people are exposed.[10]

It is evident that, of necessity, the efficacy of regulatory efforts rests almost entirely upon the voluntary cooperation of industry and employers. The most rigorous imaginable enforcement falls far short of that required to insure compliance in millions of workplaces for thousands of chemicals lacking any permissible exposure guidelines. Moreover, enforcement of permissible exposure limits may well require technology not yet available.

Even if we could assume vigorous enforcement and enthusiastic compliance with all the applicable regulations, the problems facing protection of workers from toxic chemical exposures in the workplace would dwarf our current scientific and medical knowledge. Even where established, permissible exposure limits generally govern individual chemicals and may not adequately protect workers in workplace situations if chemicals are introduced in the form of composites where identification of the chemical constituents and by-products may be impossible. Based upon the number of chemicals alone, analysis of the additive and synergistic effects of all combinations of these chemicals would involve more white mice than exist on earth.

As recently noted by a University of Washington investigator of one case involving phenol formaldehyde resins:

> The results of the various investigations were not surprising, particularly in view of the fact that there are no universally agreed upon methods for determining standards for exposures to mixtures containing more than a few individual compounds. In addition, some of the atmospheric collection and analytical techniques utilized to assess potential exposures are not always entirely effective. This is especially true for complex mixtures involving resin, some formulations of which were developed for use in the production of composites.
>
> A number of technical difficulties are apparent. In many instances, some resin by-products may not be collected; others, if collected, cannot be identified. Furthermore, the toxicity data for some of the identified components may be sparse or absent.[11]

Phenol formaldehyde resins are used in some common wood composites such as plywood and particle board, and phenolic-bonded laminates are used industrially and for home and office decorations. Phenolic resins are present in products such as brake linings and clutch facings and are used in paints, varnishes, rubber cement, nail lacquer and hardener, watch bands, fabrics, shoes, and, in the form of phenolic foam, flower arranging.[12] Although one might hope that the chemical constituents of such resins would be well understood given their use in factories, offices, cars, homes, cosmetics, and apparel, such is not the case. In fact, as recently as 1985, eleven new skin sensitizers were identified in such resins.[13]

Misapplication of Science: "When I Heard the Learn'd Astronomer"

In his poem "When I Heard the Learn'd Astronomer," Walt Whitman tells how

> When the proofs, the figures, were ranged in columns before me,
> When I was shown the charts and diagrams, to add, divide, and measure them,
> When I sitting heard the astronomer where he lectured with much applause in the lecture-room,
> How soon unaccountable I became tired and sick,

> Till rising and gliding out I wander'd off by myself,
> In the mystical moist night-air, and from time to time,
> Look'd up in perfect silence at the stars.

So, too, we often see how statistics such as permissible exposure levels and threshold limit values squeeze all the life out of the questions they seek to answer. In the final analysis, looking at the data, we are forced to ask: Of what value is it? What do PELs and TLVs tell us about an individual's susceptibility to toxic insult? The answer: not much.

Those defending employers against claims of injured workers often ignore the underlying human issues. This, perhaps, may be expected of those in service to the corporate defendants. But such defenses are based upon a misapplication of basic concepts respecting PELs and threshold limit values (TLVs). The defense, for instance, routinely will assert that a given individual could not have been injured because the exposure level was below the PEL. To understand the fallacy of this assertion requires us to understand what such figures really mean.

TLVs, established by the TLV Committee of the American Conference of Governmental Industrial Hygienists (ACGIH), were intended as unofficial guidelines for acceptable exposure. Yet they have been widely applied as official limits, and nearly 90 percent of the PELs are based directly upon the TLVs.

The TLVs are subject to change. "Each year some of the values are changed, and in a majority of instances they are reduced, sometimes to one-half or one-tenth of their previous value.... TLVs for such chemicals as benzene, vinyl chloride, and methyl chloride [have] come down from early values of 100 ppm, 500 ppm and 20,000 ppm [Cook 1945] to current levels of 10 ppm, 5 ppm and 1000 ppm," wrote S. A. Roach and S. M. Rappaport in the *American Journal of Industrial Medicine*.[14] The authors conclude that TLVs reflect the levels of exposure which were perceived at the time to be achievable in industry.

The defense consistently assumes that if exposures fall beneath certain established levels, then injury cannot occur. The ACGIH, however, has never contended that the TLVs protect all workers, even giving them the greatest conceivable weight. In fact, annually, the following language is included in the ACGIH documentation of threshold limit values:

> Because of a wide variation in individual susceptibility ... a small percentage of workers may experience discomfort from some substances at concentrations at or below the threshold limit: a smaller percentage may be affected more seriously by aggravation of a pre-existing condition or by development of an occupational illness.[15]

According to one recent study, the incidence of adverse effects *at* the threshold limit value ranged from zero to 100 percent.[16] In other words, some TLVs are levels at which 100 percent of those exposed are adversely affected. Overall, it appears that about 14 percent of workers experience adverse effects at or below the TLV.[17] Clearly, test measurements of levels below the PELs do not negate the possibility of injury or illness.

From a scientific standpoint, *even if*: (1) all the sources of contamination were identified; (2) all the toxic chemicals were identified; (3) all such chemicals were tested under circumstances precisely replicating the environment in which the exposure occurred; and (4) all levels detected by such testing were below the TLVs and PELs, the causal relationship between exposure and injury could not be negated by the logic employed by the defense. The fact that these assumptions are not correct makes the argument put forward by the defense unscientific and invalid.

The Roach and Rappaport critical analysis of TLVs concludes:

> Since so many TLVs for chemical substances appear to offer relatively little protection, we recommend that occupational hygienists and other health professionals routinely investigate the *Documentation* and, more importantly, the reference materials pertaining to particular contaminants rather than accepting on faith that every TLV provides the protection claimed by the ACGIH.[18]

The process for setting TLVs has also been criticized.[19] Although the TLV Committee, which consists of volunteers operating on a limited budget, deserves respect for its efforts to set TLVs where none had existed, it must be pointed out that initially there was little or no experimental evidence, so the levels were based on those obtainable by industry. Castleman and Ziem cite significant or complete reliance upon unpublished corporate correspondence in a substantial proportion of cases and note that corporate representatives served as consultants to the committee. They properly caution against undue corporate influence on values which are, after all, being imposed upon the corporations themselves. The authors note, "It has ... been widely recognized that the TLVs for chemical substances are in most cases poorly supported by scientific evidence."[20] They conclude that

"the numerical values for exposure limits selected as 'acceptable'" are determined by "very much a political as well as a scientific process."[21]

The epidemiological data supporting the TLVs are not based on double-blind, peer-reviewed human studies. Anecdotal evidence, studies involving small numbers of individuals, animal studies, unpublished corporate correspondence, and industrial practicality all figure in establishing the limits. It is not surprising that injured workers cannot often establish injury through double-blind epidemiological studies when the TLVs and PELs upon which the defense rests its claims are themselves seldom supported in that way. When epidemiological data are available, they nearly always arise from the exposures experienced by white male, blue-collar workers in manufacturing facilities. Such data must be looked at with some care before they can be applied to other workers. Ethical and economic factors also hamper the generation of epidemiologic studies on humans.

Perhaps most significantly, there is no scientific basis for applying the TLVs and PELs to *mixtures* of chemicals. TLVs and PELs are established for single chemical exposures. They do not take into account the additive or synergistic effects of chemicals or chemical mixtures. For instance, levels of toluene at 60 percent TLV added to levels of xylene at 60 percent TLV would have an additive effect, yet the mixture would still be below the TLV for each chemical individually. The application of single chemical TLVs and PELs to circumstances of probable multiple chemical exposures is in most cases not scientifically sound. From the standpoint of the scientific method, exposures to individual contaminants below the TLVs would not in any way rule out the potential for adverse health effects to be causally related to the environment.

Considering Scientific Causation

Participants in the regulatory and compensatory framework attempting to establish the cause of toxic injuries find themselves caught in a conflict between good law and good science. Existing compensatory schemes in the State of Washington, for example, require that the injured worker establish that the injury was proximately caused by the toxic exposure in the workplace — and do so within the applicable statute of limitations governing occupational disease.[22] One commentator has pointed out that a statute of limitations on toxic substance litigation runs counter to the

policies behind tort law: Time bars on ordinary torts promote efficient and accurate factual determinations, but toxic tort claims force claimants to seek compensation in the absence of the best scientific evidence and before the nature and extent of injury has been established.[23]

In cases where employees are exposed to novel mixtures of chemicals, the best scientific evidence is almost never available when needed. This is hardly surprising in light of the more than 4,000,000 mixtures, formulations, and blends estimated to have been registered with the EPA under the TSCA.[24] Moreover, even without undue pessimism, it is improbable that such scientific knowledge is ever likely to become available when needed, so long as toxicological and epidemiological studies must rely upon animal and human studies, due to the latency periods involved in exposures to subacute levels of chemicals.[25]

Epidemiology deals with the study of diseases within a subject population and may permit investigators to reach conclusions respecting the effects of actual chemical exposure upon groups of individuals. Such studies may eliminate the necessity of analogizing from animal studies or from similar chemicals, but involve creating analogies between more or less comparable human populations which leave such studies open to attack.[26] Obviously, a truly novel chemical formulation cannot have been the subject of epidemiological studies to help establish causation in a particular case. Assuming, however, that some analogy may be drawn to the effects of some of the known chemical constituents of the formulation or a similar mixture, such studies may be of only limited value to the injured worker.

> Even when epidemiological studies are able to determine very accurately excess risks of disease in populations, they are not able to determine which individuals in those populations would not have developed the disease without occupational exposure. In many cases, this uncertainty cannot be resolved.[27]

Moreover, not infrequently, epidemiological studies are unable to meet the high scientific burden required to establish a statistical association and fail to show any increased risk. In such cases,

> [c]ourts may erroneously assume, for example, that a showing of no increased risk eliminates any possibility of causation. In fact, such a showing may be related to difficulties inherent in epidemiology rather than the absence of a causal link.[28]

In *Ferebee v. Chevron Chemical Company*, the court stated that "a cause and effect relationship need not be clearly established by animal or epidemiology studies before a doctor can testify that in his opinion such a relationship exists."[29] From an evidentiary standpoint, in the absence of toxicological or epidemiological data, the ability of the injured worker to demonstrate the existence of an occupational disease rests almost entirely upon the ability of the treating physician to identify the constellation of symptoms the worker reports as the clinical manifestations of exposure to novel chemical formulations at levels able to be established.[30] Thus it can be most difficult, for both physician and patient, if novel chemicals give rise to new clinical entities which have not yet been widely recognized by the medical establishment.

The worker does not have only to be concerned with the conservatism of the medical establishment. Judicial opinions have questioned whether a treating physician can provide accurate testimony respecting causation without reliance upon epidemiological studies.[31] Such opinions seem to indicate that the injured worker must escape an impossible circularity to meet the burden of proof: In the absence of epidemiological and scientific studies, the worker must rely upon the testimony of his or her doctor; yet, the testimony of the doctor will not be permitted in the absence of supporting epidemiological and scientific studies. As a number of commentators have noted, such a conclusion would, in effect, raise the injured worker's burden of proof above the legal standard of "preponderance of the evidence" or "more likely than not" to one of "scientific certainty."[32]

The injured individual must labor under not only the honest burden of proof assumed by a plaintiff in civil litigation, but an enhanced burden imposed upon him or her by a defense none too scrupulous about the application of scientific principle. For instance, the defense may insist upon a scientific standard of proof that no one could sustain, such as requiring that a dose-response relationship be applied to a novel toxic mixture for which the dose may be impossible to establish. Toxicological principles of dose-response and specificity cannot be applied to complex mixtures, and the "science" of any defense insisting upon such application is unsound. A common example of a complex mixture is diesel exhaust. According to NIOSH: "Estimates indicate that as many as 18,000 different substances from the combustion process can be adsorbed onto diesel exhaust particulates."[33] Testing cannot come close to measuring such exposures to plaintiffs: "Exposure to diesel exhaust is difficult to measure because of the

complex nature of the exhaust."[34] The same principle holds true for any complex mixture.

If defense experts nonetheless insist that a dose-response relationship and specificity of response to each chemical be established, it is worth noting that it has been held that these matters raise questions of fact best left to the jury:

> The dose-response relationship at low levels of exposure for admittedly toxic chemicals ... is one of the most sharply contested questions currently being debated in the medical community, see generally Leape, Quantitative Risk Assessment in Regulation of Environmental Carcinogens, 4 *HARVARD ENVT'L L. REV.* 86, 100–103 (1980); *surely it would be rash for a court to declare as a matter of law that, below a certain threshold level of exposure, dermal absorption of paraquat has no detrimental effect. We therefore conclude that there was sufficient evidence of causation to justify submission of that issue to the jury.* [Emphasis added.][35]

In addressing exposures to diesel exhaust and other mixtures, one must consider a veritable "chemical soup" in which the worker has been submerged. The exposed individual experiences ingestion and respiration of the offending substance; dermal contact; and direct irritation to eyes, mucous membranes, and skin from particulates. The effects of such exposures include, among others, offensive odors, chemical effects, and the mechanical, irritating effects associated with particulate matter.

The physical state of the constituents may include gaseous fumes, particulates, and the chemicals adsorbed onto particulates and respired deeply into the lungs. The potential exposures to a single chemical vary widely depending upon the routes of exposure, toxicity, and states of the chemical (gas, liquid, particulate, solution, aerosol mist). This makes calculation of precise dosage difficult even for a single chemical. Precise calculation of dosage of a complex chemical mixture is likely to be impossible. Furthermore, dose-response relationships are not applicable to chemical mixtures because of the additive or synergistic (or even offsetting) effects. Finally, specificity of response by the patient to a specific chemical cannot be determined when the patient has been exposed to a complex chemical mixture. For all these reasons, principles of dose-response and specificity are not applicable to a situation where the worker was exposed to a complex chemical mixture. Such principles are also inapplicable where the precise route, duration, and extent of toxic exposures are unable to be determined, oftentimes due to the limitations of the air tests conducted at the time.

Ironically, the "science" propounded by those defending against claims of chemical injury is often based upon professional skepticism disguised as science. Defense experts, having no burden to establish causation, need only be doubting Thomases. This role may be revealed by their inability to address or explain the evidence. Most seem able only to attack the "provability" of the injured worker's case.

The methods for establishing the causal link between novel exposures and novel diseases may involve expert witnesses expressing opinions which run contrary to those of the scientific or medical establishment. Often, the opinions of the "establishment" under scrutiny are no sounder for having been generally accepted than the proposition put forth on behalf of the injured plaintiff.

Daubert and Junk Science: Copernicus Unmuzzled

The recent United States Supreme Court decision in *Daubert v. Merrell Dow Pharmaceuticals, Inc.*[36] appears to discard the *Frye* standard requiring that evidence or testimony, in order to be admissible, have "general acceptance" in the scientific community. Instead, the Court chose to admit evidence based upon an ER 702[37] inquiry into a number of factors: (1) Is the theory testable, and has it been tested? (2) Has the theory been subjected to peer review and publication? (3) What is the known or potential error rate associated with the scientific technique employed? (4) Is the technique or methodology well-known, and has it met with widespread acceptance?

This case authority suggests that the Court is moving toward acceptance of expert testimony based upon sound, but not necessarily generally *accepted*, scientific principles. If so, the door may be opening to a more liberal admission of scientific evidence. In other words, sound scientific method may be heard as testimony, even if it yields an unpopular conclusion: Copernicus *can* testify that the earth orbits around the sun, despite the weight of established opinion to the contrary.

The Washington Court of Appeals (Division I) in *Intalco Aluminum v. Dep't. of Labor and Industries*,[38] citing *Ferebee*, held that "expert testimony [must] be based on methods accepted in the scientific community"

but that "an expert physician's opinion on causation need not be generally accepted in the scientific community." In *Intalco*, the court found the extensive neurologic testing by plaintiffs' physicians to be immune from attack.

In *Ferebee*,[39] the court approved of the "basic methodology," which employed tissue samples, standard tests, and patient examinations. In *Bruns v. PACCAR, Inc.*,[40] the court approved of reliance on experts for air sampling, chemical analysis, clinical examinations, and questionnaires. (See the following section, "Products Liability Actions," for further discussion of *Bruns*.)

There would seem, then, to be little disagreement that taking a detailed patient history, conducting physical examinations, having blood samples drawn and reviewed by reliable laboratories, reviewing air test results, considering the significance of a "cluster" of similar exposures and reports of illness, and exploring the medical and scientific literature constitute sound methodology. Often, the debate by those denying chemical injury appears limited to "We disagree with your conclusions."

In *Intalco*, the Washington Court of Appeals wrote: "We agree with the *Ferebee* court that the requirement that expert medical testimony be based on methods generally accepted in the scientific community pertains to the *methods* used by, not the conclusions of, the expert witness."[41] Even in pre–*Daubert* cases, it was clear that the conclusions of the experts were reserved for the jury to consider on their merits.

Causation in novel chemical injury claims can seldom be established with *scientific* certainty. In the absence of toxicological or epidemiological data, the injured worker must rely upon the evaluation of his treating physician. "In workers' compensation cases, the court must give special consideration to the opinion of the attending physician."[42] The attending physician is seldom in a position to identify occupational diseases arising from novel chemical compounds based on an isolated presentation by his or her patient. Only rarely will the attending physician have information respecting a number of workers from a common site manifesting a similar constellation of symptoms. This information is uniquely available to the in-house physician of the employer in the case of larger employers. Unfortunately, the employer's medical staff are all too rarely supportive of the workers.

The attending physician, however, will generally be safe in expressing opinions based upon *clinical* diagnoses consistent with the symptoms associated with a toxic exposure. The problem, once more, is determining

which symptoms are associated with exposure to novel chemical combinations. The analysis at this point generally devolves to a debate respecting permissible exposure limits, test levels, and the completeness of the material safety data sheet provided by the manufacturer respecting the products or chemicals at issue. *Intalco* again proves exceedingly helpful respecting both the impact of chemical combinations and permissible exposure limits. The *Intalco* court concluded that the injured worker is not required to prove that a precise chemical caused the injury, so long as the evidence establishes that the conditions of the workplace were the major contributing cause of the disability.[43] The court also concluded that PELs respecting safe levels for the average worker were of no matter; the concern was the effects of exposure on the particular affected worker.[44]

Product Liability Actions: Proximate Cause Revisited

The defense will often seek to have a chemical injury case treated as though it involved a pharmaceutical product. Cases involving pharmaceuticals must consider whether the product causes injury if administered at the therapeutic dosage prescribed by a physician.[45] This question is entirely inappropriate for chemical injury cases. There is no therapeutic dosage for formaldehyde, toluene diisocyanate, diesel fuel, or other fumes or mixtures. Furthermore, in cases involving pharmaceuticals, in contrast to the toxic chemical exposures in homes, schools, and workplaces, there is no opportunity for lay (non-expert) testimony; there are no eye witnesses to the biochemistry of the drug at work.

Under the doctrine of *Erie R.R. v. Tompkins*,[46] substantive state law of products liability is properly applied with respect to chemicals in defective products. In the recent Washington case of *Bruns v. PACCAR*, a design defect products liability action, the Washington Court of Appeals addressed a case involving a "chemical soup" affecting drivers of new trucks.

In *Bruns*, 13 truck drivers who transported trucks manufactured by defendant Kenworth reported health problems which arose during and after driving the new trucks. Their symptoms included skin rashes, respiratory problems, nosebleeds, tight chests, numb fingers, headaches, and fatigue. The drivers maintained that multiple airborne chemicals in the trucks made them ill. Several air quality consultants investigated the situation but were

unable to pinpoint a specific chemical agent as the cause of the harm. One physician conducted clinical examinations and reviewed records and concluded that the symptoms were caused by an unspecified irritant "while driving newly-manufactured Kenworth trucks on a more probable than not basis."[47] She concluded that low levels or combinations of chemicals could have an irritant effect. A second physician likewise noted a more-probable-than-not association between the symptoms and work activities and "reported that some of the symptoms appeared consistent with irritation by some unidentified airborne chemical substance."[48] A NIOSH investigator, Dr. McCammon, "identified over 100 organic compounds in small quantities and found hydrocarbon, carbon monoxide, aldehydes, fiberglass, isocynates, and xylene in concentrations at less than 10 percent of their TLV and PEL."[49] "Dr. McCammon concluded: 'No single contaminant or set of conditions was identified to explain the truck drivers' health complaints.' [H]e found the temporal patterns reported by drivers consistent with a work-related etiology."[50]

Defendant PACCAR moved for summary judgment based on the drivers' failure (1) to identify chemicals in the trucks approaching threshold limit values (TLV), and (2) to establish a more-probable-than-not causal link. The trial court granted summary judgment. The Court of Appeals reversed:

> [T]he elements of a design defects products liability claim are (1) a manufacturer's product (2) that was not reasonably safe as designed (3) caused harm to the plaintiff. RCW 7.72.030(1). To establish a prima facie case under the statute, plaintiff must offer admissible evidence showing each of the elements.
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> [T]o establish a design defect products liability claim a plaintiff must show that the product was not reasonably safe as designed. RCW 7.72.030(1)(a). A plaintiff may demonstrate this by ... show[ing] that, at the time of manufacture, the likelihood and seriousness of harm caused by the product outweighed the manufacturer's cost and opportunity to design a product that would not have caused the harm.... Alternatively, the plaintiff may establish manufacturer liability by showing the product was unsafe as contemplated by a reasonable consumer.
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> ...The parties agree that no specific chemical emerged as the source of injury and that chemicals present in the truck cabs registered in quantities much lower than required by regulations. PACCAR contends that this would cause the jury to engage in pure speculation when undertaking the consumer expectation or risk-utility analysis.
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> The drivers argue that *neither the risk-utility nor the consumer expectation*

> *test requires proof of a specific chemical as the design defect. We agree.* A plaintiff need not prove defectiveness separately from unreasonable dangerousness.[51] [Emphasis added.]
>
> Here, the drivers point to a "chemical soup" as the defect. They provide a list of chemicals found in the truck cabs and the concentrations at which they were found. *Therefore, we find that the drivers offered sufficient evidence to allow a reasonable person to find the trucks not reasonably safe.*[52] [Emphasis added.]

The Court of Appeals found the expert opinions correlating the exposure to the new Kenworth trucks to the drivers' injuries sufficient to avoid a jury having to engage in speculation to find proximate cause.[53]

A Last Look at Causation: Where Common Sense Meets Scientific Skepticism

There is a wealth of evidence respecting causation which relies upon such time-tested sources of evidence as human observation, experience, sight, smell, taste, touch, and common sense.[54] The defense in a chemical injury case usually seeks to move the issue of causation to a purely "scientific" realm where such common sense lay evidence is subordinated to inappropriate toxicological and epidemiological studies where the skepticism of the defense finds support — or, at least, where an attempt can be made to increase the plaintiff's burden from a preponderance of the evidence to a scientific certainty.

In *Intalco Aluminum v. Labor & Industries*, the Washington Court of Appeals held that "the plaintiff should not be denied recovery simply because the precise etiological link between the plaintiff's disease and a specific toxin or toxins in the workplace has not yet been made."[55] The Court of Appeals specifically noted that "the absence of studies linking [plaintiff's exposure] to neurologic disease does not compel the conclusion that the claimants failed to make a showing of proximate cause."[56]

Both *Bruns* and *Italco* cite with approval the following language from *Earl v. Cryovac*,[57] in which the Idaho Court of Appeals rejects the defense argument that the failure by plaintiff's experts to specify which of the chemical components of the plastic vapor caused the injury to the plaintiff defeats the plaintiff's claims:

> We do not consider it fatal to the plaintiff's case that the etiology of his disease has not been traced to a discrete component or set of components with the heated plastic vapor. As explained by our Supreme Court in *Farmer v. International Harvester Co.* [97 Idaho 742, 553 P.2d 1306 (1976)], the plaintiff need only show that the product is unsafe; he need not identify and prove the specific defects which render it unsafe. The same approach is reflected in the cases ... where victims of "meatwrapper's asthma" have been allowed to recover despite scientific uncertainty as to the precise etiological link between their disease and specific chemical(s) in the heated plastic vapors.

Even the cases often cited by the defense do not contend that toxicological evidence is required to establish scientific causation. *Daubert II*,[58] the remand of *Daubert I* to the Ninth Circuit Court of Appeals by the United States Supreme Court, involved proof that a drug (Bendectin) caused birth defects was necessarily based on a statistical analysis. Even there, however, the kind of evidence often available to those in workplace or school environments who have sustained toxic injury would be persuasive:

> Not knowing the mechanism whereby a particular agent causes a particular effect is not always fatal to a plaintiff's claim. Causation can be proved even when we don't know precisely how the damage occurred, if there is sufficiently compelling proof that the agent must have caused the damage somehow.... If 50 people who eat at a restaurant one evening come down with food poisoning during the night, we can infer that the restaurant's food probably contained something unwholesome, even if none of the dishes is available for analysis. This inference is based on the fact that, in our health-conscious society, it is highly unlikely that the 50 people who have nothing in common except that they ate at the same restaurant would get food poisoning from independent sources.[59]

The existence of a common pattern of illness among affected schoolchildren or workers (or even family members), all linked closely and repeatedly with a toxic exposure, can sometimes provide precisely such compelling proof. Continuing the analogy to food poisoning, the defense is contending that testing the *reverse* side of the plate revealed nothing.[60]

Each case must be considered on its unique set of facts. Consider, for instance, *Cavallo v. Star Enterprise*.[61] Mrs. Cavallo complained she was once, for a five-minute period, within 500 feet (presumably downwind) of an AvJet aviation fuel spill, and she attributed chronic health problems to the

exposure she (and her symptomless husband) experienced. The court found no evidence of significant exposure or any correlation between her one-time exposure and her symptoms. The court noted, however:

> Also worth emphasizing is that the circumstances of each case are unique, and the absence of scientific validation through published studies and tested hypotheses is not always fatal to an expert's opinion. Specifically, there may be instances where the temporal connection between exposure to a given chemical and subsequent injury is so compelling as to dispense with the need for reliance on standard methods of toxicology.... For instance, if a known chemical is accidentally introduced into a company's ventilation system, and all of the workers exposed immediately develop the same adverse reaction, then the episode itself may be sufficiently indicative of causation.[62]

Where the opinions of the physicians are based upon standard methodologies, the *Frye/Daubert* analysis need not even be invoked:

> Here, the experts relied on air sampling, chemical analysis, examinations and questionnaires. These qualify as established scientific methods of the type relied upon by experts in the field, not novel scientific theories. Thus, we need not engage in a *Frye* analysis.[63]

The physician's taking of patient history, physical examination, and standard tests are not denigrated by the courts. Nor, for that matter, are specific epidemiological studies required. The insistence by defense experts upon double-blind, peer-reviewed, published studies of the precise exposures experienced by plaintiffs implies (incorrectly) that such information is required to be "scientific." Quite the contrary is true. In *Ferebee*, the Court of Appeals for the District of Columbia held:

> [A] cause-effect relationship need not be clearly established by animal or epidemiological studies before a doctor can testify that, in his opinion, such a relationship exists. As long as the basic methodology employed to reach such a conclusion is sound, such as the use of tissue samples, standard tests, and patient examination, products liability law does not preclude recovery until a "statistically significant" number of people have been injured or until science has had the time and resources to complete sophisticated laboratory studies of the chemical. In a courtroom, the test for allowing a plaintiff to recover in a tort suit of this type is not scientific certainty but legal sufficiency; 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. That Ferebee's case may have been the first of its exact type, or that his doctors may have been the first alert enough to recognize such a case, does not mean that the testimony of those doctors, who are concededly well qualified in their fields, should not have been admitted.

When we considered the all-important question of what evidence is *allowable* in a court of law to establish proximate cause (the cause-and-effect relationship between a toxic exposure and a given injury, for instance) we soon see that *Daubert* is the culmination of what had been a growing body of case law embracing a more sophisticated view of science than that articulated in *Frye v. United States*.[64]

In *Daubert I* (*Daubert* 1993), the Supreme Court recognized science as the product of the clash of competing theories which may be assessed by the jury on the merits — not as a body of dogma having "general acceptance" handed down from the scientific establishment, impervious to challenge by those outside.

> Nothing in the [Federal] Rules [of Evidence] as a whole or in the text and drafting history of Rule 702, which specifically governs expert testimony, gives any indication that "general acceptance" is a necessary precondition to the admissibility of scientific evidence. Moreover, such a rigid standard would be at odds with the Rules' liberal thrust and their general approach of relaxing the traditional barriers to "opinion" testimony.[65]

So long as a conclusion is reached through reasoning from scientific methods and tests, the fact that the conclusion may be controversial is not a basis for exclusion.

A trial judge determines the admissibility of evidence and the qualification of an expert to testify as a "preliminary question" in accordance with Federal Rule of Evidence 104(a). The Supreme Court in *Daubert I* called for a "preliminary assessment" of whether the testimony was "scientific knowledge" of assistance to the trier of fact.[66] The Third Circuit suggests restraint with respect to a trial court's conduct of this preliminary assessment:

> [The] judge should not exclude evidence simply because he or she thinks that there is a flaw in the expert's investigative process which renders the expert's opinions incorrect. The judge should only exclude evidence if the

> flaw is large enough that the expert lacks "good grounds" for his or her conclusions.[67]

In *Daubert I*, the Supreme Court determined that the phrase "scientific knowledge" in Federal Rule of Evidence 702 establishes a standard of evidentiary reliability.[68] Is the expert proposing to testify to (1) scientific knowledge that (2) will assist the trier of fact to understand or determine a fact in issue? "This entails a *preliminary assessment* of whether the reasoning or methodology underlying the testimony is scientifically valid and of whether that reasoning or methodology properly can be applied to the facts in issue." (Emphasis added.)[69]

These are not truly rhetorical questions. They are intended to illustrate what the Ninth Circuit stated in *Daubert II*: "Something doesn't become 'scientific knowledge' just because it's uttered by a scientist; nor can an expert's self-serving assertion that his conclusions were 'derived by the scientific method' be deemed conclusive, else the Supreme Court's opinion [in *Daubert I*] could have ended with footnote two."[70]

Many plaintiffs' cases are based upon the conclusions reached by people trying to find answers: air test companies, treating physicians, fellow workers, family members. Such individuals are motivated to find answers. By contrast, it must be recalled that the defense experts have different motivations, which are oftentimes best served by a rigid and dogmatic adherence to orthodoxy — to what has been proven to a scientific certainty — even if it means that nothing is explained.

This is why *Daubert* came to be: to permit thoughtful, scientific analysis to be considered on its merits even if it lacked the imprimatur of the scientific establishment.

The debate is that science requires more than rigid orthodoxy in order to progress. It requires rigorous and constant reexamination in order to maintain its integrity. When the defense insists upon double-blind, peer-reviewed epidemiological studies before concluding that toxic fumes sicken workers, it is, for its own purposes, twisting scientific skepticism into caricature. The defense forgets science's thirst for problem-solving innovations. It dismisses the import of these eloquent words of Sir Bradford Hill:

> All scientific work is incomplete — whether it be observational or experimental. All scientific work is liable to be upset or modified by advancing knowledge. That does not confer upon us a freedom to ignore the knowledge we already have, or to postpone the action that it appears to demand at a given time.[71]

Multiple Chemical Sensitivity Syndrome

At the outset, we described a constellation of symptoms reported by workers. This constellation is increasingly gaining recognition within the medical community as Multiple Chemical Sensitivity Syndrome (MCSS). MCSS has been defined as "an acquired disorder characterized by recurrent symptoms, referable to multiple organ systems, occurring in response to demonstrable exposure to many chemically unrelated compounds at doses far below those established in the general population to cause harmful effects."[72] Across the country, numerous workers exposed to chemicals in the workplace have reported heightened sensitivity to low levels of chemicals at work and elsewhere, and report severe illness secondary to reexposure. In Canada, the Toronto Ministry of Health Report concluded:

> While we believe that there is evidence to support the view that a significant number of persons show symptoms of environmental hypersensitivity, we are unable to make any definitive statement about the prevalence of the disorder.[73]

The scientific uncertainty respecting toxic chemical exposures and the absence of any abnormal objective findings[74] in the worker reporting symptoms of MCSS impedes the treating physician in reaching a diagnosis of occupational disease. Physicians encountering the syndrome in isolated cases, lacking objective findings and finding standard medical treatment ineffective, have reacted with frustration, ascribing the symptoms to emotional disorders, often withdrawing their support from the patient.

In a recent report to the New Jersey Department of Health, the authors note:

> Acceptance of chemical sensitivity as *bona fide* physical disease may ... be facilitated by the recognition that it is widespread in nature and is not limited to what some observers would describe as malingering workers, hysterical housewives, and workers experiencing mass psychogenic illness. We are struck by the fact that individuals in such demographically divergent groups as industrial workers, office workers, housewives, and children, report similar polysymptomatic complaints triggered by chemical exposures....
>
> Physicians who see more or less random individuals who are not members of an identifiable exposure group are less likely to recognize patterns or similarities among these patients who claim to be chemically sensitive....

> Once physicians recognize a constellation of symptoms that occur repeatedly in individuals who share similar exposure histories, the "disease" seems to change its label from "idiopathic" or "psychogenic" to a recognized disorder....[75]

Because *being believed* is of utmost importance to MCSS victims, the ability to obtain objective markers of toxic exposure becomes all the more important. Such markers may not show disease, but they may confirm that the symptoms of the patient are not fabricated, a confirmation that will help to earn the support of the treating doctor and the finder of fact, the jury.

Dr. Marks of the Department of Pharmacology and Toxicology, Faculty of Medicine, Queen's University, Kingston, Ontario, Canada, concluded that alterations of the heme biosynthetic pathway could be used as an index of exposure to a variety of toxic agents. In 1985, Dr. Marks wrote:

> The stage has now been reached where an understanding of the details of the heme biosynthetic pathway allows one to use alterations in this pathway as an index of exposure to a variety of toxic agents. The usefulness of the heme biosynthetic pathway as an indicator of exposure to toxic agents is due, at least in part, to the development in recent years of highly sensitive techniques to separate and measure porphyrins.[76]

Values on certain enzyme levels relating to the porphyrin byproducts of heme synthesis above the ninety-fifth percentile are usually evidence of disturbance of heme metabolism and can serve as a marker of toxic exposure.

MCSS exists, if not as a discrete disease, then as a clinically recognized constellation of symptoms. MCSS may not be "disproven" simply by disputes regarding its mechanism. The MCSS patient ought not to be evaluated or diminished by the "mechanism" of his or her ailment, whether it involves immunological, irritant, allergic, toxic, or psychological factors. The causation and manifestation of the ailment is likely to be multifactorial, interactive, and highly individual. That an autonomic irritant response supported by classical conditioning may account for some manifestations is not inconsistent with a toxic onset. Nor, for that matter, is evidence of derangement of metabolic function inconsistent with a psychologically mediated response. Biological systems, including human beings, are complex.

Other objective measures, such as SPECT scans and immunologic testing, may help piece together objective evidence. This evidence may help not only to establish the proximate cause needed by the courts, but to win the belief of the medical community, the lack of which has too often added insult to injury.

TORT PRINCIPLES AND WORKERS' COMPENSATION

It is important to acknowledge that the burden, however onerous, of establishing causation traditionally falls upon the plaintiff. For an injured worker, establishing a causal relationship between exposure to a novel chemical formulation and specific symptoms may constitute an insurmountable burden in the present environment of medical and scientific uncertainty, although recent shifts in the case authority will undoubtedly prove helpful. Poorly funded (often unemployed), sick, and desperate, workers suffering an occupational disease resulting from exposure to toxic chemicals in the workplace often are asked to establish, by a preponderance of the evidence (or more), the toxicity of chemicals whose effects have yet to be explored by the combined resources of industry, employer, or government agency, or to be generally recognized by the medical community.

The Washington Industrial Insurance Act (Workers' Compensation Act)[77] is based upon "a *quid pro quo* compromise between employees and employers"[78] in 1911: The employer consented to pay some claims for which it would not then have been liable under the common law in exchange for limited liability, and the employee gave up common law actions and remedies in exchange for "sure and certain relief." At the outset, the act provided basic coverage for injuries sustained in the course of employment, but specifically excluded coverage for disability resulting from occupational diseases. In 1937, the act was amended to provide compensation for disability or death caused by any one of 21 listed diseases. After a number of amendments in the intervening years, in 1961, the Legislature eliminated the list of compensable diseases and provided coverage for occupational diseases arising "naturally and proximately out of employment." When occupational diseases became compensable, the act became the exclusive remedy for employees against their employers for such diseases.[79]

The compensatory scheme has three basic elements: elimination of all

civil actions against the employer; elimination of "fault" as an issue; and limitations on recovery of damages. In exchange the employees are to receive "sure and certain relief" and compensation for certain injuries that would have been barred by the common law of 1911.

The hope of "sure and certain relief" has proved illusory. In an occupational disease claim, the injured worker may, in fact, experience legal proceedings which are greater in number, duration, complexity, and expense than in the much criticized civil justice system.[80] The compensation for certain injuries barred by the common law of 1911 is scarcely less illusory: The common law at the turn of the nineteenth century was heavily tilted towards the employer through the availability of legal defenses such as contributory negligence, the "fellow servant" rule, and assumption of risk. In a finding of contributory negligence, the worker would be deprived of any recovery if negligent in *any* degree, regardless of the extent of the employer's negligence. The "fellow servant" doctrine denied any recovery to the worker if the injury had resulted in any degree from the negligence of a fellow worker. Finally, under assumption of risk, the worker could not recover any damages if the injury was due to an inherent hazard of the job that the worker should have had recognized in advance.

All of these rules have since been eliminated as prominent, operative features of the tort system. They were, in fact, transient alterations in the common law to encourage industrialization by making the burdens on industry as light as possible.[81]

> Dangerous enterprises, involving a high degree of risk to others, were clearly indispensable to the industrial and commercial development of a new country and it was considered that the interests of those in the vicinity of such enterprises must give way to them, and that too great a burden not be placed upon them. With the disappearance of the frontier, and the development of the country's resources, it was to be expected that the force of this objection would be weakened, and that it would be replaced in time by a view that the hazardous enterprise, even though it be socially valuable, must pay its way, and make good the damage inflicted.[82]

The workers' compensation system institutionalizes the relative power of industry and the worker at that historic interval in the early 1900s when the pendulum had swung to its extreme position of promoting industrial enterprise over individual rights, in the heyday of the railroad, before trade unions and the automobile. In short, the worker to this day labors under

limitations in compensation in exchange for industry having yielded evanescent common law defenses about to be taken from it.

By contrast, the employer enjoys, under the Industrial Insurance Act, freedom from any civil action instituted by the worker even in cases of gross negligence. The principle establishing this act as the exclusive remedy for the injured worker yields only to actions against the employer for intentional injury (where the employer has the deliberate intention of producing such injury)[83] or for the tort of outrage (where the conduct is "so outrageous in character and so extreme in degree, as to go beyond all possible bounds of decency, and to be regarded as atrocious, and utterly intolerable in a civilized community").[84]

Two commentators reviewing a Florida case of two workers sexually assaulted and harassed by their supervisor on the job noted, with respect to workers' compensation laws similar to those in Washington:

> The suit was found barred by the exclusive remedy doctrine because the outrageous conduct of the supervisor could not be imputed to the employer. In its opinion, the court acknowledged that there would probably be no monetary recovery available under Workers' Compensation because the workers had not suffered any loss of wage-earning capacity. Nevertheless, the court held that the injuries arose out of the employment and were within the scope of Workers' Compensation. The exclusive remedy turned two multimillion dollar tort actions into two Workers' Compensation claims with recovery limited to actual medical expenses.[85]

Nowhere does the disparity between the civil justice system and the workers' compensation system loom larger than in the coverage for permanent disability. For loss of one eye by enucleation, the prescribed compensation as of this writing is $21,600; complete loss of hearing in one ear, $7,200; loss of all fingers except the thumb, $29,160; total bodily impairment, $90,000. Other unscheduled disabilities must be compared to percentage of total bodily impairment.[86] Death benefits are similarly limited: for a surviving spouse without children, 60 percent of the wages of the deceased worker, but not less than $185 per month, to cease upon remarriage. Burial expenses are not to exceed twice the monthly wage.[87]

The limitation on damages, accepted as central to the workers' compensation system, was recently rejected by the Washington State Supreme Court[88] in the context of civil actions as an intrusion into the province of the jury to determine damages. The effect of the limited recovery available

to workers is to reduce incentive to uncover wrongdoing: Fault is not an issue. Limitations on damages discourage aggressive pursuit of the matter. Likewise, there is limited deterrence against wrongful conduct. The maximum exposure of the employer is limited, and the company has the resources and incentive to defend the case on the issues of causation.

We would not be surprised to learn that a corporate employer would decide whether to defend or pay a claim according to which presented the lesser expense. Entering into these calculations would be the expense associated with determining the risks of exposure and taking the ambitious industrial hygiene efforts needed to safeguard thousands of workers. The greater the limitation on damages, the more reduced the employer's economic incentive to eliminate the workplace exposure or take precautionary measures.

Self-insurers under the act, rather than contributing to the state fund for accident victims, have sufficient resources to themselves cover projected costs of injuries. This system gives the employer a direct financial stake in the outcome of each compensation claim. This economic sensitivity to outcome and concomitant desire to reduce overall costs, although presently encouraging the vigor of the defense on claims, may prove to be a valuable asset in restructuring the system to accomplish the policy goals articulated by Senator Reid years ago.

Redressing the Balance

Modern tort analysis begins with the recognition that reasonable public conduct cannot be determined solely by assertion of private entitlements but depends, in part, upon policy decisions respecting cost avoidance. Oliver Wendell Holmes wrote: "If there is danger that harm to another will follow, the act is generally wrong in the eyes of the law."[89] This deceptively simple statement recognizes that the common law, outside of its historic commitment to the protection of private property rights, requires reasonable public conduct. Another noted jurist, Judge Learned Hand, held that the legal responsibility to avoid injuries to another was a function of the burden of preventative measures, the probability of injury and the gravity of the resulting injury, with liability arising if the burden of prevention is less than the product of the gravity of the resulting injury and the probability of its occurrence.[90]

It is immediately apparent that the "gravity" of the resulting injury is determined by dollars. Where, as in workers' compensation, the compensable value of injury is limited by schedule, the preventative measures reasonably undertaken by the employer based on economic factors will be similarly reduced, in effect lowering the requisite standard of care. If loss of hearing in one ear is worth $7,200 per worker, one could hardly expect protective measures significantly more costly than the compensable risk. Such risk to the employer may, in fact, be substantially offset if the costs of production are reduced by engaging in conduct which subjects workers to greater injury.[91]

The existing legal framework governing workers' compensation results in a misallocation of responsibility respecting the burden of establishing chemical toxicity. In effect, to establish causation, the worker is required to overcome a presumption of safety. If the worker fails to prove the harmfulness of the toxic exposure, the worker must bear the damages without assistance. As the standard of proof is rendered more rigorous, it becomes increasingly difficult for the worker to prevail. One author has noted that "requiring an epidemiologic standard of proof in these cases will essentially foreclose on the ability of many truly injured workers to recover any damages. The result will be to remove what apparently is one of the more potent driving forces behind workplace preventive measures."[92]

To redress the balance in favor of greater justice and reasonable accident avoidance, changes must be based upon well-established principles, starting first with the observation of Professor Calabresi: "What then are the principal goals of any system of accident law? First, it must be just or fair; second, it must reduce the costs of accidents."[93]

If the system requires injured workers to shoulder an evidentiary burden that the combined resources of government, industry, and the scientific and medical communities have been unable to meet, that system in effect allocates the cost of workplace injury to the worker. Public policy statements persuade us that this is not fair or just. More to the point, those best able to prevent injuries caused by toxic exposures are not encouraged to do so, while those powerless to avoid the injuries are largely uncompensated.

We have already seen that regulatory oversight sufficiently stringent to prevent toxic exposures is largely impracticable. There can be little doubt that the fines embodied in the Toxic Substances Control Act are insufficient to alter the incentives of the employer otherwise shielded from liability for the damages sustained by its workers. Moreover, increasing such fines,

although a laudable suggestion, is unlikely to address with sufficient sensitivity the internal economic motivations of industry and employer. Instead, we must restructure the existing legal framework to maximize incentives for accident avoidance on the part of industry, employer, and worker, without reliance upon the creation of a massive regulatory and enforcement apparatus.

Historically, theories of liability and causation have both been modified when necessary to achieve justice. Strict liability, rather than negligence, has been applied to circumstances where people exposed to injury lacked sufficient knowledge to protect themselves: For example, unseaworthiness, a species of strict liability protecting seamen from defective conditions onboard ship, creates liability in the absence of negligence on the part of shipowners, in favor of seamen. Products liability is another example, protecting the user from product defects. Such allocations of liability recognize that "potential accident victims fear pain and suffering regardless of compensation, so they will be unaffected in their choices among acts and activities by our decision whether or not to compensate them."[94] Not only are the potentially injured parties fully motivated by the desire to avoid injury, but leaving their damages uncompensated cannot enhance motivation to avoid injury: They simply do not have enough knowledge to appreciate the risks arising from technology beyond obvious apprehension. The shipowners and manufacturers, regarded as having specialized knowledge, are held strictly liable for defects, which maximizes their incentive to design safe products and to design in anticipation of foreseeable product misuses. "The purpose of such [strict] liability is to insure that the costs of injuries resulting from defective products are borne by the manufacturers rather than by the injured persons who are powerless to protect themselves."[95]

The worker exposed to toxic chemicals has virtually no way of foreseeing the risks associated with exposure, and indeed, the risks may be largely unknown, as we have seen. Unlike the consumer, the employee even lacks the choice of refraining from product use. Leaving the risk of toxic injury on the worker, where the toxicology of the chemical is unknown, cannot reduce the cost of accidents. The three routes by which the worker may be protected are increased knowledge, product selection, and industrial hygiene measures; these are exclusively within the control of the manufacturer and employer. Both manufacturer and employer may respond to economic incentives to gain knowledge respecting the effects of toxic exposures from a given product; to disseminate such knowledge to workers; to

implement workplace measures in the absence of complete knowledge; or to choose alternatives to the problematic product. The situation calls for strict liability. Such liability in the face of unprovable causation is a hollow remedy, however.

Traditional notions of causation have been modified in the past when justice so required. In *Sindell v. Abbott Laboratories*,[96] the court compromised traditional principles of causation by permitting liability based upon market share where over 200 companies had marketed the drug DES, implicated as a carcinogen, and the injured party had no way of discovering what manufacturer made the drug specifically administered to that party. In other words, establishing a strict causal relationship between a given plaintiff and a specific product or manufacturer was impossible — and held to be unnecessary.

There is precedent within the workers' compensation system to use presumptions to assist in establishing causation. For instance, under the Washington Industrial Insurance Act, there is a rebuttable presumption that respiratory disease is an occupational disease for firefighters.[97] Such a presumption for toxic exposures to workers for those symptoms identified in the material safety data sheets could address some of the impediments to establishing causation with minimal disruption to the existing compensatory scheme. Such a presumption, however, would not address the reduced motivation of employers to avoid workplace exposures as a result of the limitations on compensable damages. As it presently stands, even if the manufacturer provided the employer with complete toxicological information, the employer who routinely engaged in unsafe industrial hygiene practices in an effort to increase production or engaged in a program of product misuse could not be made to bear the full measure of damages resulting. Authorizing private civil actions by workers against employers for occupational diseases arising from toxic exposures would increase the worker's incentive to pursue litigation and heighten the risks the employer would face should the negligence continue. On the state level, the occupational disease coverage for toxic exposures could be withdrawn from the workers' compensation system. There was, after all, a time when no occupational diseases were covered by workers' compensation and a private civil action existed in its place.[98] Such an approach necessarily involves modification of the exclusive remedy provisions of the workers' compensation laws, which are central to the existing legislative scheme and which have been repeatedly and stringently upheld in Washington case authority.

In the alternative, on the federal level, a private right of action under TSCA, preempting state workers' compensation laws to the extent in conflict, could be authorized in addition to the present system of fines. Such an action could permit recovery of damages by workers for violations of TSCA, thereby easing the burden of its enforcement. Failure to comply with the industrial hygiene recommendations on the material safety data sheets could lead to the presumption of causation as to those symptoms reported on the MSDS.

Although these approaches will increase the employer's incentive to put protective measures into effect, they do not address the quantity or quality of information available to industry (upon which employers necessarily rely) because they do not motivate chemical manufacturers fully to develop toxicological data or to recommend stringent industrial hygiene measures in the absence of such data. Since toxicological data are likely to remain insufficient, we must determine who should bear the risk of the unknown consequences of exposure to unknown substances.

One of the hidden costs of the workers' compensation laws has been that, in the effort to obtain full compensation for injured workers, tort law has been stretched to expand third-party liability. Placing an affirmative duty on chemical manufacturers to assure adequate protective measures and training in the workplace would help prevent accidents. Such a duty, however, properly rests with the employer, and breach of that duty is more directly addressed by specific deterrence of wrongful acts by the employer. Nonetheless, accident avoidance would be furthered by a system in which chemical companies were required to communicate directly with the end users to assure that hazards are understood.

Without any alteration in the workers' compensation act, strict liability of chemical companies for injuries arising from toxic exposures could be restructured to place the burden of injury on the manufacturer, as the party best able to avoid the social cost of toxic exposures by thorough investigation, as well as to spread such costs by passing the expense of research and development through to its customers. Existing Washington law already creates strict liability for product manufacturers.[99] Moreover, enacted limitations on joint and several liability among joint tortfeasors arguably do not extend to cases involving hazardous substances.[100]

Modification of the existing Washington Products Liability statute could enhance worker safety. Generally, manufacturers have been permitted to interpose defenses of "state of the art" and "product misuse." These

defenses generally preclude recovery where the product is made to the highest standard presently known or has not been used as intended. Neither defense should apply against a worker injured by exposure to a toxic chemical. Toxic chemicals clearly may prove hazardous even if made to the highest level of present technology, and workers clearly have no say as to how a product is used.

Adverse health effects from exposure to "space age" chemicals and composites ought to be presumed, with the chemical manufacturer held strictly liable for such an "ultrahazardous" product. The chemical manufacturer, however, should have a claim against the employer if its product is misused or if the specifications required by the employer are such that even with "state of the art" manufacture, the product cannot be handled safely. The employer should be able to assert the defense of product defect: A product should be considered defective if its MSDS and labelling do not include specific industrial hygiene measures capable of eliminating any foreseeable adverse health effects of exposure. The claim by the manufacturer against the employer for product misuse, however, would be established if it were determined that the employer failed to institute the industrial hygiene requirements identified by the manufacturer, requirements but for which the worker would not have been injured. An employer found liable should forfeit recovery on any workers' compensation lien for employee benefits paid.

Where an employee sues a third party such as a chemical company and that company, in turn, seeks recovery against the employer, it is termed a "third-party-over" case.[101] Such cases have been held to circumvent the exclusive remedy provisions of the Industrial Insurance Act on the grounds that the act "immunizes" the employer from any liability arising from a workplace injury; the Washington Supreme Court held that legislative action would be required to permit a third party to receive contribution from the employer in the absence of an independent duty between the third party and the employer in the form of a written indemnification agreement.[102] The Legislature should act.

Streamlining claims of workers against chemical manufacturers, and in turn permitting third-party-over claims by the chemical manufacturer against the employer, would maximize the utility of the MSDS. The chemical manufacturer could recoup any damages paid to the worker, for even unknown adverse effects, by requiring industrial hygiene practices calculated to address the risk and establishing the employer's failure to comply

with them. The employer, in turn, would have incentives to comply fully with the MSDS requirements of workplace protection. Such a scheme would prevent the workers' compensation laws, intended as a shield for the workers, from being used as a shield from liability by the negligent employer who subjects the workers to risks (and profits thereby).

So long as the existing compensatory regime fails to maximize incentives for workplace safety, it unwittingly assures that the workplace will remain a "test tube" and the workers "guinea pigs." At present, the worker injured by toxic chemical exposure, which the worker is powerless to prevent, must submit to a punishing and tortuous procedure requiring a standard of proof that has eluded the grasp of employer, industry, government, science and medicine — or else go uncompensated. As Oliver Wendell Holmes put it, "A law which punished conduct which would not be blameworthy in the average member of the community would be too severe for that community to bear."[103] Such is the case here.

POST SCRIPT

In a unanimous 9–0 decision filed October 1995 in the case of *Birklid v. Boeing,* the Washington State Supreme Court, for the first time since 1922, found enough evidence to permit the question of an employer's "deliberate intention" to injure its workers to go to a jury. An injury inflicted upon a worker deliberately has always been an exception to worker's compensation permitting a direct claim against the employer. In *Birklid v. Boeing,* the State Supreme Court found that "actual knowledge" of "certain injury" and "willfully disregarding" that knowledge could constitute such deliberate intention to cause injury. The Court held, in its concluding sentence: "the blood of the worker" being "a cost of production ... no longer reflects the public policy or the law of Washington."

In *Birklid v. Boeing,* fourteen workers, supported by sworn statements and documents obtained from Boeing during nearly ten years of litigation, showed that Boeing knowingly exposed workers to toxic substances in the form of phenol formaldehyde impregnated materials (phenolic prepregs), knowing that they would be injured. In spring and summer 1987, during material research and development, an internal Boeing memorandum, after describing innumerable symptoms reported by workers including dizziness, burning eyes, and upset stomachs, stated: "We anticipate this problem to

increase as temperatures rise and production increases." The following month, the request for ventilation was denied, stating: "The odor level of the phenolic prepregs relative to other materials currently used ... does not warrant expenditure of funds for additional ventilation at this time." The material was introduced into full-scale production in August 1987. The building was freezing in the winter and, during summer months, temperatures rose to over 110 degrees. Nearly a dozen affidavits attested to workplace conditions being dramatically changed in advance of air monitoring by government agencies: cleanup was commenced, operations cut back, doors were opened, and fans brought in — just to be removed following testing. Rather than correcting the harm, the evidence offered by dozens of witnesses demonstrated a pattern of stifling worker reports of injury including discouraging the reporting of symptoms. The suit also included claims that human "experiments" had been conducted — exposing workers to chemicals while being monitored and causing them to react with violent nausea and vomiting.

Following the Supreme Court decision, Boeing and other employers lobbied the legislature to change the law so that an employer would not be liable even if it knowingly injured workers — so long as the injury occurred while advancing a business purpose. This was the same argument Boeing had advanced in the State Supreme Court unsuccessfully. After passing the State Senate, the proposed legislation was rejected by the State House in a dramatic vote involving no fewer than eight votes changing at the last minute.

Just weeks before a trial was to commence in the United States District Court in June 1997, the case was settled for an undisclosed amount. It had been ten years since the workers had first been exposed to the toxic chemicals.

References

1. S. Hrg. 101–112, "Issues Related to the Use of, and Exposure to, Various Chemicals," Hearings Before the Subcommittee on Toxic Substances, Environmental Oversight, Research and Development of the Committee on Environment and Public Works, United States Senate, March 6, 1989 (Washington: 1989).
2. S. Hrg. 101–112, p. 6.
3. S. Hrg. 101–112, pp. 55–57, 268–80.
4. S. Hrg. 101–112, pp. 56–57.
5. *See* Occupational Safety and Health Act, 29 U.S.C. Sec. 651 (1976).

6. S. Hrg. 101–112, p. 277.
7. 15 U.S.C. §§ 2601–2629 (1982).
8. S. Hrg. 101–112, pp. 235–36, 240.
9. S. Hrg. 101–112, pp. 260–61.
10. S. Hrg. 101–112, p. 266.
11. M. S. Breysse, "Industrial Hygiene Problems Associated with Recognition and Assessment of Exposure to Composites," *Applied Industrial Hygiene* (December 1989): 81–82.
12. S. E. Feinman, *Formaldehyde Sensitivity and Toxicity* (Boca Raton, Fla.: CRC, 1988), p. 28.
13. Breysse, p. 82, citing M. Bruze, "Contact Sensitizers in Resins Based on Phenol and Formaldehyde," *Acta Dermato-Venereologica Supplement 119* (1985), writes: "Researchers in Sweden reported isolating a number of contact sensitizers in resins based on phenol formaldehyde. Prior to this series of studies, only 4 sensitizers were recognized in phenol formaldehyde compounds including 2-methyl phenol, 4-methol phenol, 2, 3, 6-trimethyl phenol, and formaldehyde. Utilizing guinea pigs and humans, 11 new contact sensitizers were isolated; however, this study did not examine the possible effects of respiratory exposures."
14. S. A. Roach and S. M. Rappaport, "But They Are Not Thresholds: A Critical Analysis of the Documentation of Threshold Limit Values," *American Journal of Industrial Medicine* **17** (1990): 727–53.
15. Roach and Rappaport, p. 729, citing ACGIH, "Threshold Limit Values and Biological Exposure Indices for 1988–89" (Cincinnati, Ohio: American Conference of Governmental Industrial Hygienists, 1988).
16. Roach and Rappaport, p. 732.
17. Roach and Rappaport, p. 732.
18. Roach and Rappaport, p. 742.
19. Castleman and Ziem, "Corporate Influence on Threshold Limit Values," *American Journal of Industrial Medicine* 13 (1988): 531–59.
20. Castleman and Ziem, p. 531.
21. Castleman and Ziem, p. 556.
22. RCW 51.28.055 provides, in pertinent part, that: "Claims for occupational disease or infection to be valid and compensable must be filed within two years following the date the worker had written notice from a physician: (1) Of the existence of his or her occupational disease, and (2) That a claim for disability benefits may be filed."
23. Green, "The Paradox of Statutes of Limitations in Toxic Substance Litigation," *California Law Review* **76** (October 1988): 965.
24. Irving J. Selikoff, Keynote Address to "Occupational Health in the 1990s," *Annals of the New York Academy of Sciences* **572** (1989): 4.
25. As technology currently stands, approximation and analogy are the imperfect tools available to expedite chemical testing. The EPA employs what it terms "structure activity relationships" (SAR) and "quantitative structure activity relationships" (QSAR) as screening tools to help determine which new chemicals need to be controlled or screened. This approach involves review of existing data; analogy with data available on other related chemicals; mathematical expressions for biological activity; scientific judgment and assessment. Computer modeling, if advanced to the stage where human toxicological response could be determined without being limited by the ethical and time constraints, to which human experimentation is subject, could accelerate testing. The necessary database for such a program would undoubtedly be the crowning success of a biotechnology far ahead of anything foreseeable for decades.

26. Richard S. Cornfeld, and Michael B. Minton, "How to Defend Against an Adverse Epidemiological Study," *BNA Toxics Law Reporter*, February 8, 1989, p. 1092.
27. "Compensating Victims of Pollution: The Workers' Compensation Experience." Statement of Leslie I. Boden, Assistant Professor of Economics, Occupational Health Program and Department of Health Policy and Management, Harvard School of Public Health, Before the Subcommittee on Commerce, Transportation and Tourism of the Committee on Energy and Commerce, U.S. House of Representatives, November 22, 1983, at 6 [original emphasis].
28. Dore, "A Commentary on the Use of Epidemiological Evidence in Demonstrating Cause-in-Fact," *Harvard Environmental Law Review* 7 (1983): 429, 434.
29. 736 F.2d 1529, 1535–36 (D.C. Cir.), *cert. denied*, 469 U.S. 1062 (1984).
30. The "dose-response" relationship, which correlates extent of exposure with certain symptoms, requires precise knowledge of test techniques to determine the exposure (dermal, inhalation of vapors, particulate exposures, ingestion), it is important to recognize that "air test levels" are useless for testing routes of exposure other than respiration of vapors. It is often impossible to determine the total individual exposure. Permissible exposure limits established by the government rely heavily upon studies conducted upon white males based upon an eight-hour workday; consequently, even these guidelines for the "average" worker may not be instructive for a wide variety of workers who differ from the study cohorts by virtue of body size, gender, other characteristics relevant to physiological response, or length of workday.
31. *Brock v. Merrell Dow Pharmaceuticals, Inc.*, 874 F.2d 307 (5th Cir. 1989); *Heyman v. United States*, 506 F. Supp. 1145, 1149 (S. D. Fla. 1981). ("Given the general inability of a physician to make accurate predictions of causation without at least some reference to epidemiological studies, plaintiff's position that her illness was caused by the swine flu shot amounts to nothing more than speculation.")
32. *See, e.g.* Nace, "Standard of Proof in Drug and Toxic Tort Products Liability Cases—'Preponderence' or 'Scientific Certainty'," *Products Liability Law Journal* **1** (October 1988): 87; Cheek, "Legal vs. Medical Criteria for Determining Causation in Occupational Disease Claims," *Annals of the New York Academy of Sciences* **572** (1989): 17.
33. NIOSH *Current Intelligence Bulletin* **50** (August 1988): 2. (Quoted in Breysse, *op. cit.*, App. E.)
34. Id. at 25.
35. *Ferebee*, 1529, 1536.
36. 113 S. Ct. 2786 (1993).
37. Rule 702 provides: "If 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."
38. 66 Wn. App. 644, 661–62 (1992).
39. At 1535.
40. 77 Wn. App. 201, 216 (1995).
41. *See also Osburn v. Anchor Labs, Inc.*, 825 F.2d 908, 914–915 (5th Cir. 1987) (an expert physician's opinion on causation need not be generally accepted in the scientific community; it is the *methods* upon which the expert relies in forming his or her opinion that must be generally accepted), *cert. denied*, 485 U.S. 1009 (1988).

42. *Intalco* at 654; *Hamilton v. Dep't of Labor & Industries*, 11 Wn.2d 569, 571 (1988).
43. *Intalco* at 657–58.
44. *Intalco* at 663–64.
45. Such a case is *Grimes v. Hoffmann-LaRoche*, 907 F. Supp. 33 (D.N.H. 1995), in which the issue was whether cataracts could be caused by prescription doses of Accutane. Such a claim necessarily depends upon expert epidemiological testimony to establish causation.
46. 304 U.S. 64 (1938).
47. *Bruns* at 205.
48. *Bruns* at 205.
49. *Bruns* at 207.
50. *Bruns* at 207.
51. *Bruns* at 211–12.
52. *Bruns* at 213.
53. *Bruns* at 217.
54. Under Washington law, even with respect to medical issues, when the results of an alleged act of negligence are within the experience and observation of an ordinary lay person, the trier of fact can draw a conclusion as to the causal link without resort to expert testimony. *Riggins v. Bechtel Power Corp.*, 44 Wn. App. 244, 254, 722 P.2d 819 (1986); *Bennett v. Department of Labor & Industries*, 95 Wn.2d 531, 533, 627 P.2d 104 (1981); *Sacred Heart Medical Center v. Carrado*, 92 Wn.2d 631, 600 P.2d 1015 (1979).
55. The Court of Appeals in *Bruns*, 77 Wn. App. at 212, refused to distinguish *Intalco* as dealing with workplace conditions rather than design defects as urged by the defense holding.
56. *Intalco,* at 660.
57. 115 Idaho 1087, 1095, 772 P.2d 725 (Ct. App. 1989).
58. *Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 43 F. 3d 1311 (9th Circuit), *cert. denied*, 116 S. Ct. 189 (1995).
59. *Daubert* (1995) at 1314.
60. It must be recalled that the air testing conducted by the defense will often fail to replicate the conditions of exposure either because of the alteration of conditions or the passage of time. This must be likened to testing the "reverse" side of the plate in the investigation of food poisoning.
61. 892 F. Supp. 756 (1995).
62. *Cavallo* at 773-74.
63. *Bruns* at 216.
64. 293 F. 1013 (D.C. Cir. 1923). See *Ferebee*; *Osburn v. Anchor Labs, Inc.*, 825 F. 2d 908, 914–15 (5th Cir. 1987) *cert. denied*, 485 U.S. 1009 (1988); and *Intalco*.
65. *Daubert* (1993) at 2790.
66. *Daubert* (1993) at 2796.
67. *Paoli R.R. Yard PCB Litigation*, 35 F.3d 717, 746 (1994).
68. *Daubert* (1993) at 2796.
69. *Daubert* (1993) at 2796.
70. *Daubert* (1995) at 1315–16.
71. A. B. Hill, "The Environment and Disease: Association or Causation?" *Proceedings of the Royal Society of Medicine* 58 (1965): 295–300.
72. Mark R. Cullen, "The Worker with Multiple Chemical Sensitivities: An Overview," *Occupational Medicine: State of the Art Reviews* **2**, no. 2 (October-December 1987): 655, 657.

73. "Report of the Ad Hoc Committee on Environmental Hypersensitivity Disorders," Office of the Minister of Health, Toronto, Canada, 1985, p. 233.
74. "Report of the Ad Hoc Committee," p. 18; Cullen, p. 657.
75. Ashford and Miller, "Chemical Sensitivity: A Report to the New Jersey State Department of Health," December 1989, pp. ii–iv, 13.
76. G. S. Marks, "Exposure to Toxic Agents: The Heme Biosynthetic Pathway and Hemoproteins as Indicator," *CRC Critical Reviews in Toxicology* **15**, no. 2 (1985): 151.
77. RCW 51.04.010 *et seq.*
78. *Wolf v. Scott Wetzel Services*, 113 Wn.2d 665, 668 (1989); *McCarthy v. Department of Social and Health Services*, 110 Wn.2d 812, 816 (1988); *Sterz v. Industrial Insurance Commission*, 91 Wash. 588, 590 (1916).
79. *McCarthy*, at 816; RCW 51.16.16.040; RCW 51.32.180.
80. In a recent lead poisoning case, the author undertook representation of the worker in 1989 just prior to the commencement of trial before the Board of Industrial Insurance Appeals. The worker had been poisoned between 1980 and 1984. The board reversed the determination of the Department of Labor and Industries denying the existence of an occupational disease. Such a result may be appealed to a *de novo* trial before the Superior Court jury on the transcript (RCW 51.52.115). After exhaustion of all appeals through the judicial system, if the finding of the board reversing the department's order is upheld, the matter will be remanded to the department for determination of the extent of disability and appropriate compensation. The jurisdiction of the board on appeal is limited to the scope of the department order denying the existence of an occupational disease (*Lenk v. Department of Labor and Industries*, 3 Wn. App. 977, 982 [1970]). The department's determination of disability will then be subject to repetition of the appellate review outlined above. In the civil justice system, determination of both liability and damages would occur simultaneously in a single proceeding.
81. M. Horwitz, *The Transformation of American Law 1780–1860* (Cambridge, Mass.: Harvard University Press, 1977). For instance, in the early nineteenth century it was accepted that the master was responsible to all injured parties for the acts of his servant.
82. Prosser, *Law of Torts*, 4th edition (St. Paul: 1971), at 509.
83. RCW 51.24.020; *See Foster v. Allsop Automatic, Inc.*, 86 Wn.2d 579, 584 (1976).
84. *Guffey v. State*, 103 Wn.2d 144, 146 (1984), quoting *Grimsby v. Samson*, 85 Wn.2d 52, 59 (1975). *See also Wolf v. Scott Wetzel Services,* 113 Wn.2d 665, 678 (1989).
85. DeCarlo and Minkowitz, "Workers' Compensation and Employers' Liability Law: National Developments and Trends," *Zippy Mart, Inc.*, 470 So.2d 720 (Fla. Dist. Ct. App. 1985).
86. RCW 51.32.080.
87. RCW 51.32.050.
88. *Sofie vs. Fibreboard Corp.*, 112 Wn.2d 636 (1989).
89. Holmes, *The Common Law* (Boston: 1881, 1923), p. 162.
90. *United States v. Carroll Towing Company,* 159 F.2d 169 (2d Cir. 1947).
91. On an individual level, it is the equivalent of a driver choosing to drive without a pollution control device where the use of such a device reduces gas mileage 30 percent, the fine is only $50, and the chance of citation is small.
92. Ozonoff, "Medical and Legal Causation," *Annals of the New York Academy of Sciences* **572** (1989): 23, 25.
93. G. Calabresi, *The Costs of Accidents: A Legal and Economic Analysis* (New Haven and London: Yale University Press, 1970), p. 24.

94. Calabresi, p. 22, n. 5.

95. *Greenman v. Yuba Power Products, Inc.*, 59 Cal.2d 67, 27 Cal. Rptr. 697, 377 P.12d 897 (Cal. 1963).

96. 607 P.2d 924 (Cal. 1980).

97. RCW 51.32.185.

98. *McCarthy v. Department of Social and Health Services*, 110 Wn.2d 812, 817 (1988); *Pellerin v. Washington Veneer Co.*, 163 Wash. 555, 558–59 (1931); *Depre v. Pacific Coast Forge Col*, 145 Wash. 263, 264 (1927).

99. RCW 7.72.030.

100. RCW 4.22.070(3)(a) provides: "Nothing in this section affects any cause of action relating to hazardous wastes or substances or solid waste disposal sites."

101. DeCarlo and Minkowitz, pp. 522–23.

102. *Glass v. Stahl Specialty Co.*, 97 Wn.2d 880 (1982); *Jones v. Robert E. Bayley Construction Co.*, 36 Wn. App. 357 (1984).

103. Holmes, p. 50.