Fall 1993

Proportional Liability: Statistical Evidence and the Probability Paradox

David A. Fischer
University of Missouri School of Law, fischerd@missouri.edu

Proportional Liability: Statistical Evidence and the Probability Paradox

*David A. Fischer**

I. INTRODUCTION

Numerous writers have proposed modifying traditional tort rules[1] to permit plaintiffs to recover from a defendant who contributed to the risk of causing the plaintiff's harm without proving that the defendant actually caused the harm.[2] These proposals would determine recovery

* James Lewis Parks Professor of Law, University of Missouri-Columbia. B.A., 1965, J.D., 1968, University of Missouri-Columbia. The Author gratefully acknowledges the assistance of the following persons who read early drafts of the manuscript and provided helpful comments: David W. Barnes, R. Wilson Freyermuth, Jr., Dr. Michael L. Lefevre, Peter Mueser, Jerome Organ, David F. Partlett, Philip G. Peters, William Powers, Jr., and Leonard L. Riskin. I also thank participants in the faculty colloquium at the University of Missouri-Columbia. The work on this Article was supported by a grant from the University of Missouri Law School Foundation.

1. See discussion in text accompanying note 11.

2. See, for example, Samuel D. Estep, *Radiation Injuries and Statistics: The Need for a New Approach to Injury Litigation*, 59 Mich. L. Rev. 259 (1960); Daniel A. Farber, *Toxic Causation*, 71 Minn. L. Rev. 1219 (1987); William M. Landes and Richard A. Posner, *Tort Law as a Regulatory Regime for Catastrophic Personal Injuries*, 13 J. Legal Stud. 417 (1984); John Makdisi, *Proportional Liability: A Comprehensive Rule to Apportion Tort Damages Based on Probability*, 67 N.C. L. Rev. 1063 (1989); Glen O. Robinson, *Probabilistic Causation and Compensation for Tortious Risk*, 14 J. Legal Stud. 779 (1985); David Rosenberg, *The Causal Connection in Mass Exposure Cases: A "Public Law" Vision of the Tort System*, 97 Harv. L. Rev. 851 (1984); Gregory L. Ash, Comment, *Toxic Torts and Latent Diseases: The Case for an Increased Risk Cause of Action*, 38 U. Kan. L. Rev. 1087 (1990); David P.C. Ashton, Comment, *Decreasing the*

by multiplying the plaintiff's total damages by the percentage chance that the defendant caused the damages, thereby giving her a portion of her damages.

Although these proposals for proportional liability take many forms, they may be divided into three major categories. The "proportional damage recovery" category would permit a plaintiff to recover a portion of her damages only after she has suffered the injury or acquired the disease.[3] Thus, if a defendant created a twenty percent probability of having caused the harm, an injured plaintiff would recover twenty percent of her damages. If a defendant created a sixty percent probability of having caused the harm, the plaintiff would recover sixty percent of her damages.

By contrast, the "proportional risk recovery" category would permit a plaintiff to recover a portion of her prospective damages before she has been injured or made ill. Thus, if a defendant exposed ten persons to a toxin that created a ten percent risk of causing a certain disease in the future, each exposed person would recover ten percent of her prospective damages in advance.[4]

Under the third category of "insurance fund proportional risk recovery," plaintiffs also would sue before injury. A judgment for a plaintiff would require the tortfeasor either to set aside an amount equal to the exposure victims' prospective damages in an insurance fund[5] or to buy insurance.[6] Money from the fund, or proceeds from the insurance policy, would later go to those exposed persons who actually contracted the illness or injury.

Problems of proof associated with modern toxic tort cases represent the primary impetus for these proportional liability theories. In

---

Risks Inherent in Claims for Increased Risk of Future Disease, 43 U. Miami L. Rev. 1081 (1989); Brent Carson, Comment, *Increased Risk of Disease from Hazardous Waste: A Proposal for Judicial Relief*, 60 Wash. L. Rev. 635 (1985); Steve Gold, Note, *Causation in Toxic Torts: Burdens of Proof, Standards of Persuasion, and Statistical Evidence*, 96 Yale L. J. 376 (1986); Dwight C. Harvey, Comment, *Epidemiologic Proof of Probability: Implementing the Proportional Recovery Approach in Toxic Exposure Torts*, 89 Dickinson L. Rev. 233 (1984); Barton C. Legum, Note, *Increased Risk of Cancer as an Actionable Injury*, 18 Ga. L. Rev. 563 (1984); David S. Pegno, Note, *An Analysis of the Enhanced Risk Cause of Action (or How I Learned to Stop Worrying and Love Toxic Waste)*, 33 Vill. L. Rev. 437 (1988).

3. American Law Institute, Reporters' Study, 2 *Enterprise Responsibility for Personal Injury, Approaches to Legal and Institutional Change* 369-75 (American Law Institute, 1991); Makdisi, 67 N.C. L. Rev. at 1064-65 (cited in note 2); Harvey, 89 Dickinson L. Rev. at 235 (cited in note 2).

4. Landes and Posner, 13 J. Legal Stud. at 428-30 (cited in note 2); Rohinson, 14 J. Legal Stud. at 779 (cited in note 2); Rosenberg, 97 Harv. L. Rev. at 885-87 (cited in note 2); Legum, 18 Ga. L. Rev. at 563 (cited in note 2).

5. Estep, 59 Mich. L. Rev. at 281-98 (cited in note 2).

6. Ash, 38 U. Kan. L. Rev. at 1105-07 (cited in note 2); Ashton, 43 U. Miami L. Rev. at 1119-39 (cited in note 2); Carson, 60 Wash. L. Rev. at 649-50 (cited in note 2).

such cases, there is often insufficient particularistic evidence to show causation. Therefore, plaintiffs commonly rely on epidemiological evidence instead. Frequently, this evidence will show a less than fifty percent chance that a particular toxin caused a plaintiff's harm. Under traditional rules, the plaintiff would not be able to make a case based on such statistical evidence. Proportional liability would permit limited recovery in such cases, and most commentators would limit proportional liability to cases of this type.[7] They would not apply it, for example, to hold a negligent driver liable for nearly having an accident.

Three major policies underlie tort liability: deterrence, compensation, and corrective justice. A primary justification for proportional liability is its alleged superiority in advancing the tort policy of deterrence. This Article demonstrates a significant flaw in this claim by showing that the use of tort liability in multiple cause cases involving statistical evidence in fact serves the policy of deterrence quite poorly. Tort liability fails to serve the deterrence policy because of a characteristic inherent in statistical evidence referred to in this Article as the "probability paradox." The Article shows that the paradox arises because probability is a relative concept, varying as background risks change. As a result, tort law induces people to use less care as the environment becomes more dangerous. The Article illustrates how this paradox undermines deterrence in such cases, whether proportional liability is used or not, and how switching to proportional liability may not produce heightened overall deterrence. The Article further analyzes the extent to which proportional liability advances the tort policies of corrective justice and compensation. The Article points out that the use of statistical evidence also impairs the ability of proportional liability to advance these policies. In short, the Article questions the viability of this novel theory considering its limited ability to achieve tort law goals.

II. DETERRENCE AND THE PROBABILITY PARADOX

The economic argument for proportional liability claims that it enhances the deterrent value of tort law.[8] Professor David Rosenberg has described the economic theory of tort law in general as follows:

> Accidents waste productive resources, both human and capital. The most obvious costs of accidents are the losses resulting from personal injury. But there is

7. See, for example, Robinson, 14 J. Legal Stud. at 796-97 (cited in note 2). But see Makdisi, 67 N.C. L. Rev. at 1064 (cited in note 2) (advocating a system of proportional damage recovery that applies to all cases, not just toxic tort cases).

8. Christopher L. Callahan, *Establishment of Causation in Toxic Tort Litigation*, 23 Ariz. St. L. J. 605, 657 (1991); Farber, 71 Minn. L. Rev. at 1239 (cited in note 2); Rosenberg, 97 Harv. L. Rev. at 876-77 (cited in note 2).

another category of accident costs: the costs of avoiding accidents, which include not only investments in safety, but also reductions in the rate of production or consumption. On the assumption that a dollar of injury loss has the same disutility as a dollar of avoidance cost, utilitarian theory suggests that minimizing the sum of accident costs will maximize social welfare.

With perfect information, the government could achieve this goal by direct regulation. But because information is costly and regulation under conditions of uncertainty may be less efficient than leaving control of risk to the market, society has continued to rely on the tort system to provide "general deterrence." The threat of tort liability should induce rational actors to take "optimal care"—that is, to reduce the chance of accidents to the point at which the cost of any further accident prevention measures would exceed the injury losses they would prevent. Optimal care thus minimizes the sum of accident costs. Optimal deterrence of tortious conduct—of inefficient risk-taking—is the system's dominant utilitarian function.[9]

According to this theory, tort liability induces actors to use optimal care under both negligence liability and strict liability. The following hypothetical illustrates this function:

A product manufacturer sells a machine without a safety guard. There is a one in one thousand chance (one-tenth percent) that over the life of the machine a worker will be injured in an accident that the guard would have prevented. The average damage suffered by a worker in such an accident is $100,000.

Under the law of negligence, the manufacturer would be liable for all injuries caused by the lack of a guard if each guard costs less than $100. The law imposes liability because the cost of the accident prevention measure (the guard) is less than the anticipated $100 injury loss ($100,000 in damages multiplied by the one-tenth percent chance that the damages will occur). If the guard costs $100 or more, the manufacturer would not be negligent because the cost of the accident prevention measure equals or exceeds the anticipated injury loss. Thus, negligence law achieves optimal economic deterrence because the manufacturer only takes the accident prevention measure when it costs less than the accidents it would prevent.

Strict liability achieves the same result. If the guard costs less than $100, the law induces the manufacturer to equip the machine with the guard as a cheaper alternative than paying for the anticipated injury loss. If the guard costs more than $100, the law will induce the manufacturer to sell the machine without the guard because it is cheaper to pay the anticipated injury loss than to pay for the guard.

If one assumes perfect information, proportional liability produces the same result. Under proportional risk recovery, for example, each worker exposed to the risk of injury because of the absence of the guard would receive her anticipated damages discounted by the chance that she would not be injured. These damages would add up to $100 per

9. Rosenberg, 97 Harv. L. Rev. at 861-62 (cited in note 2).

machine, giving the manufacturer the same incentive to guard the machine as under the common-law all or nothing rule.[10]

Proportional liability proponents claim that two traditional rules undermine the deterrent value of tort law in cases involving multiple potential causes of harm. One rule requires plaintiffs to prove that causation is more probable than non-causation. Another rule grants plaintiffs full recovery if they meet this standard of proof and no recovery if they fail to meet it. In many toxic tort cases, a defendant's conduct creates a less than fifty percent risk of harming any person exposed to the toxic substance, and it is impossible to determine whether any given individual contracted the disease from exposure to the toxin or from some other source. These traditional rules would permit defendants in such cases to escape all liability, leaving them significantly underdeterred.[11] Similarly, in some toxic tort cases a defendant's conduct creates a greater than fifty percent risk of causing illness. Under traditional rules, defendants in such cases would be liable for more harm than they actually caused and would be significantly overdeterred.[12] If a defendant's toxic release created a sixty percent risk of causing cancer in people exposed to the toxin, therefore, the defendant would have caused cancer in only sixty out of one hundred exposed people who contracted cancer. Under the more probable than not standard, however, the defendant would be liable to all one hundred cancer victims exposed to the toxin for one hundred percent of their damages.[13]

---

10. Under proportional damage recovery each injured worker would receive 100% of her damages because the hypothetical assumes a 100% probability that the guard would have prevented the harm. Thus, assuming perfect information, and in the absence of competing causes, proportional damage recovery yields the same result as the all or nothing rule in this hypothetical.

11. Makdisi, 67 N.C. L. Rev. at 1070 (cited in note 2); Robinson, 14 J. Legal Stud. at 784 (cited in note 2).

12. Estep, 59 Mich. L. Rev. at 279 (cited in note 2); Makdisi, 67 N.C. L. Rev. at 1070-71; Rosenberg, 97 Harv. L. Rev. at 880-81 (cited in note 2).

13. In theory, holding a defendant liable for more harm than it caused does not produce overdeterrence in negligence cases. Under the law of negligence, an actor can avoid all liability by spending the optimal amount on accident avoidance measures. Assume in the above example that the damages in each of the 100 cancer cases were $1,000,000. Since the actor's conduct risked causing only 60 cases, it would not be negligent if it spent $60,000,000 for accident avoidance measures. Thus, because it can avoid $100,000,000 in damages by spending $60,000,000 in accident avoidance measures, it has no incentive to spend more than $60,000,000.

In practice this may not be true because there are substantial elements of strict liability in negligence cases. Steven Shavell, *An Analysis of Causation and the Scope of Liability in the Law of Torts*, 9 J. Legal Stud. 463, 489 (1980). See also William M. Landes and Richard A. Posner, *The Economic Structure of Tort Law* 236-37 (Harvard U., 1987). Defendants often are held liable under the law of negligence even though they use, or attempt to use, due care. This is because errors frequently are made in finding facts, in determining appropriate levels of care, and in formulating due care standards. Shavell, 9 J. Legal Stud. at 489. If there is a significant risk that the jury will hold the actor liable for failing to spend more than the optimal amount on accident

In theory, proportional liability would tailor the remedy precisely so that a given defendant would be held liable for the exact amount of harm it caused.[14] Thus, the defendant arguably should have the precise economic incentive to use due care.[15]

This argument for proportional liability is fundamentally flawed in cases involving multiple potential causes of the plaintiff's harm. Neither the common-law approach nor proportional liability correctly signals how much the defendant should invest in safety. Their inability to promote adequate safety investment occurs because probability is a relative concept; probability changes dramatically as background risks vary. Yet, these changes may not rationally be related to the amount of care that society wants an actor to use.

The etiology of many diseases caused by toxic substances is poorly understood.[16] In toxic tort cases, therefore, it is easy to confuse the problems arising from causal uncertainty with the problems arising from relativity of risk. To avoid this confusion, this Article first illustrates the point about relativity of risk by using non-toxic tort examples in which causation is clear. The examples involve sporadic accidents in which particularistic evidence is at least potentially available. Many advocates of proportional liability would not apply the theory in such cases;[17] therefore, the Article uses additional examples to show that the problems arising from the relativity of risk also occur in toxic tort cases involving multiple causes when particularistic evidence is unavailable.

The first sporadic accident example involves a single potential cause of harm:

> Defendant negligently fails to remove a land mine from a road. This mine has a special feature that causes it to lose its detonation capacity within one month of being activated. Because of its position in the road, the amount of traffic, and the possibility that a wild animal will step on the mine and detonate it, the mine creates only an eighty percent chance of killing a motorist who drives down the road during the one month when the mine is functional. If the motorist is killed, the damages will be $1,000,000.

If the driver hits the mine, the defendant would pay one hundred percent of the plaintiff's damages. If the defendant's conduct produces no compensable harm, the defendant would pay nothing. In effect, tort law

---

avoidance, then the negligence cause of action will produce the same incentive as the strict liability cause of action.

14. Rosenberg, 97 Harv. L. Rev. at 881 (cited in note 2) (stating that proportional liability "holds the wrongdoer accountable for neither more nor less than the injury losses fairly attributable to the wrongdoer's conduct").

15. Makdisi, 67 N.C. L. Rev. at 1071, 1073 (cited in note 2); Rosenberg, 97 Harv. L. Rev. at 866; Legum, 18 Ga. L. Rev. at 577, 582-83 (cited in note 2).

16. Callahan, 23 Ariz. St. L. J. at 616-17, 624-25 (cited in note 8); Farber, 71 Minn. L. Rev. at 1227-28 (cited in note 2).

17. See note 7 and accompanying text.

provides the defendant with an economic incentive to invest up to $800,000 to prevent this accident ($1,000,000 in damages multiplied by an eighty percent chance that a person will be killed).

Modifying the example to make it into a multiple cause case significantly alters the defendant's incentive to use due care:

> Assume that nine other people also carelessly fail to remove nine other identical land mines from the same stretch of road. With ten mines in the road, the risk that a driver will be killed is now virtually one hundred percent. The risk that any given mine will kill him, however, is only ten percent. Additional drivers are not likely to be killed because the danger will become evident after the first accident, and drivers will stop using the road until the one month danger period has expired. A driver hits a mine and is killed. The death causes $1,000,000 in damages. No particularistic evidence is available to show whose mine he hit.

Under proportional liability, the defendant would be held liable for $100,000 because the probability that he caused the $1,000,000 in damages is ten percent. Thus, proportional liability gives the defendant a $100,000 incentive to remove the mine. If ninety-nine other people had left ninety-nine other such mines in the road, the defendant would be liable for $10,000 because the probability that he caused the death is one percent. Correspondingly, he would have a $10,000 incentive to remove the mine.

The common-law all or nothing rule produces the same incentives if the defendant knows about the other mines and believes that it will be possible to identify the owner of the mine that caused the harm. With ten mines in the road, the rule provides the defendant with an economic incentive to invest up to $100,000 to prevent this accident ($1,000,000 in damages multiplied by a ten percent chance that the driver will be killed by the defendant's mine). If there are ninety-nine other mines in the road, the defendant has a $10,000 incentive to prevent the accident ($1,000,000 in damages multiplied by a one percent chance that the driver will be killed by the defendant's mine).

In the first and second variations of the hypothetical, the defendant's incentive to use care is reduced significantly compared to the original hypothetical. The bare statistics create the impression that the risk decreased in the first and second variations because the defendant's omission became less dangerous. This impression is misleading because it views risk solely from the defendant's perspective. In the second variation, viewed from the vantage point of the driver about to enter the mine field, the defendant's conduct is no less dangerous than it was in the original example. The defendant also needs no less deterrence.

Proportional liability advocates believe that in the first variation of the example, the defendant must be liable for ten percent of the plaintiff's damages to be deterred properly. In the second variation, however, he need only be liable for one percent to have a sufficient economic

incentive to refrain from the conduct. Common sense rebels at this notion because the defendant's conduct was exactly the same in both cases. The risk decreased only from the defendant's perspective. Significantly, the risk did not diminish because the defendant's conduct became intrinsically less dangerous; rather, it decreased only because the possibility increased that another wrongdoer would kill the plaintiff before the defendant could. This phenomenon shall be referred to as the "latency factor." In the example above, this largely fortuitous factor probably should not control the proper size of the penalty required to regulate the defendant's antisocial conduct.

A toxic tort example illustrates the same point about relativity of risk arising from the latency factor. Professor Samuel Estep used the following example based on census figures:

> If 100,000 people were exposed to a dose of radiation sufficient to cause 143 leukemia deaths over a twenty year period, only 107 would actually die of leukemia. Not all would die of leukemia hecause thirty-six of the potential leukemia victims first would have died of other causes.[18]

Under proportional liability theory, the tortfeasor who caused the radiation exposure would be liable for the damages caused by 107, rather than 143, leukemia deaths.[19] Otherwise, according to the theory, the law would induce the tortfeasor to spend too much money to protect against the risk of exposing the public to radiation.

The latency factor actually operates in all cases involving death or permanent disability, including those not normally regarded as multiple cause cases. This factor operates because tort damages are calculated on the basis of the victim's earning capacity and projected life span, thereby holding the defendant liable only for the loss of earnings that would have occurred between the time of death or disability and the time when the victim would have died from another cause. Mortality tables determine the time of death from the other cause. Thus, if the defendant kills a young person in mid-career, the damages from lost income will be substantial. If the defendant kills an elderly person, however, the damages will be smaller. Ignoring these alternative potential causes of death would lead to the assumption that the victim would have lived forever. The defendant, therefore, would be liable for the wages that could have been earned in a life of infinite duration. In effect, awarding compensation to a plaintiff for only the portion of damages that an alternative cause would not have produced limits a defendant's liability. In a sense, all such cases impose a form of proportional liability. The relative nature of risk reduces the defendant's lia-

18. Estep, 59 Mich. L. Rev. at 275-79 & 276-77 n.52 (cited in note 2).
19. Id. at 283.

bility in proportion to the extent that other causes have shortened the victim's life expectancy. People who are most at risk from these alternative potential causes of death receive the smallest damage awards.

The difference between the standard death or permanent disability case and the proportional liability case arises from the timing of the other potential causes of harm. In the standard case, the law discounts the damages for which the tortfeasor is liable by the possibility that another cause of death would have taken effect *after* the tortfeasor's cause took effect. In the proportional liability case, the law discounts the damages for which the tortfeasor is liable by the chance that another cause of harm actually took effect *before* the tortfeasor's cause would have taken effect.

In a broader sense, all non-death cases awarding compensation for lost wages are multiple cause cases affected by the latency factor. If the defendant tortiously disables the plaintiff for six months, she will have to compensate the plaintiff for six months of lost earning capacity. That lost capacity will be greater if the plaintiff is a surgeon than if she is a custodian. The circumstances that cause the plaintiff to be a custodian rather than a surgeon are causes operating independently of the defendant's actions. The law gives the defendant the full advantage of these causes by requiring that she compensate an injured custodian only for the lost earning capacity of a custodian. The tort penalty for injuring a person therefore is greatly affected by the victim's age or occupation because the defendant may reduce her liability by the amount that concurring causes reduce the plaintiff's earning capacity. By contrast, in criminal law, which is also concerned with deterrence, the penalty for homicide or assault is not affected by the victim's age or occupation.

In the previous examples, the relativity of risk phenomenon occurred because of the latency factor. The same phenomenon can operate, however, even when none of the potential causes affects the chances that the other potential causes will take effect. The same phenomenon can occur, for example, whenever a jury decides a case on the basis of bare statistical evidence that correlates poorly with actual risk.

The following example, which involves multiple potential causes occurring simultaneously, demonstrates this:

> Defendant hunter and one other hunter each fire a shotgun in plaintiff's direction. Plaintiff is hit in the eye by one pellet and is blinded. It is impossible to determine from which gun the pellet came.[20]

On the basis of statistical evidence alone, there is a fifty percent chance that the defendant shot the plaintiff. If nine other hunters had fired in

20. This example is based on *Summers v. Tice*, 33 Cal. 2d 80, 199 P.2d 1 (1948).

the plaintiff's direction at the same time as the defendant, there would be a ten percent chance that the defendant shot the plaintiff. If there had been ninety-nine other hunters, the chance that the defendant shot the plaintiff would be one percent. Under proportional liability, the defendant will be liable for fifty percent, ten percent, or one percent of the plaintiff's damages, depending on whether the other hunters numbered one, nine, or ninety-nine.

In this hypothetical, the number of other hunters affects the absolute risk of harm to the plaintiff. The number, however, has no effect on the risk that the defendant will hit the plaintiff. There is no effect because the harm from the conduct of all hunters took place, or failed to take place, simultaneously. The defendant either hit the plaintiff or missed the plaintiff. If the defendant missed the plaintiff, he caused no loss. If the defendant hit the plaintiff, he caused the entire vision loss. This statement would be true even if the plaintiff's eye had been hit by several pellets from other hunters. Under the twin-fires rule, the defendant would be fully liable for the harm that his pellet was sufficient to cause, even if the conduct of other actors also was sufficient to cause the same loss.[21]

Under proportional liability, the change in the defendant's liability occurs only because probability is a relative concept. It does not occur because the defendant's conduct is more dangerous when he is a member of a small hunting party than when he is a member of a large one. Thus, the statistical evidence presented says nothing about the defendant's marksmanship. The risk that the defendant's pellet would hit the plaintiff may have been the same in all three cases. That risk depended on factors such as the type of shotgun and shot that the defendant used, the spread pattern produced by the shotgun, the distance from the defendant to the plaintiff, and where the defendant aimed the gun. We do not know the extent of risk because we have a dearth of information concerning these relevant points. The number of hunters provides the basis for deciding the case only because of this evidentiary vacuum. If particularistic evidence were available showing which hunter hit the plaintiff, a jury would hold him liable for all harm and exonerate all other hunters. Because risk is relative, however, basing proportional liability on the inferior statistical evidence produces a perverse result. The defendant's incentive to use care diminishes as the situation becomes more dangerous, even though the defendant's conduct does not become less dangerous.

---

21. See, for example, *Kingston v. Chicago & N.W. Ry. Co.*, 191 Wis. 610, 211 N.W. 913 (1927) (holding a defendant who negligently started a fire that merged with another fire and destroyed the plaintiff's property liable even though its fire was not a "but for" cause of the harm).

The following series of illustrations shows that similar distortions in liability can occur due to the relative nature of risk, even if good information exists about risk. The first illustration involves a single potential cause of harm:

> An armed assassin with one bullet shoots at a diplomat. The assassin is a poor shot and has only a thirty percent chance of hitting the diplomat.

Here it is necessary to make a distinction between the pre-injury risk of causing harm and the post-injury probability that the actor caused the harm. Proportional risk recovery compensates on the basis of the former;[22] proportional damage recovery compensates on the basis of the latter.[23] If the diplomat is killed by a bullet, the post-injury probability that the assassin killed her is virtually one hundred percent because there is no evidence of any other possible source of the fatal bullet. If the bullet misses, the post-injury probability of harm is zero because no harm occurred. The pre-injury risk of causing death, however, is always thirty percent. This risk remains unchanged whether the bullet hits or misses. Thus, proportional risk recovery would always award thirty percent of prospective damages. Proportional damage recovery would award either one hundred percent or zero percent, depending on whether the diplomat was hit by a bullet and killed.

Modifying the example to make it into a multiple cause case significantly alters the percentages:

> Seven armed assassins, each acting independently and each with one bullet, simultaneously shoot at a diplomat. Because of poor aim, each assassin has only a thirty percent chance of hitting the diplomat. The damages will be $1,000,000 if the diplomat is killed.

With seven assassins, a ninety-two percent chance exists that the diplomat will be hit by at least one bullet.[24] Assume the diplomat is hit by one bullet and compensation is awarded on the basis of proportional damage recovery. Each assassin would be liable for fourteen and three-tenths percent of the damages because there is a fourteen and three-tenths percent post-injury probability that any given assassin hit her. This figure is derived by dividing the one hundred percent probability that the diplomat was hit by the number of assassins (seven) because

---

22. Robinson, 14 J. Legal Stud. at 783 (cited in note 2).

23. Reporters' Study, *Approaches to Legal and Institutional Change* at 373 n.46 (cited in note 3); Makdisi, 67 N.C. L. Rev. at 1070-72 (cited in note 2); Glen O. Robinson, *Multiple Causation in Tort Law: Reflections on the DES Cases*, 68 Va. L. Rev. 713, 759 (1982).

24. The chance that the diplomat would not be hit hy any bullet is .70 x .70 x .70 x .70 x .70 x .70 x .70 = .0823543, or approximately 8%. If there is an 8% chance that the diplomat will not be hit by any bullet, then there is a 92% chance that the diplomat will be hit by at least one bullet. See Sam Kash Kachigan, *Statistical Analysis: An Interdisciplinary Introduction to Univariate & Multivariate Methods* 122 (Radius, 1986).

each of the assassins is equally likely to have hit her. So far the case does not differ from the hunter hypothetical discussed previously. Liability is based on post-injury probability, but the evidence of this probability is unsatisfactory for the reasons discussed above. Solving this problem requires particularistic evidence of causation.

Assume, however, that the diplomat is not hit and that she seeks compensation on the basis of proportional risk recovery. This variation differs from the hunter hypothetical because the court will impose liability on the basis of pre-injury risk, about which the court has good information. The court is faced with two alternatives by which to determine pre-injury risk. The first approach is to rule that each assassin created a thirty percent pre-injury risk of shooting the diplomat. This leads to the absurd conclusion that the assassins collectively created a 210 percent risk of killing the diplomat, a statistical impossibility. This approach would permit the diplomat to recover $2,100,000 in prospective damages (each of the seven assassins will pay $300,000, or thirty percent of the $1,000,000 prospective damages), even though the actual damages would have been only $1,000,000 if she had been killed. Furthermore, this approach creates perverse incentives. If the diplomat lives, each assassin's liability under proportional risk recovery would be $300,000. As stated above, if the diplomat dies, each assassin's liability under proportional damage recovery would be $143,000. Thus, each assassin's potential liability more than doubles in the event that the bullet misses its mark. This creates an added incentive for the assassins to aim with care and kill the diplomat.

The second approach to determining pre-injury risk is to divide the ninety-two percent pre-injury risk that the diplomat will be killed by the number of assassins on the theory that each assassin contributed equally to that risk. Under this approach, each of the seven assassins would be liable to the plaintiff for $131,000 ($1,000,000 prospective damages multiplied by the thirteen and one-tenth percent pre-injury risk of harm). Here, the plaintiff's total compensation would be appropriate because it would equal her prospective damages multiplied by the actual pre-injury risk of death.

This latter approach logically imposes liability in accord with the actual pre-injury risk of harm to the diplomat, and for this reason it produces the appropriate compensation level. The approach produces these logical results because it reflects the fundamental relativity of risk. Yet, for this same reason, the approach dramatically reduces an assassin's incentive to avoid killing the diplomat as the number of competing sources of harm increases. Thus, in the first hypothetical, the lone assassin will be liable for $300,000 ($1,000,000 prospective damages multiplied by the thirty percent pre-injury risk of harm). In the second

hypothetical, the seven assassins each will be liable for $131,000 ($1,000,000 prospective damages multiplied by the thirteen and one-tenth percent pre-injury risk of harm attributable to each assassin). The seven assassins have less than half the incentive to avoid killing the diplomat as has the lone assassin, yet they are just as much in need of deterrence as the lone assassin.

Without evidence of synergy,[25] these same problems arise in lawsuits arising out of exposure to multiple toxic substances or radiation. The following example demonstrates why:

> According to *Case v. Fibreboard Corp.*,[26] "[l]ung cancer is a common disease resulting from exposure to a variety of carcinogens including chromates, nickel, coke oven emissions, cigarette smoke, uranium, arsenic, auto emissions, and other pollutants."[27] Assume there are epidemiological studies for each of the seven named carcinogens. Each study shows that a certain level of exposure to that carcinogen creates a thirty percent risk of causing lung cancer within a certain period. Assume that the defendant exposes both Plaintiff A and Plaintiff B to the level of nickel specified in the study. Nickel is the only carcinogen to which Plaintiff A was exposed. Plaintiff B also was exposed to each of the six other carcinogens, to the extent specified in each of the six other studies. Both plaintiffs get lung cancer and suffer $1,000,000 in damages.

This hypothetical is directly analogous to the assassin example; analyzing it produces virtually identical results. Under proportional damage recovery, the defendant would probably pay Plaintiff A at least $900,000 (ninety percent of her damages) because Plaintiff A probably could establish at least a ninety percent post-injury probability that the defendant's nickel caused her cancer. This assumes that there is no post-hoc evidence of contact with any other carcinogen. In the absence of any competing explanation for the cause of the disease, the defendant's nickel emerges as the only likely source of the disease. Under proportional damage recovery, the defendant would be liable to Plaintiff B for only $143,000 because each of the seven carcinogens presents an equal post-injury probability of having caused the harm. Proportional damage recovery, therefore, dictates that the defendant should spend six times as much to protect Plaintiff A from exposure to nickel as it should spend to protect Plaintiff B.

---

25. The presence of synergy among toxins can change the analysis. Assume that exposure to toxin A creates a 10% risk of causing a disease and exposure to toxin B alone creates a 20% risk of causing the same disease. Exposure to both toxins, however, creates a 60% risk of causing the disease. Here, using the "but for" test of causation, a plaintiff exposed to both toxins can prove that each toxin created the 60% risk of causing the disease. That is, if the plaintiff had not been exposed to toxin A, she would not have a 60% risk of illness. Likewise, if the plaintiff had not been exposed to toxin B, she would not have a 60% risk of illness.

26. 743 P.2d 1062 (Okla. 1987).

27. Id. at 1066 (quoting Special Project, *An Analysis of the Legal, Social, and Political Issues Raised by Asbestos Litigation*, 36 Vand. L. Rev. 573, 609 n.190 (1983)).

Assume that the plaintiffs bring a proportional risk recovery suit prior to injury. For the reasons discussed above, Plaintiff A would get $300,000 ($1,000,000 prospective damages multiplied by the thirty percent pre-injury risk of harm). Plaintiff B would get $131,000 ($1,000,000 prospective damages multiplied by the thirteen and one-tenth percent pre-injury risk of harm).[28] Here, proportional risk recovery dictates that the defendant should spend more than twice as much to protect Plaintiff A from exposure to nickel as it should spend to protect Plaintiff B.

In cases involving multiple causes, proportional liability sends this perverse message because of the "probability paradox." Because probability is relative, probabilistic causation requires people to use the least care when the world is the most dangerous. A member of a hundred-person hunting party, shooting near the plaintiff's house, need use only a fraction of the care that a single hunter must use. Railroads should use less care to avoid chemical spills in polluted areas than in non-polluted areas. On the contrary, most people use as much or more care in a highly dangerous situation as in a less dangerous one.

Proportional liability cannot avoid the probability paradox in multiple cause cases as long as it relies on the economic theory that money spent on accident prevention measures should not exceed anticipated injury losses. The previous examples involving the latency problem are cases in which each potential cause affected the probability that the other potential causes would take effect. One might argue that imposing liability on the basis of the risk that would have been created by the defendant's conduct if the defendant had acted in isolation from the other potential causes of the plaintiff's injury could avoid the probability paradox. Recall Professor Estep's example in which radiation exposure sufficient to cause 143 leukemia deaths actually would cause only 107 deaths because thirty-six exposure victims would die of other causes.[29] Under the suggested approach, the tortfeasor would be liable for the value of 143 cases rather than 107 cases. Under the eco-

---

28. The 13.1% risk is derived by dividing the 92% chance that B will get cancer by seven because each of the seven carcinogens is equally likely to have caused the cancer. Each study is invalid with respect to B because the assumptions concerning her background risks are inaccurate. Epidemiological evidence, which unrealistically assumes a uniform background risk, often is misleading because it suggests awarding everyone in a rather large group the same percentage of damages. Farber, 71 Minn. L. Rev. at 1244 (cited in note 2). This evidence appears valid only when nothing is known except the link between the exposure and the disease. Background risks often change with knowledge of other risk factors.

Even if no differences exist with respect to background risks, all people exposed to toxins usually are not equally at risk. Id. at 1243-44. While risk is normally related to the amount of exposure, in reality the relationship between dosage and disease is poorly understood. Id. The timing of the exposure also may be significant. For example, DES exposure appears to be harmful to fetuses but not adults.

29. See note 18 and accompanying text.

nomic theory, this result would not properly deter the tortfeasor. Assuming that the average amount of damage in each of the 107 actual leukemia cases is $1,000,000, holding the tortfeasor liable for the equivalent of an additional thirty-six cases would give him an incentive to spend up to $143,000,000 to prevent $107,000,000 in actual damages. Spending this amount would produce a net social utility loss of $36,000,000.

The economist assumes that the appropriate measure of damage is calculated by using actual risk of harm, which produces the correct level of deterrence. With this measure, however, only 107 cases would be compensated, resulting in the probability paradox. Under the economic premise, damages become smaller as the world becomes more dangerous. Thus, because of the probability paradox, each of the mutiple tortfeasors in a toxic tort case harm potential victims in two ways by exposing them to a toxin. First, they increase the risk of causing illness. Second, they increase the incentive for other tortfeasors to expose the victim to toxins by reducing other tortfeasors' potential liability.

A legal economist most likely would object to the foregoing analysis and deny that economic theory presents a paradox in multiple cause cases. An economist would assert that it makes economic sense to focus limited accident-prevention resources in the areas where they do the most good. For example, people should take greater precautions to avoid polluting a pristine lake than a sludge-filled lake. Focusing resources this way is not paradoxical.

There is some merit to this argument. The economist's insight that risk-benefit analysis is relevant to determining reasonableness is valid and represents a significant contribution to tort law. Contrary to the economic assumption, however, risk-benefit is not the only relevant factor. The probability paradox arises in the non-economist's mind when other considerations, such as the injurer's moral obligation to avoid injury, make the conduct unreasonable notwithstanding that the accident avoidance costs exceed the expected injury loss. Allowing for consideration of other factors in determining reasonableness of conduct, it becomes permissible to let accident prevention costs exceed expected accident losses. In fact, it is very likely that judges and juries consider factors other than risk-benefit analysis when deciding liability and damages issues. Certainly, there is little reason to believe that juries are receptive to risk-benefit analysis as the basis for finding a defendant not negligent or a product not defective in design.[30] Perhaps moral con-

30. Gary T. Schwartz, *The Myth of the Ford Pinto Case*, 43 Rutgers L. Rev. 1013, 1036-47 (1991).

siderations influence juries to value the victim's utility more than the actor's. A jury may believe that a person who left a land mine in the road is morally obligated to locate and retrieve it, even though the cost of removal exceeds the amount of potential damages multiplied by the chance that the damages will occur. The jury probably would not hold the actor responsible for an extreme expenditure. The size of the maximum required expenditure, therefore, need not be exactly equivalent to risk. While the required expenditure can be affected by a number of factors, however, it normally would not shrink because other land mines are present in the same stretch of road.

It is also likely that judges reject the economic premise as the primary basis for determining the size of damage awards. Courts award damages in tort cases primarily to make the plaintiff whole, not to signal the precise amount that actors should spend on accident prevention measures. As pointed out above, in permanent disability or death cases the damages awarded for loss of earning capacity vary tremendously depending on the age and occupation of the victim. Young surgeons receive much more money than elderly custodians. Courts probably tailor awards in this way to compensate fully for the loss, not to encourage dangerous driving in poor neighborhoods and near retirement homes. If the desire to compensate indeed motivates such damage awards, then the proper basis for such compensation is evidence that the defendant actually caused the plaintiff's loss.

The probability paradox raises serious questions about whether tort rules fashioned by economic theory can provide effective deterrence in multiple cause cases. The paradox operates under both proportional liability and the common-law all or nothing rule. Its effect is especially pronounced in toxic tort cases involving long latency periods and low probabilities of causation. Such cases provide the maximum opportunity for competing causes to insulate the defendant from the consequences of its conduct, yet these are the cases in which proportional liability is most likely to be applied. Therefore, the policy of furthering deterrence may provide little reason to reject the common-law rule and adopt proportional liability.

Arguably, proportional liability is nevertheless superior to the common-law approach in promoting deterrence. It imposes at least some liability on wrongdoers who expose people to a less than fifty percent risk of injury, while the common law exempts such wrongdoers from all liability.

This argument may be invalid. Proportional liability does not merely increase the liability of wrongdoers who create a less than fifty percent chance of causing harm; it also reduces the liability of wrongdoers who create a greater than fifty percent chance of causing harm. The

probability paradox also can operate in these cases to produce underdeterrence. The common law would hold the wrongdoer liable for one hundred percent of the victim's damages in such cases. The decreased deterrence resulting from reducing liability in these cases may more than offset the increased deterrence resulting from increasing liability in cases involving a less than fifty percent risk. Considering this result, the traditional all or nothing rule may produce superior overall deterrence.[31] If proportional liability does not advance the policy of deterrence, courts should not adopt the approach unless it furthers the remaining tort policies of corrective justice and compensation more effectively than does the common-law rule. The next two Parts of this Article analyze the ability of proportional liability to achieve these goals.

III. Corrective Justice and Statistical Evidence

A. *Tortious Infliction of Harm*

Many people consider corrective justice a primary rationale for tort liability, viewing tort law as a system of civil justice designed to resolve

31. It is beyond the scope of this Article to attempt to resolve this question. Until this question has been resolved, however, the case for proportional liability as a producer of superior deterrence has not been made.

Also beyond the scope of this Article is the question of whether a modified form of proportional liability would produce better overall results than the traditional common-law approach. One possible solution is to modify proportional liability, as suggested above, and impose liability on the basis of the risk that the defendant's conduct would have created if the other potential causes of the plaintiff's harm had been nonfunctional. This approach would produce a stronger deterrent effect by factoring out the probability paradox.

Although this approach is worth considering, it raises several potential problems. First, it is difficult to determine which of the competing causes to factor out. As discussed above, factoring out all competing causes of death results in the assumption that the tortfeasor terminated a life of infinite duration. Everyone would agree that this effect is undesirable. Second, it is extremely difficult to obtain accurate statistical information about a hypothetical event that has no basis in reality. Third, basing liability on the revised statistic possibly will create overdeterrence.

Other variations of proportional liability also may be worth considering. Courts might, for example, impose proportional liability in cases in which the risk of harm is less than 50% and impose full liability in cases in which the risk is more than 50%. This approach also would produce more deterrence than pure proportional liability. It does, however, raise serious questions about fairness and the possibility of overdeterrence.

Another possibility is to apply proportional liability only in cases in which the tortfeasor can readily control the risk level caused by its conduct. Assume that a tortfeasor creates a 60% risk of injury. Under the common-law all or nothing rule, the tortfeasor is liable for all damages. The rule, however, provides an incentive to lower the risk to 50% rather than eliminate it. At the 50% risk level, the tortfeasor escapes all liability. Thus, in the hypothetical involving ten land mines, if one tortfeasor controls six of the ten mines, it would be liable for the motorist's full compensation under the all or nothing rule. If it removes just one of the mines, it then creates less than 51% of the risk and escapes all liability. Thus, the tortfeasor has an incentive to remove only one of its six mines.

disputes and correct wrongs arising in society. Tort law serves this important governmental function in a way that is unique to our society. The American legal system is available to any person without regard to her status or power. Justice is meted out by ordinary citizens, sitting as jurors, who are not subject to undue influence by the wealth or power of a litigant.

Corrective justice is based on the moral concept of individual responsibility.[32] Proof of causation is fundamental to a system of corrective justice because the causal nexus between the actor and the injury provides an important moral basis for tort liability.[33] It is fair to make a person pay for harm he caused, but it is unfair to force him to pay for harm he did not cause.[34]

The customary burden of proof in tort cases promotes corrective justice. It requires the plaintiff to use particularistic evidence and to lead the jury to "believe" that the defendant caused her injury.[35] Particularistic evidence such as eyewitness identification testimony, fingerprint evidence, and ballistics evidence directly links the defendant's conduct with the plaintiff's harm.

Courts most likely will apply proportional liability in toxic tort cases, which are based largely on epidemiological evidence. These cases usually lack particularistic evidence of causation. Epidemiological evidence can show that a certain number of diseases in a given population were caused by a certain toxin, but it cannot identify which diseases that toxin caused and which ones other factors caused.[36] With increasing frequency, courts have dispensed with the requirement of particularistic evidence in such cases because it is impossible to produce.[37] As a result, the burden of proof has changed.[38] Traditionally, judges have not regarded pure statistical evidence as sufficient to lead a jury to believe that the defendant caused the plaintiff's injury.[39]

---

32. Troyen A. Brennan, *Causal Chains and Statistical Links: The Role of Scientific Uncertainty in Hazardous-Substance Litigation*, 73 Cornell L. Rev. 469, 491 (1988); Richard W. Wright, *Causation, Responsibility, Risk, Probability, Naked Statistics, and Proof: Pruning the Bramble Bush by Clarifying the Concepts*, 73 Iowa L. Rev. 1001, 1064 (1988); Adrian A.S. Zuckerman, *Law, Fact or Justice?*, 66 B.U. L. Rev. 487, 499 (1986).

33. Brennan, 73 Cornell L. Rev. at 514-15.

34. Wright, 73 Iowa L. Rev. at 1064.

35. Gold, 96 Yale L. J. at 384 (cited in note 2).

36. Callahan, 23 Ariz. St. L. J. at 626-27 (cited in note 8).

37. See, for example, *Elam v. Alcolac, Inc.*, 765 S.W.2d 42, 176, 178 (Mo. Ct. App. 1988).

38. Callahan, 23 Ariz. St. L. J. at 669 (cited in note 8).

39. See Richard J. Heafey, *Trial by Lottery: The Misuse of Epidemiology and Statistics to Prove Causation in Drug and Chemical Litigation*, 12 Am. J. Trial Advoc. 19 (1988); Wright, 73 Iowa L. Rev. at 1051-54, 1056-57, 1061-63, 1065 (cited in note 32).

Some writers argue that changing the burden of proof in this way works a fundamental change in the tort system.[40] Using statistical rather than particularistic evidence undermines corrective justice by imposing corporate punishment;[41] it imposes liability on all members of a group based on the transgressions of some of its individual members. Judgments based on pure statistical evidence, therefore, are contrary to the notion of individual responsibility. Such judgments openly accept the possibility that the defendant belongs to the innocent minority.[42]

This argument relies on the notion that statistical evidence differs qualitatively from particularistic evidence in that it never says anything about what actually happened, regardless of how high the statistical probability.[43] Statistical evidence tells only about classes of events. It provides no method of drawing a conclusion about a specific event.[44] Without particularistic evidence, the jury cannot form a belief that a particular plaintiff was harmed by the toxin. The jury can only deter-

---

40. Charles R. Nesson, *The Evidence or the Event? On Judicial Proof and the Acceptability of Verdicts*, 98 Harv. L. Rev. 1357, 1383 (1985); Wright, 73 Iowa L. Rev. at 1064. See also Brennan, 73 Cornell L. Rev. at 489-91 & 489 n.100 (cited in note 32); Zuckerman, 66 B.U. L. Rev. at 499-501 (cited in note 32); Gold, 96 Yale L. J. at 382-84 (cited in note 2).

41. Zuckerman, 66 B.U. L. Rev. at 499.

42. Id.

43. Wright, 73 Iowa L. Rev. at 1058, 1061 (cited in note 32). Because of this difference, statistical evidence is not probative evidence in cases in which the jury must determine what actually happened. Id. at 1054, 1056-57, 1061. Courts often have rejected statistical evidence for this reason. See cases cited in Brennan, 73 Cornell L. Rev. at 491-501 (cited in note 32); Heafey, 12 Am. J. Trial Advoc. at 29-36 (cited in note 39); Wright, 73 Iowa L. Rev. at 1050-51.

For example, assume that A fired 99 bullets in the plaintiff's direction and B fired one bullet. The plaintiff was hit by one bullet. The statistics show that A was 99 times more likely to hit the plaintiff than B, yet cannot show which bullet actually hit the plaintiff. Any inference created by statistical evidence will disappear in the face of particularistic evidence to the contrary, such as ballistics evidence showing that the bullet came from B's gun. This happens even when the particularistic evidence creates a lower probability than the statistical evidence; for example, the ballistics evidence shows a 90% chance that the bullet came from B's gun. This phenomenon occurs because statistical evidence merely substitutes for evidence of what really happened. Heafey, 12 Am. J. Trial Advoc. at 29. The 99% statistical probability that A shot the plaintiff loses force upon introduction of particularistic evidence showing 90% probability that B shot the plaintiff. As one court stated:

> Quantitative probability, however, is only the greater chance. It is not proof, nor even probative evidence, of the proposition to be proved. That in one throw of dice there is a quantitative probability, or greater chance, that a less number of spots than sixes will fall uppermost is no evidence whatever that in a given throw such was the actual result. Without something more, the actual result of the throw would still be utterly unknown. The slightest real evidence that sixes did in fact fall uppermost would outweigh all the probability otherwise.

Day v. Boston & Me. R.R., 96 Me. 234, 52 A. 771, 774 (1902).

In short, statistical evidence is useful for predicting what did or will happen, but not useful for ascertaining whether the prediction was correct. Statistical evidence could be used to bet on what happened, but not to resolve the bet. Wrigbt, 73 Iowa L. Rev. at 1062-63.

44. Charles R. Nesson, *Agent Orange Meets the Blue Bus: Factfinding at the Frontier of Knowledge*, 66 B.U. L. Rev. 521, 522-23 (1986).

mine the statistical chance that the toxin harmed the plaintiff.[45] The reformulated burden of proof requires the plaintiff to show that it is more probable than not that the defendant caused her harm.[46] The jury no longer needs to believe that the defendant caused the plaintiff's harm to decide the case for the plaintiff. Instead, the jury must believe that the statistical probability of causation is greater than fifty percent.[47]

Other commentators disagree that the two types of evidence differ and assert that all evidence is probabilistic.[48] For example, there is always a risk that an eyewitness is mistaken or lying. The jury must take this risk into account in evaluating the evidence. Ultimately, its finding always represents a prediction based on probability.[49]

For purposes of this Article, it is not necessary to resolve the question of whether a fundamental difference exists between statistical and particularistic evidence in cases decided under the common-law all or nothing rule. Regardless of the merits of that controversy, proportional liability necessarily undermines the ability of tort law to achieve corrective justice in two ways.

First, proportional liability undermines corrective justice by allowing recovery in the large number of cases in which statistical evidence shows a less than fifty percent chance that the the defendant caused the harm. In such cases there is undoubtedly no rational basis for a belief that the defendant caused a particular plaintiff's harm. Proportional liability in such cases imposes corporate responsibility, openly accepting the likelihood that the defendant did not harm most of the plaintiffs that it is required to compensate.

---

45. See Gold, 96 Yale L. J. at 382-84 (cited in note 2).

46. Id. at 384-86.

47. See id.

48. Laurence H. Tribe, *Trial by Mathematics: Precision and Ritual in the Legal Process*, 84 Harv. L. Rev. 1329, 1345-46 (1971); Rosenberg, 97 Harv. L. Rev. at 870 (cited in note 2). See also Ronald J. Allen, Comment, *Rationality, Mythology, and the "Acceptability of Verdicts" Thesis*, 66 B.U. L. Rev. 541, 547-48 (1986).

49. The belief that statistical evidence is not qualitatively different than individualized proof does not compel the conclusion tbat statistical evidence is always sufficient to make a submissible case. One could recognize that while background statistics are relevant, they still are not sufficient to produce a belief as to what actually occurred. Lea Brilmayer, *Second-Order Evidence and Bayesian Logic*, 66 B.U. L. Rev. 673, 684-85 (1986). A reasonable person, for example, would not form a belief that a particular car was blue simply because she learns that the majority of cars are blue. She would want more evidence before forming a belief. Under this view, statistical evidence alone would produce a belief in a proposition only if the probability were extremely high. Richard D. Friedman, Comment, *Generalized Inferences, Individual Merits, and Jury Discretion*, 66 B.U. L. Rev. 509, 518-19 (1986); Nesson, 66 B.U. L. Rev. at 522 n.3 (cited in note 44).

Second, proportional liability undermines corrective justice by undercompensating the plaintiffs that the defendant actually harmed. Consider the following example:

> Defendant negligently spills a chemical. Thereafter, forty people in the area of the spill get sick. Epidemiological evidence shows that if the chemical had not been spilled, nineteen people would have contracted the illness.

Assume that suit is brought in a jurisdiction that does not use proportional liability and does not require particularistic evidence. In this example, the court would hold the defendant liable on the basis of the statistical evidence and would require the defendant to pay the full damages to all forty people. Viewed from the perspective of the defendant's twenty-one actual victims, corrective justice is fully achieved because each victim is fully compensated. Viewed from the defendant's perspective, the result is unjust, because the defendant paid damages to forty people, but only harmed twenty-one people.

Proportional liability ameliorates the injustice from the defendant's perspective because the defendant pays for only as much harm as it actually caused.[50] Thus, the result is fair to the defendant as long as the evidence concerning the amount of harm done is accurate, which may be doubtful.[51] From the victim's perspective, however, proportional lia-

---

50. Makdisi, 67 N.C. L. Rev. at 1073 (cited in note 2).

51. Even when the probability paradox does not operate, the highly speculative and unreliable nature of the evidence that determines the percentage of contribution of each defendant prevents proportional liability from achieving its deterrence goals. See Andrew G. Celli, Jr., *Toward a Risk Contribution Approach to Tortfeasor Identification and Multiple Causation Cases*, 65 N.Y.U. L. Rev. 635, 691-92 (1990); Richard A. Schmalz, *On the Financing of Compensation Systems*, 14 J. Legal Stud. 807 (1985); E. Donald Elliott, *Why Courts? Comment on Robinson*, 14 J. Legal Stud. 799 (1985). Risk quantification is a highly complex and imperfect science. *Developments in the Law—Toxic Waste Litigation*, 99 Harv. L. Rev. 1458, 1646 (1986). Opposing experts rarely agree. In the Agent Orange cases, for example, estimates ranged from a 0% to a 120% increase over background risk. Id. & n.64.

For proportional liability, exact percentage figures are necessary to calculate awards. Farber, 71 Minn. L. Rev. at 1255 (cited in note 2). In mass tort cases, scientists rarely will have enough information to make even rough estimates of probability. See Elliott, 14 J. Legal Stud. at 802. Expert testimony unsupported by animal studies or epidemiological evidence carries little weight. Farber, 71 Minn. L. Rev. at 1257-58. While animal studies are useful, it is not clear that extrapolation between species is valid. Callahan, 23 Ariz. St. L. J. at 619-21 (cited in note 8); Farber, 71 Minn. L. Rev. at 1228. Also, animals get much higher doses. Callahan, 23 Ariz. St. L. J. at 620-21; Farber, 71 Minn. L. Rev. at 1228. Furthermore, epidemiological evidence often is inconclusive regarding the level of risk created by a toxic substance. Callahan, 23 Ariz. St. L. J. at 624-25, 627-28; Farber, 71 Minn. L. Rev. at 1228.

Basically, epidemiological evidence is used not because it is accurate, but rather because it is the only evidence available. See, for example, Callahan, 23 Ariz. St. L. J. at 628-29; Farber, 71 Minn. L. Rev. at 1241 (stating that proportional compensation is directed as precisely as possible based on "highly limited information"). Accurate information about risks is necessary to fulfill the deterrence goal underlying proportional liability, but such evidence simply is not available. Widescale proportional liability on the basis of highly speculative evidence would produce widely divergent judgments in similar cases, a harmful, rather than beneficial, effect.

bility achieves corrective justice very poorly. The defendant's actual victims receive reimbursement for substantially less harm than the defendant inflicted.

B. *Tortious Creation of Risk*

Several authors advocate an alternative corrective justice theory in support of proportional liability. These authors believe that subjecting a person to a risk of future harm is itself a compensable wrong.[52] This theory could be used as a basis for recovery in all cases of tortious risk creation. For example, if a negligent driver nearly hits a pedestrian, the pedestrian would have a cause of action. The plaintiff's damages would be measured by multiplying the amount of harm he would have suffered if he had been hit by the percentage chance that the negligent act would have resulted in an injury.

While this theory is logical, it may not have enough appeal to provide a basis of recovery. The following example illustrates why:

> A motorist drives carelessly on ten occasions. On each occasion she creates a ten percent chance of hitting a pedestrian and causing $50,000 in damages. In the first nine cases, the car does not hit the pedestrian. In the tenth case, the car does hit the pedestrian.

The negligent infliction of risk cause of action would require the motorist to give each of ten pedestrians $5000 in damages ($50,000 potential damages multiplied by the ten percent chance of an accident). Common-law courts, of course, have rejected this approach. They favor requiring the driver to give the full $50,000 to the one pedestrian actually injured. This approach illustrates a strong intuitive preference for granting a cause of action for tortious infliction of harm rather than tortious creation of risk.

Proportional liability advocates may be influenced by the same bias. They would grant recovery only to people who actually have been injured or to people exposed to a continuing risk of future injury. They would not apply the theory as a basis for recovery in sporadic near-accident cases creating no continuing risk of future harm.[53] Therefore, advocates use proportional liability as a way to compensate for actual injury. They either would compensate people with present injuries[54] or people at risk in order to protect against future injury by buying insurance[55] or medical monitoring services.[56] In reality, advocates may be us-

52. See Robinson, 14 J. Legal Stud. at 789-91 (cited in note 2); Wright, 73 Iowa L. Rev. at 1073 (cited in note 32). See also Christopher H. Schroeder, *Corrective Justice and Liability for Increasing Risks*, 37 UCLA L. Rev. 439 (1990).

53. See, for example, Robinson, 14 J. Legal Stud. at 796-97 (cited in note 2).

54. See authorities cited in notes 3, 5, and 6.

55. See Robinson, 14 J. Legal Stud. at 786-87 (cited in note 2).

56. See id. at 785-86.

ing this novel corrective justice theory merely as a rationale for compensating for infliction of harm, rather than creation of risk.[57] If so, the approach does not really represent a new theory of corrective justice after all.

Notwithstanding these suspicions, the tortious creation of risk theory lends support to the claim that proportional liability achieves corrective justice. The claim is much stronger for proportional risk recovery and for the insurance fund type of proportional risk recovery than for proportional damage recovery because proportional damage recovery imposes liability after the plaintiff suffers his injury. Many diseases caused by exposure to toxic substances and radiation have long latency periods. Typically, the wrongdoer would be held liable many years after the wrongful conduct. Because most wrongdoers in such cases are corporations, many of the officers, directors, and shareholders would be different persons at the time of liability than at the time of the wrongful conduct. When proportional damage recovery punishes persons who had nothing to do with inflicting the harm, tort law fails to achieve corrective justice.[58]

IV. Compensation and Statistical Evidence

Many scholars today recognize that compensation cannot be a free-standing goal of tort law.[59] It is far too expensive and exempts far too many people to provide an efficient form of loss insurance. A private insurance system or government benefits program could deliver greater compensation at a lower cost tban the tort system. Nevertheless, the desire to use the tort system to provide compensation remains a supplemental argument in support of tort liability. The ability of proportional liability to achieve rational and fair compensation depends on the version tbat the courts adopt.

---

57. See *Fennell v. Southern Maryland Hosp. Ctr., Inc.*, 320 Md. 776, 580 A.2d 206, 213 (Md. Ct. App. 1990) (stating that in a loss of a chance case, the distinction between compensation for harm and compensation for risk may be "an exercise in semantics"). See also Farher, 71 Minn. L. Rev. at 1241 (cited in note 2).

58. See American Law Institute, Reporters' Study, 1 *Enterprise Responsibility for Personal Injury, The Institutional Framework* 25, 27, 355 (American Law Institute, 1991). The common-law approach, of course, suffers from the same difficulty as proportional damage recovery in long latency cases.

59. See, for example, Robinson, 68 Va. L. Rev. at 736-37 (cited in note 23); Rosenberg, 97 Harv. L. Rev. at 873 (cited in note 2).

A. Proportional Damage Recovery and Insurance Fund Proportional Risk Recovery

These forms of proportional liability are less capable of providing fair compensation than traditional tort liability because they drastically overcompensate some people and drastically undercompensate others.[60] Consider the following example:

> Defendant releases a toxic substance that exposes people to a risk of contracting a particular disease. Five people who were exposed to the substance contract the disease. The evidence shows that the defendant created a twenty percent post-injury probability of having caused the disease in each of the five people. They bring an action against the defendant.

The defendant will pay each of the plaintiffs twenty percent of their damages. If damages are $100,000 per plaintiff, the defendant would pay each plaintiff $20,000. If, however, the statistical evidence is correct, the defendant caused the disease in only one of the five plaintiffs. Of course, there is no way of identifying which plaintiff was harmed by the defendant. A lawsuit based upon proportional liability drastically undercompensates that plaintiff. She receives only $20,000, although her damages amounted to $100,000. On the other hand, the other four plaintiffs in the case are grossly overcompensated by the defendant. They each receive $20,000 but suffered no damages caused by the defendant. Because their illnesses would have occurred regardless of the defendant's actions, they have no rightful claim to the defendant's money.

The traditional common-law approach, which requires proof on a more probable than not basis, produces superior results because it is right more often than it is wrong. Applying the traditional rule to the above example would result in a denial of recovery in all five cases. The application of the traditional rule produces a correct result in four cases and an incorrect result in one case. Likewise, the common law would impose liability in all cases if the probability that the defendant caused the injury had been greater than fifty percent. Once again, it would resolve more cases correctly than incorrectly. As demonstrated above, proportional damage recovery makes a mistake in every case.

B. Proportional Risk Recovery

Proponents of proportional risk recovery make a plausible argument that the scheme provides appropriate compensation.[61] This method compensates plaintiffs who have been exposed to a toxic sub-

60. Harvey, 89 Dickinson L. Rev. at 245 (cited in note 2).

61. Rosenberg, 97 Harv. L. Rev. at 886-87 (cited in note 2); Ashton, 43 U. Miami L. Rev. at 1137-38 (cited in note 2).

stance at the time of exposure rather than waiting until the disease actually occurs. Obviously, some of the compensated plaintiffs will get the disease and others will not.

The compensation argument is based on the premise that the wrong compensated for is exposure to risk rather than causation of disease. When a person is exposed to a risk of future harm, her life expectancy has been reduced in an actuarial sense.[62] A present injury results because the economic value of her life is diminished. In theory, such a person would have to pay more for life insurance than a person who was not exposed to the risk.[63] Also, if she were later killed by another tortfeasor, her survivors would receive a smaller recovery than if she had not been exposed to the toxin.[64] Thus, the person who shortened that life expectancy caused this economic harm to the victim at the time of exposure.

In a risk exposure case, the appropriate remedy is to determine how much the victim's life expectancy has been shortened, discount the future damages (for example, loss of future earnings) to present value, and award the victim this remainder. With this money, the plaintiff can afford to pay for the increased cost of life and medical insurance. Alternatively, if the plaintiff can minimize or avoid the risk by seeking additional medical monitoring, she could use the money to pay for that service. In theory, the victim's reduced recovery does not undercompensate her because it bears a direct relationship to the increased cost of insurance.

Several factors undermine this theory of compensation. First, there may be many cases in which a plaintiff's actuarial loss produces no real economic loss. As a practical matter, it is unlikely that every significant exposure to a toxin will affect insurance premiums or wrongful death damage awards. Second, this theory produces overcompensation and undercompensation in much the same way as the other types of proportional liability because it uses epidemiological or other statistical evidence.[65] Proportional risk recovery based on epidemiological evidence awards everyone in a large group the same percentage of damages. As discussed previously, however, some members of the group are subject to a higher than average risk, and others are subject to a lower than average risk.[66] For example, if epidemiological evidence shows that the average risk is twenty percent, some members of the group will have

62. Rosenberg, 97 Harv. L. Rev. at 886-87.

63. Id. at 886.

64. Id. at 885-86.

65. Callahan, 23 Ariz. St. L. J. at 670 (cited in note 8); Farber, 71 Minn. L. Rev. at 1244 (cited in note 2).

66. See note 28 and accompanying text.

only a ten percent risk, while others will have a thirty percent risk. Paying each member of the group twenty percent overcompensates some and undercompensates others. Notwithstanding these factors, proportional risk recovery provides a far superior means of advancing the goal of compensation than the other forms of proportional liability.

V. CONCLUSION

The probability paradox raises serious questions about the ability of proportional liability to deter wrongdoers effectively. Use of statistical evidence also impairs the ability of proportional liability to achieve the tort policies of corrective justice and compensation. Proportional damage recovery does the worst job of advancing the compensation and corrective justice policies. Insurance fund proportional risk recovery also does a poor job of providing compensation, but does a better job of achieving corrective justice. The type of proportional liability that does the best overall job of providing compensation and achieving corrective justice is proportional risk recovery. Ironically, this version of proportional liability represents the most significant departure from traditional tort principles. Therefore, courts and legislatures are least likely to adopt it.[67]

This Article has discussed several theoretical problems raised by proportional liability stemming from its reliance on statistical evidence. Other commentators have discussed practical problems with implementing the theory.[68] In view of both classes of problems, proponents of proportional liability may have not yet made the case that it is superior to the common-law all or nothing rule.

The common law appears to do a better overall job of accommodating the need to do justice between the parties and to provide appropriate incentives to use care. Nevertheless, the tort system clearly fails to provide a remedy in many toxic exposure cases because plaintiffs cannot prove causation. Toxic exposure cases present a substantial and growing problem in our society. A possible solution is for legislatures to create an administrative or criminal remedy. Also worth considering is whether some modified form of proportional liability, such as those previously discussed,[69] should be used in such cases. Until the case for change has been made, however, there is not sufficient reason to alter the common-law approach.

---

67. See, for example, Reporters' Study, *Approaches to Legal and Institutional Change* at 369-75 (cited in note 3) (advocating adoption of proportional damage recovery). The reporters believe that adoption of proportional risk recovery is a legal step that is "premature at best." Id. at 373.

68. See note 51.

69. See note 31.