Damned Causation

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The inherent mismatch between the questions law asks and the answers statistics provides has led courts to create arbitrary rules for statistical evidence. Adherence to these rules undermines deterrence goals and runs the risk of depriving recovery for whole categories of injuries. In response, some courts adopt new theories of recovery, relying on the loss of chance doctrine to provide some relief to injured plaintiffs. These solutions, however, only serve to exacerbate the fundamental misunderstanding of probabilities. While these doctrines largely operate within the context of medical malpractice, the increased ability to capture more statistical data may prompt courts to acknowledge the probabilistic nature of causation in other contexts. It is important to ensure that courts correctly approach this information. This Article presents a simple framework for thinking about probabilistic harm. The framework identifies the "attributable risk rate" as the correct metric for assessing whether a plaintiff belongs to the "avoidable" class—people who would not have experienced harm in the absence of negligence—or the "inevitable" class—people who would have experienced harm even in the absence of negligence. The Article then proposes a practical two-step ("personalize/operationalize") process for using attributable risk rates to assess causation. It provides a concrete example of how this process compares to other legal rules. It also demonstrates that this process is compatible with current legal requirements, harmonizes the treatment of causation in probabilistic and non-probabilistic contexts, and ensures that statistical evidence is taken seriously.

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"There are three kinds of lies: Lies, Damned Lies, and Statistics."[1]

INTRODUCTION

Lawyers pose dichotomous questions about causation, the answers to which are not knowable with certainty. No one observes the world in which the tortious act does not take place; one can only guess about the likely outcome in such a "counterfactual" state. The law relies on juries to assess proferred evidence and transform it into beliefs about the outcome in such a counterfactual state. The burden of proof specifies the requisite level of confidence the jury must have in its beliefs. The jury's task is not simple, but it is intuitive.

While legal scholars have long accepted that the world is not deterministic,[2] law explicitly acknowledges probabilities in only certain contexts. In doing so, this intuitive process is disrupted. Courts' discomfort with statistical evidence leads them to fashion inconsistent rules for recovery based on arbitrary probability thresholds. While such rules undoubtedly result in incorrect awards for individual cases (and potentially undermine optimal deterrence), the chief danger they pose is in perpetuating misleading fictions about how law and statistics interact. These fictions will continue to undermine the judiciary's institutional competence in a world trending toward big data and easily accessible statistics. This Article proposes a simple framework for how courts should conceptualize the causation issue in contexts where negligence increases the risk of injury. It then provides a two-step process ("personalize/operationalize") to guide juries in specifying the most appropriate probability that the negligent act caused the relevant harm and determining—based on the range of outcomes implied by the probability—whether the current case is recoverable. In doing so, the framework reconciles the approach in so-called probabilistic contexts with that in non-probabilistic contexts, remaining faithful to both existing tort and statistical principles.

Consider a patient, unknowingly afflicted with lung cancer, who goes for an annual checkup. The doctor negligently fails to perform a scan and fails to diagnose the lung cancer until the cancer progresses to stage two. The patient

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1. Sir Charles Dilke.

2. *See, e.g.*, Glen O. Robinson, *Probabilistic Causation and Compensation for Tortious Risk*, 14 J. LEGAL STUD. 779, 780 (1985); Alessandro Romano, *God's Dice: The Law in a Probabilistic World*, 41 U. DAYTON L. REV. 57, 58 (2016). An outcome is deterministic if it occurs with probability one; conversely, probabilistic outcomes denote a range of outcomes that occur with some nonzero probability. Viewing the world as probabilistic is in part an acknowledgement of the incomplete conception of the world we have. *See infra* note 85.

eventually dies from lung cancer.[3] Did the doctor's negligence *cause*[4] the death? This is a difficult inquiry: while it is possible that the patient could have been saved by early detection, it is also possible that the patient's death from cancer may have been inevitable even with early detection. A jury should find causation satisfied if, based on the evidence presented, it believes the negligent medical care more likely than not caused the harm.[5]

Once statistical evidence is introduced, however, the intuitive process of imagining a "counterfactual" (i.e., a world in which the tortious act did not occur) is made deceptively more complex. While courts are generally reticent to acknowledge probabilities in legal causation, medical malpractice seems to be one exception, potentially due to the relative availability of survival rate information. As data become easier to collect and aggregate, statistics will become more readily available, and courts may be more willing to engage with statistical evidence in other contexts. The method by which courts approach statistical information, however, will determine whether introduction of statistical data will enhance or distort our judicial process.

Suppose the defense introduced expert testimony that prior to the negligent act the patient only had a 40% chance of survival. Does this statistic necessarily defeat the preponderance of the evidence standard for causation? Some courts have answered this question in the affirmative, requiring the patient to have had at least a 50% chance of survival prior to the negligent act before allowing the question of causation to go to a jury.[6] Other courts,

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3. Based loosely on facts from *Herskovits v. Grp. Health Coop. of Puget Sound*, 664 P.2d 474 (Wash. 1983).

4. This article is largely concerned with contexts that lend themselves to but-for causation; however, it is worth noting that tort law has developed many theories of causation in fact to capture situations that seem consequentially linked. But-for causation requires the negligent act be necessary for the injury: harm should occur in the presence of negligence and not in its absence. 3 AM. L. TORTS § 11:2 (2021). The substantial factor test has suffered from significant ambiguity, as it is sometimes synonymous with but-for causation and other times refers to a more attenuated relationship. *Id.* Situations not satisfying but-for causation can still seem consequentially linked: in a canonical example, two fires, each sufficient to consume a whole house, converge and envelop a house. Each fire defeats but-for causation for the other; however, intuitively it seems clear that each is causally related to the property damage. To accommodate this issue, courts allow causation to be established by multiple sufficient causes, essentially requiring sufficiency but not necessity. *See* RESTATEMENT (SECOND) OF TORTS § 432 (AM. L. INST. 1965). The more controversial "necessary element of a sufficient set" (NESS) requires neither necessity nor sufficiency. Richard W. Wright, *Causation in Tort Law*, 73 CAL. L. REV. 1735, 1774 (1985). In circumstances in which multiple causes combine to form an overdetermined causal set, NESS allows causation to be established despite no factor being a but-for cause. *Id.* Under NESS, each factor is necessary to a sufficient set and, accordingly, causally linked. *Id.*

5. RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM § 28 cmt. a (2010).

6. *See, e.g.*, Gooding v. Univ. Hosp. Bldg., Inc., 445 So. 2d 1015, 1019–20 (Fla. 1984) ("Other jurisdictions have allowed recovery even where the chance of survival was less than

feeling the unfairness of such a stark response, pivot to reformed definitions of harm to provide some level of compensation to patients.[7] The most common way they do this is by transforming the harm from death to the deprivation of a chance of survival ("loss of chance").[8]

The most reasonable interpretation behind the 50% survival rate requirement appears to be the belief that the preponderance of the evidence requires that the negligent act double the risk of harm.[9] If a person has a less than 50% chance of survival (i.e., at least a 51% chance of death), negligence cannot double the risk of death. This doubling requirement, however, seems inconsistent when applied to more acute harm contexts. For example, a recent study suggests that a 1% increase in speed results in an increased chance of crash of 2%.[10] Applying the doubling rule, a 50% increase in speed will lead to a 100% increase in harm rate (i.e., a doubling). Suppose a driver was speeding in a 70-mph zone. If the driver was going 90-mph in a 70-mph zone (roughly a 28.6% increase in speed), a reasonable jury may well find that the driver *breached* the standard of care; however, a jury would not be allowed to find that speeding *caused* an accident unless the driver was going 105-mph (1.50 x 70) in a 70-mph zone. Intuitively, this seems over-restrictive, missing many cases in which a reasonable jury could find that the speeding caused the crash. This is, however, illustrative of the absurd conclusions that may result when courts' current treatment of probabilities is extended to other contexts.

This Article welcomes statistical data as evidence but cautions against using discrete probability thresholds to screen out cases from a jury. Statistical evidence is not a problem; however, without adequate context, it can be used to distort the legal process. This Article builds upon prior work outlining the connection between legal requirements and probabilistic

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even . . . . Relaxing the causation requirement might correct a perceived unfairness to some plaintiffs who could prove the possibility that the medical malpractice caused an injury but could not prove the probability of causation, but at the same time could create an injustice . . . . We cannot approve the substitution of such an obvious inequity for a perceived one.").

7. *Herskovits*, 664 P.2d at 486 (Pearson, J., concurring).

8. Margaret T. Mangan, *The Loss of Chance Doctrine: A Small Price to Pay for Human Life*, 42 S.D. L. REV. 279, 291 (1997).

9. *See infra* Part I.A.

10. Letty Aarts & Ingrid Van Schagen, *Driving Speed and the Risk of Road Crashes: A Review*, 38 ACCIDENT ANALYSIS & PREVENTION 215, 223 (2006).

evidence by scholars like Lars Noah,[11] Vern Walker,[12] Richard Wright,[13] and Mark Kelman.[14] Lars Noah has provided a particularly insightful critique of the implementation of the loss of chance doctrine, documenting the inconsistent ways that courts have tried to assess loss of chance and proposing the "attributable risk rate" as the relevant metric.[15]

Building upon this critique, this Article suggests that the appeal to the loss of chance doctrine is a symptom of courts' inability to sort through statistical information. Instead, this Article proposes a framework[16] to address probabilistic harm without appealing to arbitrary probability thresholds. The framework reduces the probabilistic harm inquiry into two parameters: out of 100 people, the number of people belonging to the inevitably injured class ("inevitable") and the number of people belonging to the avoidably injured class ("avoidable"). These two parameters combine to form the same attributable risk rate that Noah recommends.[17] The analysis, however, cannot stop there. Accordingly, this Article proposes a process for courts to refine, interpret, and apply statistical evidence.

First, the courts must ensure that the attributable risk rate specifically captures the risk for a patient with the plaintiff's demographic characteristics and medical history. The temptation to match legal inquiries to available probabilities is strong, but the proposed process demonstrates that available statistics are likely not the most *relevant* statistics. The delegation of causation to expert witnesses has obscured—but not solved—the mismatch between available and relevant statistics. Raw population frequency rates must be refined to isolate causal relationships from observed correlations.[18] Moreover, average rates mask important differences in attributable risk rate

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11. Lars Noah, *An Inventory of Mathematical Blunders in Applying the Loss-of-a-Chance Doctrine*, 24 REV. LITIG. 369, 378 (2005).

12. Vern Walker, *Direct Interference in the Lost Chance Cases: Factfinding Constraints Under Minimal Fairness to Parties*, 23 HOFSTRA L. REV. 247, 255 (1994) [hereinafter *Direct Interference in the Lost Chance Cases*]; Vern Walker, *Preponderance, Probability and Warranted Factfinding*, 62 BROOKLYN L. REV. 1075, 1098 (1996) [hereinafter *Preponderance, Probability and Warranted Factfinding*].

13. Richard W. Wright, *Causation, Responsibility, Risk, Probability, Naked Statistics, and Proof: Pruning the Bramble Bush by Clarifying the Concepts*, 73 IOWA L. REV. 1001 (1988)

14. Mark Kelman, *The Necessary Myth of Objective Causation Judgments in Liberal Political Theory*, 63 CHI.-KENT L. REV. 579 (1987).

15. Noah, *supra* note 11 at 378, 382.

16. This Article will concentrate on the loss of chance doctrine and, accordingly, the issue of causation in medical malpractice; however, the framework can be applied to other scenarios. While toxic torts is a related field, this Article will not focus on it.

17. Noah, *supra* note 11.

18. Indeed, social scientists developed a whole field of applied statistics—econometrics—meant to isolate causation in the face of confounding socioeconomic determinants of, *inter alia*, health. The considerations motivating this field are relevant to the judicial determination of causation as well but have been largely seen as separate.

by demographics, medical history, and lifestyle. Ignoring such heterogeneity is not without consequence; defining harm claims by their average attributable risk rate runs the risk of whole classes of injuries erroneously being treated as non-recoverable. This will have practical effects on deterrence, particularly insofar as this is known to physicians at the time of treatment.[19]

Second, even with the most specific attributable risk rate, courts must correctly operationalize such statistics. *Any* plaintiff-specific attributable risk rate between zero and one will produce a range of outcomes. While statistics about the effect of a negligent act *influence* causation for a single observation, their relationship to such thresholds are not *dispositive* of causation. The jury's task is to parse these counterfactual states of the world and identify which state of the world actualized. The strategy for doing this depends on whether the type of harm is one for which "ex-post evidence"—individuating evidence left in the wake harm that distinguishes between avoidable and inevitable injuries—is expected to be available. Harm expected to generate such ex-post evidence is denoted as "distinguishable harm," as opposed to "indistinguishable harm."

The proposed framework will make three conclusions clear. First, both for cases of distinguishable and indistinguishable harm, allowing arbitrary thresholds on the attributable risk rate to keep issues from a jury is distortionary. Second, for distinguishable harm, the attributable risk rate is a necessary but not a sufficient metric to characterize causation.

Third, and most importantly, the process enumerates the many steps necessary to properly implement statistical evidence. Perfect implementation is practically impossible, due in part to data constraints, and in part to lack of judicial expertise. The answer to this impossibility is not nihilism, however. The personalize/operationalize process helps to move us closer to the correct answer; perhaps more importantly, however, the articulation of the necessary steps should serve as a powerful reminder of the dangers of allowing imperfect estimates to screen out cases. Statistics provide important information, but not taking them seriously can result in systematically incorrect outcomes.

Section I outlines how courts have dealt with issues of probabilistic harm in the context of medical malpractice, including the rise of the loss of chance doctrine. Section II describes the proposed framework for approaching probabilistic harm, reducing the inquiry into two parameters, the size of the inevitable and avoidable classes. It then discusses the personalize/operationalize process for approaching causation, which varies depending on the nature of the harm. Section III explains how the

19. *See infra* Part I.B.

personalize/operationalize process aligns with the preponderance of the evidence standard and the existing expert witness testimony requirements. Section IV provides a concrete numerical example to illustrate the benefits of the personalize/operationalize process relative to other legal rules. Section V addresses other benefits of the framework, noting that it better reconciles the approach in probabilistic and non-probabilistic harm cases, retains other avenues to limit liability, and treats statistics with the gravity deserved.

I. PROBABILISTIC HARM AND LOSS OF CHANCE

While all causation is probabilistic, probabilistic harm is most frequently acknowledged in the context of medical malpractice and wrongful death, specifically where an already-ill patient is the victim of negligence. These scenarios are characterized by the negligent act increasing an existing risk of injury.

The most pressing issue with probabilistic causation is its interaction with burden of proof, specifically the preponderance of the evidence standard. The preponderance of the evidence standard is sometimes represented in percentage terms, requiring greater than 50% confidence that negligence caused the harm.[20] The assignment of a percentage to the burden of proof, paired with the availability of statistical evidence on causation, has a history of confusing courts.

A. Probabilistic Harm and the Rise of the Loss of Chance Doctrine

Some courts have interpreted the preponderance of the evidence standard to require a pre-negligence survival rate greater than 50%.[21] In the oft-cited case of *Cooper v. Sisters of Charity of Cincinnati, Inc.*, a young child came to the hospital with a head injury.[22] The attending doctor allegedly negligently failed to diagnose a basal skull fracture, and the boy died after being sent home.[23] At trial, an expert testified that "while there is practically a 100% mortality rate without surgery for patients with similar injuries as decedent's, 'there certainly is a chance and I can't say exactly what—maybe some place around 50%—that he would survive with surgery.'"[24] The trial

20. *See, e.g.*, Falcon v. Mem'l Hosp., 462 N.W.2d 44, 47 (Mich. 1990). This characterization has been criticized by scholars, potentially for good reason. *See Preponderance, Probability and Warranted Factfinding*, *supra* note 12, at 1098.

21. Cooper v. Sisters of Charity of Cincinnati, Inc., 272 N.E.2d 97, 104 (Ohio 1971) ("Probable is more than 50% of actual.") (citing Price v. Neyland 320 F.2d 674, 678 (D.C. Cir. 1963)), *overruled by* Roberts v. Ohio Permanente Med. Grp., Inc., 668 N.E.2d 480 (Ohio 1996).

22. *Id.* at 99.

23. *Id.* at 99–101.

24. *Id.* at 101.

court held that this was insufficient evidence to submit the issue of causation to a jury and instead granted a directed verdict for the defendant.[25]

Confronted with these stark outcomes, courts have looked to other options. Some courts have allowed evidence of increased risk to go to a jury under the Second Restatement of Torts section 323,[26] under the theory of duty arising under a voluntary undertaking.[27] In *Hamil v. Bashline*, the court held that under section 323, the plaintiff need not "introduce medical evidence in addition to that already adduced to prove defendant's conduct increased the risk of harm."[28] Instead, after the jury hears evidence on "the likelihood that defendant's conduct resulted in plaintiff's harm, that Section leaves to the jury, and not the medical expert, the task of balancing probabilities."[29] Instead of proving that "a defendant's act or omission set in motion a force which resulted in harm, the theory of the present case is that the defendant's act or omission failed in a duty to protect against harm from another source."[30] Scholars have critiqued this approach as conflating the definition of duty with the issue of causation.[31]

Other courts started to adopt the loss of chance doctrine to allow recovery for plaintiffs who had less-than-even odds of recovery. The Washington Supreme Court's decision in *Herskovits v. Group Health Cooperative of Puget Sound*,[32] which resulted in no fewer than four opinions, demonstrates some of the considerations prompting adoption of the loss of chance doctrine.[33] The case was brought by the plaintiff's estate, alleging that his physician's failure to diagnose lung cancer in its early stage was

25. *Id.* at 102 ("Even with the best surgical intervention no one could say with any certainty that there would be recovery; that there is no possible way for a physician to ascertain with any degree of certainty whether with further medical attention the decedent would have lived or would have died and that it is a matter of pure speculation and guess to render any opinion concerning the chances of recovery."). The court eventually overruled *Cooper*, adopting a version of loss of chance. Roberts v. Ohio Permanente Med. Grp., Inc., 668 N.E.2d 480, 484 (Ohio 1996).

26. *See, e.g.*, Hamil v. Bashline, 392 A.2d 1280, 1288 (Pa. 1978).

27. RESTATEMENT (SECOND) OF TORTS § 323 (AM. L. INST. 1965) ("One who undertakes, gratuitously or for consideration, to render services to another which he should recognize as necessary for the protection of the other's person or things, is subject to liability to the other for physical harm resulting from his failure to exercise reasonable care to perform his undertaking, if (a) his failure to exercise such care increases the risk of such harm, or (b) the harm is suffered because of the other's reliance upon the undertaking.").

28. *Hamil*, 392 A.2d at 1288.

29. *Id.*

30. *Id.* at 1286.

31. Wright, *supra* note 13, at 1070–71.

32. Herskovits v. Grp. Health Coop. of Puget Sound, 664 P.2d 474 (Wash. 1983).

33. Though *Hamil* and *Hicks v. United States*, 368 F.2d 626 (4th Cir. 1966), are cited as early origins of the doctrine, both involved greater-than-even odds of survival. *Herskovits*, 664 P.2d at 485 (Pearson, J., concurring) (noting that *Hamil* and *Hicks* both involved survival chances greater than 50%).

malpractice.[34] The majority suggested that a reduction in the probability of survival from 39% to 25% was sufficient reduction to be submitted to a jury on the issue of proximate cause.[35] The court rejected the obligation to show that "Herskovits 'probably' would have had a [fifty-one] percent chance of survival if the hospital had not been negligent" and held that "medical testimony of a reduction of chance of survival from 39 percent to 25 percent is sufficient evidence to allow the proximate cause issue to go to the jury."[36]

The perhaps more famous concurrence, authored by Justice Pearson and referencing the seminal article by Joseph King, adopted the loss of chance doctrine.[37] Dismissing the majority's reliance on cases with survival probabilities exceeding fifty percent, Justice Pearson suggested that the most equitable option would be to transform the harm from death to loss of chance for survival.[38] Essentially, the claim would be that the physician's negligence caused the loss of chance to survive. Causation then must still be established but with respect to the reduction in survival likelihood. Justice Brachtenbach dissented, reasoning that the burden of proof should not be relaxed for malpractice cases.[39] Instead, "the record would need to reveal other facts about the patient that tended to show that he would have been a member of the 14 percent group whose chance of 5 years' survival could be increased by early diagnosis."[40] Brachtenbach did not feel that the evidence presented was sufficient to present to the jury, however.[41] The second dissenting opinion by Justice Dolliver drew a bright line: "Whether the chances were 25 percent or 39 percent decedent would have survived for 5 years, in both cases, it was more probable than not he would have died."[42]

These four fractured opinions showcase the ideological schisms in understanding probabilistic harm. Justice Pearson's opinion seems to characterize what is commonly considered loss of chance: transforming the harm in question from the ultimate harm (bodily injury or death) to the deprivation of a chance of recovery.[43] And indeed, depending on how

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34. *Herskovits*, 664 P.2d at 475 (majority opinion).

35. *Id.* at 479.

36. *Id.*

37. *Id.* at 486–87 (Pearson, J., concurring) (discussing Joseph H. King, Jr., *Causation, Valuation, and Chance in Personal Injury Torts Involving Preexisting Conditions and Future Consequences*, 90 YALE L.J. 1353 (1981)).

38. *Id.* at 485 ("Under these cases, the defendant is liable, not for all damages arising from the death, but only for damages to the extent of the diminished or lost chance of survival.").

39. *Id.* at 488–89 (Brachtenbach, J., dissenting).

40. *Id.* at 490.

41. *Id.* at 491.

42. *Id.* at 492 (Dolliver, J., dissenting).

43. *But see* Roberts v. Ohio Permanente, 668 N.E.2d 480, 484 (Ohio 1996) ("In order to maintain an action for the loss of a less-than-even chance of recovery or survival, the plaintiff

damages are calculated, some may argue that this makes no practical difference. However, the dichotomous thinking it represents—drawing a qualitative threshold at fifty percent—is worth highlighting. Despite the different outcomes of Justice Pearson's and Justice Dolliver's frameworks, an important commonality remains: both would require a baseline survival rate exceeding fifty percent in order to recover under traditional negligence principles. Justice Pearson's workaround avoids the stark consequences of leaving malpractice victims uncompensated.

In contrast, the majority and Justice Brachtenbach seem to allow for recovery despite baseline rates below fifty percent; however, Justice Brachtenbach believes that there was insufficient evidence to submit the issue to the jury.[44]

B. Criticisms of the Loss of Chance Doctrine

The loss of chance doctrine, despite Justice Pearson's endorsement, has had mixed reception. A threshold issue has been whether the loss of chance doctrine is compatible with various state wrongful death statutes.[45] In considering the substantive effect of the doctrine, some scholars have praised the idea of recognizing a general property interest in lost chance.[46] Others support the doctrine for placing a primary emphasis on valuing human life.[47] Other scholars have been a bit more critical, noting the difficulty that courts have had understanding the statistics that they apply. Tory Weigand and Lars Noah note that misunderstandings about the progression of diseases like

must present expert medical testimony showing that the health care provider's negligent act or omission increased the risk of harm to the plaintiff. It then becomes a jury question as to whether the defendant's negligence was a cause of the plaintiff's injury or death. Once this burden is met, the trier of fact may then assess the degree to which the plaintiff's chances of recovery or survival have been decreased and calculate the appropriate measure of damages. The plaintiff is not required to establish the lost chance of recovery or survival in an exact percentage in order for the matter to be submitted to the jury. Instead, the jury is to consider evidence of percentages of the lost chance in the assessment and apportionment of damages." (citing McKellips v. Saint Francis Hosp., Inc., 741 P.2d 467, 475 (Okla. 1987))). *Roberts* defines loss of chance as the ability to submit the question to the jury. *Id.*

44. *Herskovits*, 664 P.2d at 491. (Brachtenbach, J., dissenting).

45. *See* Brian Casaceli, *Losing a Chance To Survive: An Examination of the Loss of Chance Doctrine Within the Context of a Wrongful Death Action*, 9 J. HEALTH & BIOMEDICAL L. 521, 522–24 (2014).

46. *See, e.g.*, Howard Ross Feldman, *Chances as Protected Interests: Recovery for the Loss of a Chance and Increased Risk*, 17 U. BALT. L. REV. 139 (1987).

47. *See, e.g.*, Mangan, *supra* note 8; *see also* Jed Kurzban et al., *It Is Time for Florida Courts To Revisit Gooding*, FLA. BAR J., Nov. 2017, at 8 (arguing for Florida to adopt the loss of chance doctrine).

cancer could lead to incorrect calculations of the loss of chance.[48] Noah goes on to comprehensively document the types of mathematical errors courts make in assessing the magnitude of a loss of chance, resulting in inconsistent treatment across patients.[49]

In addition to the issues with implementing the loss of chance doctrine, there are theoretical concerns with the doctrine itself. First, while damages under a loss of chance theory *may* be roughly similar to the damages under the traditional tort framework, loss of chance runs the risk of overcompensation in jurisdictions that impose proportional recovery only in contexts with survival rates below 50%. For an intuitive explanation, if a plaintiff believes that they can provide proof of a higher than 50% likelihood of survival, they will claim the traditional theory of causation. If they cannot, however, they can fall back on loss of chance, recovering for whatever probability they can prove. If all plaintiffs bring suit, deterrence typically will not be optimal.

Second, the logic of the loss of chance doctrine is questionable. Loss of chance transforms the relevant harm from the actual physical harm into the deprivation of some level of chance (often of survival). This transformation allows courts to make awards in low-probability cases because the causation analysis asks whether the negligence caused the reduction in chance of survival, not the harm. Simultaneously, however, this transformation does not provide a good reason for not compensating lost chances even if harm does not result. Scholars have raised this as a concern;[50] however, courts that adopt loss of chance have largely not awarded damages without harm.

This Article adds to these critiques by arguing that resort to loss of chance results from a misunderstanding of how law and statistics interact. Resolving this misunderstanding is vitally important in the future, where attributable risk rates will be more available in contexts outside of medical malpractice. Available risk rates generally need considerable adjustment in order to be relevant to the causation inquiry at trial. Moreover, events associated with probabilities of less than 50% occur with regularity. Because of this, raw risk rate levels should not be a screening device to take the question of causation away from the jury under a traditional analysis. Instead, cognizant of potential confounding factors for observational data, courts should seek a plaintiff-specific attributable risk rate. Then, having been given this rate as

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48. Tory A. Weigand, *Loss of Chance in Medical Malpractice: The Need for Caution*, 87 MASS. L. REV. 3, 20 (2002); Noah, *supra* note 11, at 385. For example, "lead time bias" refers to the phenomenon in which cancer patients "simply learn of their disease earlier but do not really survive longer in absolute terms." Noah, *supra* note 11, at 385. Not accounting for this bias would lead to overinflation of loss of chance recovery because the negligent act of failing to diagnose earlier does not reduce the patient's lifespan but rather their time living with the diagnosis. *Id.*

49. Noah, *supra* note 11, at 383–403.

50. Wright, *supra* note 13, at 1072.

evidence, the jury must be asked whether the current case corresponds to a state of the world in which negligence caused the harm. The following Section discusses this proposed framework in more depth.

II. INTERPRETING OBSERVATIONAL DATA TO ASSESS PROBABILISTIC HARM

Establishing causation with statistical evidence is not straightforward, in part due to the inherent incompatibility between a deterministic view of law and the probabilities communicated by statistical evidence. Statistical evidence can only convey how likely an event is, not whether it occurred. This is a particularly poor fit for litigation, which—unlike regulation—is concerned with an individual circumstance, not average outcomes.

To transform continuous probabilities provided by statistics into the dichotomous decisions it desires, the law imposes arbitrary thresholds,[51] characterized by the burden of proof. The preponderance of the evidence burden of proof requires that the jury believe that causation is "more likely than not" established. This standard has been conceptualized as a belief that the probability of causation is strictly greater than 50%.[52] Events associated with probabilities below this threshold are considered a legal impossibility, despite their regular and predictable occurrence. This fiction ignores the fact that a jury can be confident that causation is more likely than not established in an individual case despite an average probability below 50%.

This Section proposes that statistical evidence—after being subjected to refinements necessary to convert available data to a plaintiff-specific probability—not be evaluated by such thresholds to screen cases from the jury or to determine whether the plaintiff is eligible for traditional or proportional recovery. Instead, the type of recovery should be dictated by whether the harm is distinguishable or indistinguishable, and statistical evidence should be submitted to the jury—along with testimony about the

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51. *See* Michelle M. Mello, *Using Statistical Evidence To Prove the Malpractice Standard of Care: Bridging Legal, Clinical, and Statistical Thinking*, 37 WAKE FOREST L. REV. 821, 828–831 (2002).

52. *See, e.g.*, *Direct Interference in the Lost Chance Cases*, supra note 12, at 258. Other scholars suggest that the relevant conception of the burden of proof is not the absolute probability that the defendant is liable but instead a probability ratio of the plaintiff's and defendant's claims, conditional on the evidence. Edward K. Cheng, *Reconceptualizing the Burden of Proof*, 122 YALE L.J. 1254, 1259 (2013). This Article is sympathetic to this conceptualization, as the idea of comparing two narratives does not contribute to the myth that only events with a sufficiently high level of nominal probability occur. *See* Nancy Pennington & Reid Hastie, *The Story Model for Juror Decision Making*, *in* INSIDE THE JUROR: THE PSYCHOLOGY OF JUROR DECISION MAKING 192 (Reid Hastie ed., 1993). The argument nonetheless shows that the proposed personalize/operationalize process can be reconciled with the more traditional conception of the preponderance of the evidence.

considerations addressed by the statistic—as probative but not dispositive to an individual case. This solution allows statistics to assume their rightful place in the causation inquiry while preserving most of the existing litigation structure.

This Section presents a simple framework for how to think about probabilistic causation. Based on this framework, the Article outlines the personalize/operationalize process, which converts available rates into the plaintiff-appropriate metrics and—considering the range of outcomes implied by that metric—determines whether the plaintiff should recover in the current case.

A. Description and Implications of the Framework

Most questions of probabilistic harm in a medical malpractice setting consist of a healthcare provider, in violation of the standard of care, neglecting to provide a specific treatment to an already-ill patient.[53] The lack of such treatment usually reduces the survival rate of the patient.[54] The jury is then tasked with ascertaining whether the (allegedly) negligent act caused the harm in question.[55]

These features can be combined into Table 1. Out of 100 people, some number (*b*) are going to experience harm without negligence. With negligence, an additional number (*d*) of people will experience harm.

Table 1 separates a population of 100 people into two columns in two alternative worlds (rows). The first row describes the world in which the negligent act did not occur, and the second row describes the world in which the negligent act did occur. The first column consists of people who do not experience the harm and the second of people who do experience the harm. These parameters are necessary to answer the probabilistic question of causation; however, finding the right values is not straightforward.

53. Robert J. Rhee, *Loss of Chance, Probabilistic Cause, and Damage Calculations: The Error in* Matsuyama v. Birnbaum *and the Majority Rule of Damages in Many Jurisdictions More Generally*, 1 SUFFOLK U. L. REV. ONLINE 39, 40–42 (2013).

54. *Id.*

55. *Id.*

Table 1. Basic Framework for a Population of 100.[56]

	No Harm	Harm
No Negligence	100-*b*	*b*
Negligence	100-*b*-*d*	*b*+*d*

Given this common framework,[57] we can identify 1) the relevant causation inquiry and 2) the probability associated with it. Personalizing this probability and operationalizing it for a causation judgment will be covered in Section II.B.

Because the plaintiff is already injured at the time of trial, we are only interested in column (2) of Table 1. The first row displays the number of injuries that would occur even in the absence of negligence ("inevitable injuries"), and the second row adds the number of injuries that would only occur with negligence ("avoidable injuries"). In considering the causation element, the plaintiff has already addressed the presence of the negligent act; accordingly, we focus on the second row of the second column, *d*+*b*. Table 2 decomposes this cell into the relevant two categories. At trial, juries must determine whether the patient in question belongs to the "inevitable" category that would have experienced the harm even without the negligence (*b*), or the "avoidable" category that would not have experienced harm in the absence of negligence (*d*). Notably, this is akin to the reasoning in Justice Brachtenbach's dissenting opinion.[58]

56. Table 1 represents a population of 100 in two counterfactual worlds: the first row represents a world where the negligent act did not occur, and the second row represents a world in which it did. A certain number of people, *b*, would be injured in either world, while an additional number, *d*, are only injured in the presence of negligence.

57. Vern Walker refers to the same basic concepts as "residual baseline risk" (*b*) and "defendant-caused risk" (*d*). *Direct Interference in the Lost Chance Cases*, *supra* note 12, at 254–55.

58. Herskovits v. Grp. Health Coop. of Puget Sound, 664 P.2d 474, 490 (Wash. 1983) (Brachtenbach, J., dissenting) ("To meet the proximate cause burden, the record would need to reveal other facts about the patient that tended to show that he would have been a member of the 14 percent group whose chance of 5 years' survival could be increased by early diagnosis.").

Table 2. The Relevant Causation Question at Trial[59]

	Inevitable	**Avoidable**
Experiencing Harm	b	d

Table 2 provides two insights. First, for issues of probabilistic harm, the relevant causation probability is $\frac{d}{b+d}$, the probability that the plaintiff belongs to the avoidable category. This probability corresponds to the concept of "attributable risk" endorsed by Lars Noah.[60] At least one court, *Marcantonio v. Moen*, has acknowledged Noah's endorsement of this metric for liability and soundly rejected it, reasoning that the probability of survival, not the risk of morbidity, is the correct measure of liability.[61] The above framework table contradicts this, demonstrating that the relevant metric for analyzing probabilistic harm *must* be the attributable risk rate.

The second insight Table 2 provides is that the attributable risk rate is the relevant metric regardless of survival rate level. Any requirement on the attributable risk rate must apply at all levels of survival in order to be consistent. If survival rates exceed 50% (i.e., when b is less than 50),[62] the jury still must determine whether the plaintiff falls within the avoidable or inevitable injury class. For example, if $b = 15$ and $d = 5$—corresponding to a survival rate of 85% without negligence and 80% with negligence—the attributable risk rate is only $\frac{5}{15+5} = \frac{1}{4}$. Here, despite the survival rate exceeding 50%, a plaintiff has less than even odds in being a part of the "avoidable" class. Another implication of this rule is that at very high levels of survival rates, small declines in survival rates can produce high attributable

59. Table 2 modifies Table 1 by only looking at worlds in which harm actualizes. It then separates the number of injured people into those who would be injured in the absence of negligence, b, and those who are only injured in the presence of negligence, $(b+d)-b = d$.

60. Noah, *supra* note 11 at 378, 382. The relative risk ratio ("RRR"), $\frac{b+d}{b}$, is a related concept, representing the increase in risk associated with, in this context, negligence. A straightforward calculation shows that the attributable risk ratio of 0.5 corresponds to a RRR of 2. The RRR has been cited by courts, again imposing strict thresholds to prove causation. *See* Theofanis v. Sarrafi, 791 N.E.2d 38, 48 (Ill. App. Ct. 2003) ("Several courts have concluded that a plaintiff meets the burden of proving causation by presenting evidence that the relative risk due to the defendant's acts or omissions exceeds two."). The rest of this Article will continue to use attributable risk rate (as it most simply corresponds to the causation inquiry), but a similar argument can be made using the RRR.

61. Marcantonio v. Moen, 937 A.2d 861, 876 (Md. Ct. Spec. App. 2007), *rev'd*, 959 A.2d 764 (Md. 2008).

62. Lars Noah also notes that the same inquiries are relevant for survival base rates greater than 50. Noah, *supra* note 11, at 393.

risk rates. The *Marcantonio* court acknowledges this possibility and uses it as a reason to, somewhat confusingly, reject the attributable risk approach.[63] The focus on nominal level of risk rather than the probability that the plaintiff falls within the avoidable class exemplifies courts' confusion.

Lars Noah presents a thorough inventory of other types of mathematical errors that courts make in deciding whether to use the loss of chance doctrine, errors that are clear from this framework. Some courts, like the *Marcantonio* court, only consider the baseline survival rate, $\frac{100-b}{100}$.[64] The mistake is understandable; courts are likely responding to the fact that if $b = 50$, d cannot be strictly greater than b.[65] Other courts have required a decline in likelihood of survival of 50 percentage points (equivalent to $d \geq 50$)[66] or that the increase in risk be 50% of the base risk ($d > 0.5b$).[67] Finally, some courts use a percent change in survival rates ($\frac{d}{100-b} > 0.50$).[68] None of these corresponds to the probability that the plaintiff belongs to the avoidable class.

Notably, the choice of metric is not inconsequential. Depending on what metric is used, the magical 50% threshold is harder or easier to meet. Figure 1 plots four of these metrics, shading the area in which the relevant metric is greater than 50%. Panel (a) displays the levels of b and d for which the attributable risk rate exceeds 50%, panel (b) the same where the percent decline in survival rate exceeds 50%, panel (c) where the increase in risk is greater than 50% of the base risk, and panel (d) where the percentage point decrease in survival exceeds fifty. The variety of shapes and sizes make clear that, while all subscribe to a particular interpretation of the 50% threshold, each impose wildly inconsistent requirements. The variety of ways to describe increased risk shows the difficulty in conforming to the 50% threshold. Moreover, these strategies systematically ignore a certain level of actual injuries attributable to negligence.

63. *Marcantonio*, 937 A.2d at 876. The court notes that "[a]doption of such an approach would allow recovery for wrongful death based upon the mere possibility that prior to the malpractice the decedent was not in the . . . percent of the population that would have died absent the negligence." *Id.* This explanation is unclear and demonstrates the confusion courts face.

64. Noah, *supra* note 11, at 393–94.

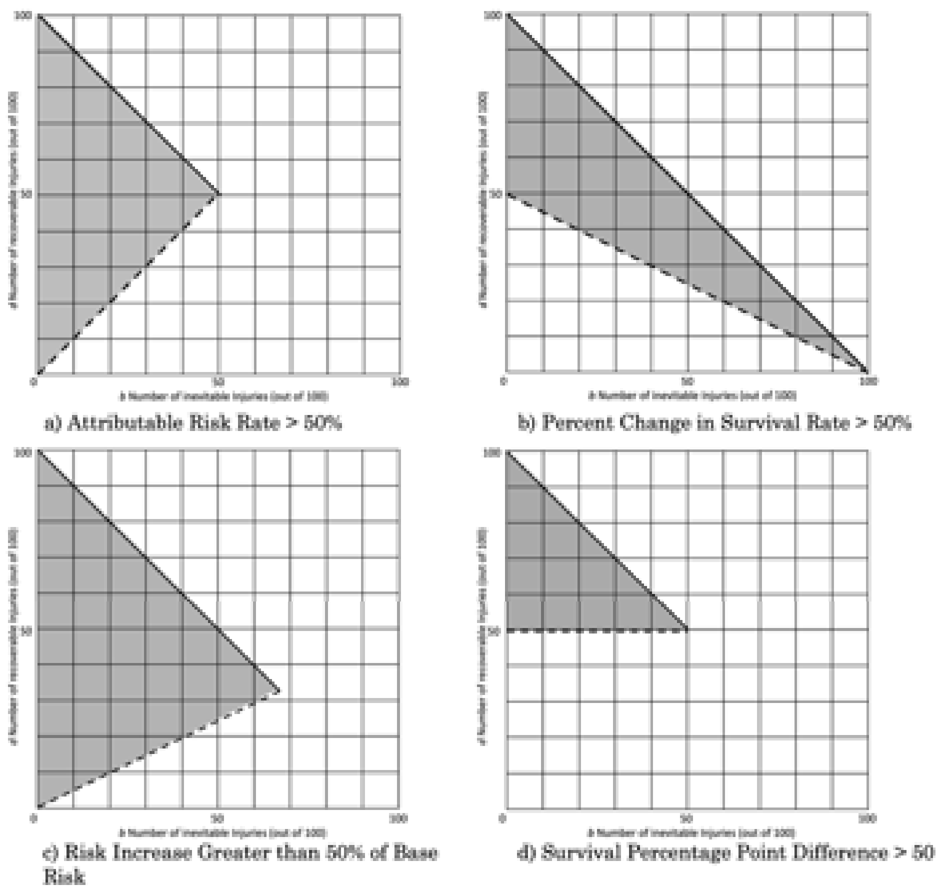
65. This is because the total potential harm ($d + b$) in a population of 100 individuals is 100 and 50 is exactly half of 100. We will come back to this issue in Section II.B.d.2. In a population of a different size, the threshold value of b above which d cannot be greater than b is $\frac{population}{2}$.

66. *See, e.g.*, *Marcantonio*, 937 A.2d at 875 (calculating the change between two in ten people dying to five in ten people dying as "at most, thirty percent" reduction in survival).

67. One critical point of confusion in terms is the conflation of "percent" and "percentage points." For example, an increase from 0.02 to 0.04 is a 100% increase ($\frac{.04-.02}{.02}$ x 100 = 100%), but also an increase of two percentage points.

68. Noah, *supra* note 11, at 394–97.

Figure 1. A Variety of Requirements.[69]



In contrast, the basic framework presented isolates the likelihood that the plaintiff belongs to the avoidable class of patients that would not have experienced harm in the absence of negligence. This basic framework allows us to concentrate on the two subsequent questions a jury must face: 1) what

69. This figure displays four of the metrics discussed in this section. The shaded regions represent the levels of *b* and *d* for which each metric exceeds 50%. Panel (a) indicates the area where the attributable risk rate exceeds 50%, panel (b) where the percent decline in survival rate exceeds 50%, panel (c) where the increase in risk is greater than 50% of the base risk, and panel (d) where the difference in survival exceeds 50 percentage points. Each of these areas concern some 50% threshold but impose wildly different requirements of *b* and *d*. For interested readers, the functions plotted in Figure 1 are as follows: for panel (a): $\frac{d}{b+d} > 0.50$; panel (b): $\frac{d}{100-b} > 0.50\boxed{\frac{d}{100-b}}$; panel (c): $d > 0.5b$; and panel (d): $d > 50$. The plots represent the intersections of these functions with $d \leq 100 - b$.

is correct level of *b* and *d* for a patient with the same observable and unobservable features as the plaintiff; and 2) given the correct *b* and *d*, did the negligence cause the harm?

B. Personalize/Operationalize Process

With the relevant concepts defined, this Article proposes a process for implementing these concepts. The first step uses pre-incident "ex-ante" evidence about the plaintiff—including the plaintiff's demographics and medical history—to predict the most specific attributable risk rate for patients identical to the plaintiff. The second step uses this specific attributable risk rate to describe the counterfactual states of the world. If individuating case-specific evidence is likely to be available to patients falling within the avoidable class, the factfinder must incorporate case-specific "ex-post" evidence—evidence left in the wake of the harm—to assess whether the current case is an actualization of avoidable or inevitable harm. If patients falling within the avoidable class are no more likely to have individuating evidence, proportional recovery is appropriate (regardless of the level of the attributable risk rate).

1. Step One: Find the Right Attributable Risk Rates

The first step in the process is to find the most relevant attributable risk rate for a patient like the plaintiff, adjusting *b* and *d* for the plaintiff's observable and unobservable characteristics. As previously noted, perfect adjustment is essentially impossible. Even if courts had the institutional knowledge to recompute probabilities, the available data is incomplete. This does not mean that the endeavor is worthless, however; it merely means that the practice should be undertaken carefully, with an eye towards its limitations. Knowing the revisions necessary to make a probability accurate will help courts identify how probative their current evidence is. Moreover, the acknowledgement of such limitations makes clear why these admitted statistics should not serve to screen cases from the jury.

a. Definition of Harm

The first, and easiest, iteration of refining observational data is to identify the right type of harm: harm that is medically indistinguishable from the type expected from the alleged negligent care. The cases invoking the loss of chance doctrine generally involve negligence that fails to treat or exacerbates the underlying medical condition.

Despite the specific application of the doctrine, the terminology with which it is described is often imprecise. Courts often phrase the threshold issue as whether "a plaintiff's estimated chance of surviving or recovering from an existing illness or injury, absent the malpractice, is [fifty percent] or less[.]"[70] This focus on total survival rates, however, obscures the relevant inquiry, which is not whether death eventually finds the plaintiff but whether the alleged negligence caused *this* harm.[71] If a patient was likely to die of a disease eventually, a negligent act that brought about an earlier death does not escape liability.[72] Survival rates are relevant to the causation inquiry, but only insofar as the rates incorporate the right type of harm.

This distinction becomes clear as we consider more acute examples of medical malpractice. For example, consider a stage four cancer patient who is involved in a car accident and enters the emergency room with abdominal bleeding. While the patient may have a less-than-even chance of survival due to the advanced stage of cancer, the physician who negligently ignores the patient is not excused from liability. Connecting the death from blood loss to the negligent act is straightforward and has nothing to do with the cancer patient's eventual death from cancer. While both harms involve death, death from abdominal bleeding is medically distinguishable. Deaths that are medically distinguishable from those expected from the negligent act are accordingly not represented by *b* or *d*.

b. Estimating the Inevitable Injuries: b

Having defined the relevant harm, we estimate the risk in the absence of negligence, a counterfactual count of inevitable injuries. This is represented by the parameter *b* in Table 1.[73] For a given individual, the counterfactual state is always unknowable. The best estimate of this counterfactual would consider people with the same set of observable and unobservable features as the patient who would inevitably suffer harm. In the medical malpractice context, factors that may affect the baseline risk level of an underlying

70. Holton v. Mem'l Hosp., 679 N.E.2d 1202, 1209 (Ill. 1997).

71. See Noah, *supra* note 11, at 389 (noting that jurisdictions do not focus on this distinction).

72. RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYS. & EMOT. HARM § 26 (AM. L. INST. 2010).

73. Vern Walker notes that discrepancy in this measure may be caused by different sets of included control factors. *Direct Interference in the Lost Chance Cases*, *supra* note 12. This is true but unavoidable. While the goal should be to be as specific as possible, even that will not avoid a probabilistic interpretation. Walker also discusses how subjective probabilities map onto frequentist probabilities. *Id.* at 253. The framework here allows frequencies (with some adjustments) to be the best estimate for a subjective probability.

condition include demographics, medical history, lifestyle choices, and genetic endowments.[74]

How do we find these estimates? Some of these observable features may be accounted for in published literature. Some studies do disentangle the marginal effect of gender, race, or age on outcomes for a particular condition. Other distinctions are not always easy to incorporate into published rates. Factors such as nutrition, alcohol and nicotine usage, or co-morbidities, may only be associated with a qualitative effect on causation.[75] For example, the published literature might specify that poor nutrition reduces survival rates, though it does not estimate a marginal effect size for this. Yet other factors, such as genetic endowments, are entirely unobservable to researchers. Accordingly, while adjustments should be made, they will necessarily be incomplete. Noting factors by which the estimate must be further adjusted provides the jury a basis in constructing their beliefs.

c. Estimating the "Negligence Effect": d

We must then define the magnitude of the additional harm that occurs only in the presence of negligence (the "negligence" effect).[76] This is represented by *d* in Table 1. Implicit in the causation inquiry is the necessity of causality, not mere correlation.

Experiments that randomly assign participants to control and treatment groups, the latter receiving medical intervention and the former not, produce a straightforward estimate of the average causal effect. A comparison of outcomes across the treatment and control captures the average decrease in risk rate attributable to the treatment. The negligence effect is essentially the mirror image of the treatment effect; rather than calculate the decrease in risk rate with the appropriate medical intervention, the negligence effect measures the increase in risk rate without it. Without a randomized controlled experiment, however, eliciting an unbiased treatment effect from observational data is complicated.

Comparisons of probabilities of harm with and without the negligence are insufficient to characterize *d,* unless these probabilities represent a causal

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74. Douglas G. Manuel & Laura C. Rosella, *Commentary: Assessing Population (Baseline) Risk is a Cornerstone of Population Health Planning—Looking Forward to Address New Challenges*, 39 INT'L J. EPIDEMIOLOGY 380, 380 (2010), https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2846444/pdf/dyp373.pdf [https://perma.cc/XZP9-7QD9].

75. *See, e.g.*, PAUL SLOVIC, THE PERCEPTION OF RISK (Ragnar E. Löfstedt ed., 2000).

76. In the context of medical malpractice, this will often be the absence of a particular procedure.

relationship.[77] An example of such a danger is as follows: suppose a necessary treatment is disproportionately denied to patients with poor nutrition. A simple sample difference between outcomes of patients with and without the treatment would incorporate not only the effect of the treatment but the effect of the poor nutrition. The measured effect of the treatment accordingly is an overestimate. Another example is a treatment that is reserved as a last resort measure and is only offered to patients for whom other treatments have failed. If the treatment is accordingly conflated with poor underlying health, a simple sample difference would underestimate the effect of the treatment. This would be a biased, and certainly unhelpful, estimation of the effect of negligence. Disentangling the confounding effects to isolate the causal effect is a nontrivial, but essential, process. Indeed, in an extreme version of the above example, treatment could have no effect on outcomes and the estimated effect could be entirely driven by nutrition.

These issues are not new to the field of social science; indeed, there are various complicated statistical strategies social science research uses to disentangle causal relationships from correlations observed in data.[78] While this Part II does not suggest that juries will become expert statisticians, a court's acknowledgment of the complexities of untangling these confounding factors provides a basis upon which experts can opine. Part III will further discuss how the current legal infrastructure can accommodate these complications; for now, it is enough to know that these estimates are not self-evident truths that a jury must just accept.

Finally, in the same way that the rate of inevitable injuries can vary by demographic factors, there can be a differential negligence effect. This means that a treatment may be more or less efficacious for different subsets of the population. While this might not be the case, allowing for a differential negligence effect is less restrictive than assuming that the effect is uniform.

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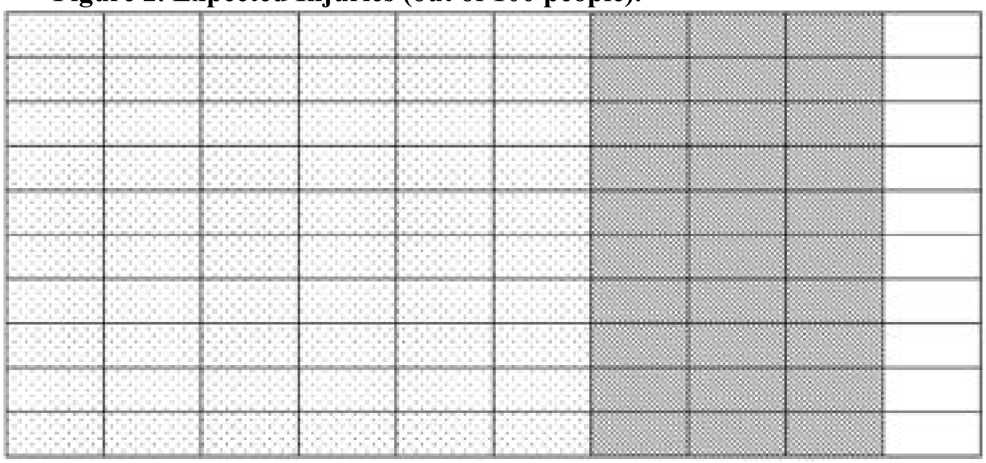
77. While this is assumed to be true in the above table, considerable expert testimony may be necessary to establish a general causal connection between the negligent act and harm. This Article focuses on the circumstances in which a plaintiff can recover, given some general established relationship between negligence and injury. Similarly, there are other difficulties in using statistical data to establish a general causal connection between negligence and harm. Scholars have tackled the difficulties in parsing statistical concepts such as statistical significance and model fit with burden of proof. David W. Barnes, *Too Many Probabilities: Statistical Evidence of Tort Causation*, 64 L. & CONTEMP. PROBS. 191, 198–205 (2001). Conditional on resolving these issues, this Article is instead concerned with the additional difficulty in relating the probabilistic results to the burden of proof.

78. *See, e.g.*, JOSHUA D. ANGRIST & JÖRN-STEFFEN PISCHKE, MOSTLY HARMLESS ECONOMETRICS (2008).

d. The Importance of Heterogeneity in Attributable Risk Rates

Combining these parameters, the jury is presented with an estimated probability that the plaintiff only experienced the harm because she was subjected to negligent treatment. Average attributable risk rates that are not customized to the plaintiff's characteristics not only increase the number of errors but also carve out categories of injuries for which there is no legal recovery.

Figure 2. Expected Injuries (out of 100 people).[79]



One way to visualize this is pictorially. Let *b* be the number of dotted boxes, signifying the number of injuries experienced by the average patient without negligence. The striped boxes, *d*,[80] are the number of injuries experienced only in the presence of negligence. But-for causation requires that the plaintiff belongs to the striped section, not the dotted section. The chart looks simple, as the shaded regions represents the average number of injuries with and without negligence. This is not, however, the relevant inquiry.

Figure 3 is a composite of patients with different demographics, health histories, and unobservable genetic factors. Each subpopulation varies by observable or unobservable factors and is indicated by a different Greek letter. Figure 3 is represented in tabular form in Table 3.

79. Figure 2 represents a population of 100 (each person indicated by a box). The people who would inevitably suffer harm even without negligence (b) are represented by dotted boxes. The people who will suffer harm only with negligence (d) are represented by striped boxes. People who are uninjured are unshaded.

80. Here, in a population of 100, *b*=60 and *d*=30.

Figure 3. Accounting for Heterogeneity within an Average.[81]

α	α	α	β	β	γ	α	γ	δ	α
α	α	α	β	β	γ	β	γ	δ	α
α	α	α	β	β	δ	β	γ	δ	α
α	α	β	β	γ	δ	β	γ	δ	α
α	α	β	β	γ	δ	β	γ	δ	α
α	α	β	β	γ	δ	β	δ	δ	β
α	α	β	β	γ	δ	γ	δ	δ	γ
α	α	β	β	γ	δ	γ	δ	δ	γ
α	α	β	β	γ	δ	γ	δ	δ	δ
α	α	β	β	γ	δ	γ	δ	δ	δ

Figure 3, individual characteristics can affect both the baseline risk of harm for person *i*, b_i, and, potentially, the magnitude of the negligence effect, d_i. While the average likelihood of belonging to the "avoidable" class is only ~33.33% (30 out of 90) overall, the probability varies for each population: subpopulation Alpha (~4%), subpopulation Beta (20%), subpopulation Gamma (50%), and subpopulation Delta (~65%).

Table 3. Tabular Version of Figure 3

	b_i: Inevitable Harm	d_i: Avoidable Harm	Unharmed	Attributable Risk Rate
Alpha ($\boldsymbol{\alpha}$)	23	1	5	4%
Beta ($\boldsymbol{\beta}$)	20	5	1	20%
Gamma ($\boldsymbol{\gamma}$)	9	9	2	50%
Delta ($\boldsymbol{\delta}$)	8	15	2	65%
Total	60	30	10	33.33%

Importantly, these attributable risk rates have only been tailored to incorporate features of the patient. We have not yet considered the informative value of other types of evidence involving the specific

81. Figure 3 is the same as Figure 2, except that the 100-person population consists of distinct subsamples, signifying patients of different observable and unobservable features. Each subsample varies by total size, number of inevitably injured, and number of recoverably injured.

circumstances of the harm. This type of evidence is addressed in the following Part.

Given how specific the appropriate probability should be, it should become clear that the appropriate probabilities are likely not easily available. While it is theoretically possible that the quoted percentages at trials incorporate the demographic features of a given individual, complete specification of this is practically impossible. Conversely, the most available concrete probabilities are likely not the most appropriate. In circumstances like this, factors that influence the attributable risk rate should be discussed along with their predicted effect. Submitting such evidence to the jury is potentially a more accurate mechanism for determining causation.

2. Interpreting the Attributable Risk Rate

Once the most specific ex-ante attributable risk rate is found—which is itself a difficult endeavor—the jury is still faced with a probabilistic inquiry.[82]

How are juries supposed to interpret these probabilities? Rules that screen out cases based on arbitrary thresholds—essentially treating probabilities as discrete jumps between certainties—have dire consequences when applied to individual cases. This is not to say that probabilities are irrelevant. Patient i experiencing harm even without negligence becomes more likely for higher levels of b_i. Patient i experiencing harm only in the presence of negligence is less likely for low levels of d_i. However, even at higher levels of the former and lower levels of the latter, a predictable number of patients will satisfy but-for causation. The probabilities should not serve as a *per se* bar to juries considering whether they believe the plaintiff is likely to have been one of those patients.

As an example, suppose the plaintiff belongs to the Beta (β) group in

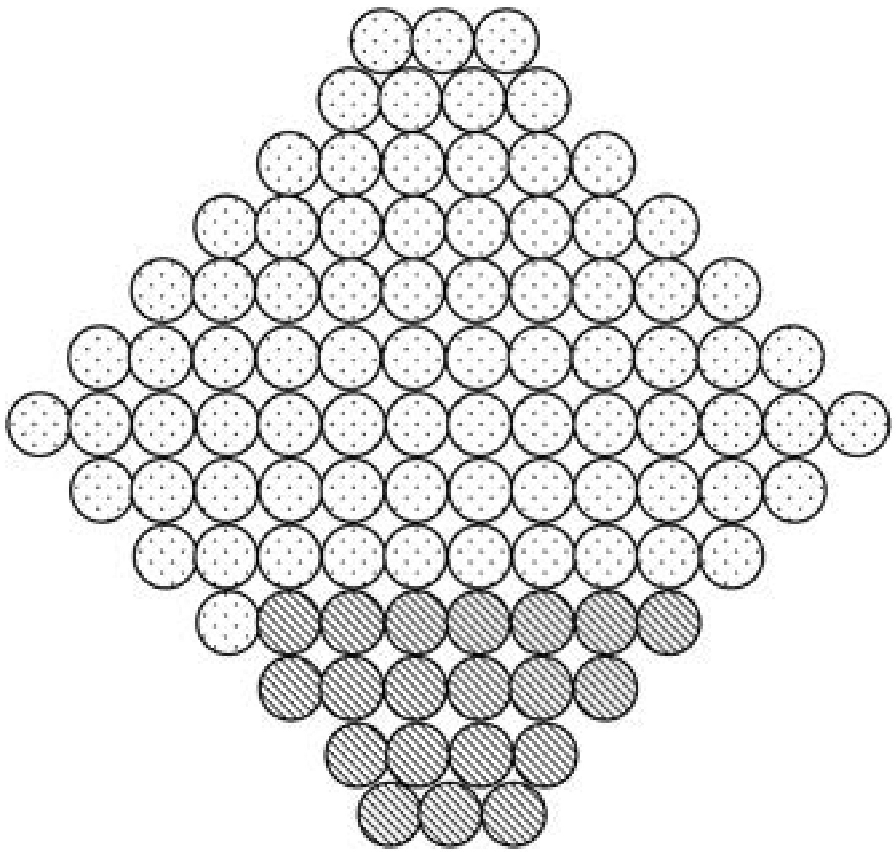
Figure 3: out of a population of 26 people, 25 will be injured, and 5 of those injuries will be attributable to negligence.[83] At trial, we consider the attributable risk rate: conditional on harm occurring, the probability that harm was caused by negligence is 20% (5/25). This inquiry can be imagined as the quintessential science-fiction multiverse: in one hundred parallel universes, a range of outcomes occur. To emphasize that any attributable risk rate (here, 20%) is consistent with a range of outcomes, Figure 4 uses circles to represent

82. Vern Walker agrees that a probabilistic element will remain unless the "residual baseline risk" reduces all the way to zero (in our context, b=0). *Direct Interference in the Lost Chance Cases*, *supra* note 12, at 253. Similarly, in a subsequent paper, Walker acknowledges that factfinder ignorance may be a function of incomplete scientific knowledge and not always the fault of the defendant's negligence. *Preponderance, Probability and Warranted Factfinding*, *supra* note 12, at 1129.

83. For simplicity's sake, suppose these numbers are population parameters.

parallel universes.[84] Out of 100 parallel universes in which the plaintiff experiences harm, on average, the plaintiff would have been inevitably injured in eighty of these worlds (dotted circles) and injured only in the presence of negligence in twenty (striped circles). Does the present case represent a striped circle or a dotted circle?[85]

Figure 4. Counterfactual Worlds.[86]



84. For any attributable risk rate, we can draw a comparable figure. The change from rectangles to circles serves to emphasize that while the rectangles represent observable people, for any attributable risk rate (appropriate to the plaintiff's ex-ante characteristics), we will only see one of the potential counterfactual circles.

85. Scholars correctly acknowledge that a fully specified circumstance would not have any variation in counterfactuals, as all the factors would work together to produce the same outcome in each parallel world. The impossibility of this full specification (i.e., instantaneous blood sugar levels, room temperature, blood pressure, etc.), however, makes this fully hypothetical. If the circumstances were fully specified, the attributable risk rate would be zero or one. For attributable risk rates between zero and one, the variation in counterfactuals follows as a function of the attributable risk rate.

86. Each circle represents a counterfactual state of the world predicted by the attributable risk rate of 20%. The dotted circles represent the states of the world where harm inevitably occurs, and the striped circles represent the states where harm would only occur with negligence.

How juries should handle this question is a function of the nature of the harm. We can imagine two categories of injuries. For some types of injuries, no ex-post evidence will be available to distinguish between inevitable and avoidable injuries ("indistinguishable harm"). For these injuries, we must rely only on the attributable risk rate. For other types of injuries, certain evidence may be more likely to be available in the states of the world where the harm is caused by negligence ("distinguishable harm").[87] For these injuries, the attributable risk rate is just the starting point for the analysis.

Notably, this distinguishable-indistinguishable categorization must be on an injury-specific basis, not based on the availability of individuating evidence for a particular case. The question is not whether individuating evidence exists in the specific case but whether this is the type of harm for which individuating evidence would be expected when negligence was the cause. Moreover, the type of harm does not correlate with the level of the attributable risk rate. Injuries with attributable risk rates of 10% or 90% may be characterized by distinguishable harm.

a. Indistinguishable Harm

In some harm types, plaintiffs belonging to the "avoidable" class would not expect to have any individuating circumstantial evidence. This is either because the inevitable and avoidable injuries are truly indistinguishable (such that no related evidence exists) or because the plaintiff will not be expected to have access to such individuating evidence.

Being faithful to the underlying statistical principles would require a jury to be allowed to infer causality based on the attributable risk rate, even when less than half of the counterfactual injured states were attributable to negligence. In the above example, for twenty out of one hundred injuries, negligence *did* cause the harm. On the flip side, treating attributable risk rates above 50% as certainties has the same distortions. If $b_i = 20$ and $d_i = 60$, in 100 counterfactual states, on average sixty out of the eighty injuries would have been caused by negligence. However, juries should only award damages in 75% (60/80) of the cases for optimal deterrence. A 100% award rate may result in overdeterrence.[88] Indeed, there are a limited set of circumstances in

87. For the sake of simplicity, I will treat this as a dichotomous category; however, this distinction itself exists on a continuum. At some point, ex-post evidence left by negligently caused injuries becomes sufficiently noisy to be considered essentially an "indistinguishable harm."

88. Joseph H. King, Jr. acknowledges this point as well. Joseph H. King, Jr., *Causation, Valuation, and Chance in Personal Injury Torts Involving Preexisting Conditions and Future Consequences*, 90 YALE L.J. 1353, 1387 (1981). Law and economics scholars such as Steven

which treating probabilities above 50% as certain and equal or below 50% as impossibilities would satisfy optimal deterrence.[89]

In fact, from a social deterrence perspective, it does not matter if the jury just guesses whether this is the state of the world in which the negligence caused the harm. Even if the jury erroneously awards damages in inevitable cases and denies liability in avoidable cases, average deterrence for this type of patient is optimal if damages are awarded the right proportion of the time. Indeed, in an admittedly controversial approach, once a jury determines the relevant probability, use of a random number generator would ensure that damages are awarded at the right rate. This is, however, difficult to reconcile with legal principles.

Alternatively, proportional recovery is a perfectly acceptable solution for indistinguishable harm. The recovery would be distinct from loss of chance, however, in three ways. First, unlike under the loss of chance framework, proportional recovery does not depend on level of attributable risk rate. Second, the loss of chance doctrine does not currently appear, at least explicitly, to be limited to cases with indistinguishable harm. Finally, the rationale for proportional harm is distinct and dodges one of the concerns associated with loss of chance.[90] There is no recovery without harm because recovery is not based on a property interest in survival probabilities. Proportional recovery is merely a function of insufficient identification of the relevant state of the world, an acknowledgement that out of the multiple counterfactual states of the world, the plaintiff should recover a specified percent of the time. Because the jury has no way of knowing which state of the world has actualized, proportional recovery is optimal. While the outcome is the same, the difference in rationale is important, as it acknowledges the true nature of both high and low probabilities.

Indeed, while scholars have pointed out that proportional recovery always results in erroneous recovery,[91] proportional recovery does not raise the same fairness concerns we might expect from other implementations of the average rates. This is a context where it is not even clear to the plaintiff whether they fall within the inevitable or avoidable category, so there is less incentive to game the system.

Shavell have long acknowledged that dichotomous "threshold probabilities" create adverse reactions. Steven Shavell, *Uncertainty Over Causation and the Determination of Civil Liability*, 28 J.L. & ECON. 587, 587–88 (1985).

89. This is explained in more depth in Part IV.

90. *See supra* section I.B

91. David A. Fischer, *Proportional Liability: Statistical Evidence and the Probability Paradox*, 46 VAND. L. REV. 1201, 1224 (1993). The rationale is that plaintiffs who were truly injured do not receive full compensation and those who are not receive some compensation, both errors. *Id.*

b. Distinguishable Harm

As the prior section shows, for injuries categorized as indistinguishable harm, the attributable risk rate is the only metric guiding a jury on causation. Other injuries, however, might be amenable to more distinguishing evidence. For such injuries, evidence about the incident can help to distinguish injuries that would have been inevitable from those that are avoidable. In these situations, the analysis does not stop with the ex-ante attributable risk rate. Instead, using the ex-ante attributable risk rate and understanding the counterfactual states of the world, the jury will use the ex-post evidence about the case itself to make a more specific estimate regarding whether the plaintiff belongs to the avoidable class.

As an example of distinguishable harm, consider two lung cancer patients with the same demographics, health histories, and genetic markers. Both patients did not receive a scan and failed to be diagnosed until their tumors had progressed to stage 2, reducing their chances of survival over the next 5 years from 39% to 25%. While both patients' tumors were the same size at eventual removal, Patient A's tumor grew rapidly, suggesting that Patient A's tumor may not have been discernible even if a scan had been done at stage one. Patient B's tumor experienced steadier growth. The location of Patient A's tumor was also a bit more obscure, whereas Patient B's tumor was easily discoverable, conditional on scan.[92]

Notably, insofar as aspects of the lung cancer cases (such as steady tumor growth and location of tumor) produce ex-post evidence that allow the jury to distinguish between inevitable and avoidable cases, both Patient A and Patient B's cases should be classified as involving distinguishable harm. The inability of Patient A to present such data does not change the nature of the harm;[93] it does, however, weigh against the probability of her belonging to the avoidable class. For injuries where plaintiffs belonging to the "avoidable" class would be more likely to have individuating evidence, the absence of such individuating evidence should serve as a permissible inference against the plaintiff.

92. Similar facts were cited by Justice Brachtenbach against the plaintiff in *Herskovits*, suggesting that the plaintiff's individual characteristics suggested that the likelihood of harm without negligence was higher than average. Herskovits v. Group Health Coop. of Puget Sound, 664 P.2d 474, 490–91 (Wash. 1983) (en banc) (Brachtenbach, J., dissenting).

93. Patients A and B are contrasted just for illustration; however, the fact that one plaintiff falls into the recoverable class does not decrease the likelihood that another plaintiff falls into the recoverable class. Population averages are not generally replicated in small samples.

Indeed, even the filing of suit may have some informational value.[94] Given some states' requirements of pre-suit notice,[95] often accompanied by the submission of an expert report supporting the claim, the ability to make it to trial potentially provides a signal that the sequence of events evinces membership in the avoidable class. In light of this acknowledgement, some of these selection effects might become more attenuated over time. Weak cases may attempt to "bluff" by continuing to trial in order to get an inference of credibility. This is not a problem so long as the assessment of the selection effect is continuously updated. Ignoring this selection effect entirely, however, will generally result in a systematically biased estimate.

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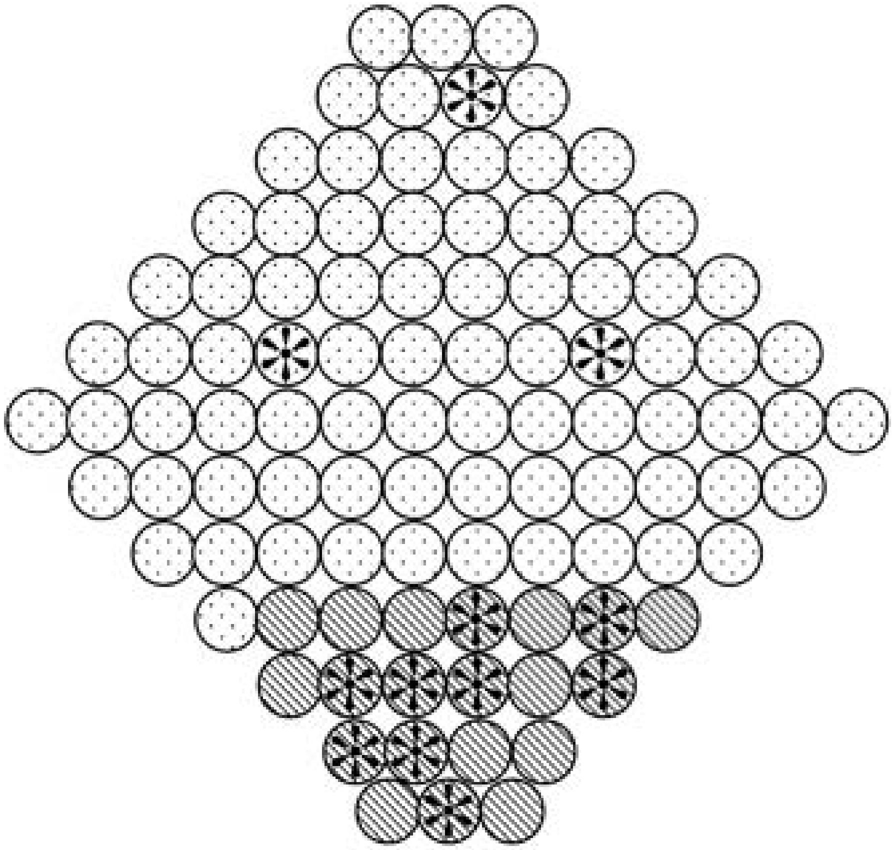
94. Prior literature discusses how the cases that proceed to trial are not a representative sample of all cases. The set of patients who eventually file a malpractice case is a distinct subset of the underlying injured population. Joanna Shepherd, *Uncovering the Silent Victims of the American Medical Liability System*, 67 VAND. L. REV. 151, 194 (2014). Malpractice scholars believe that these subsamples are more likely to be true negligence cases, as the process of filing the suit reveals more information about the validity of the claim. *See* TOM BAKER, THE MEDICAL MALPRACTICE MYTH 86 (2005); David A. Hyman & Charles Silver, *Medical Malpractice Litigation and Tort Reform: It's the Incentives, Stupid*, 59 VAND. L. REV. 1085 (2006). Relatedly, George Priest and Benjamin Klein present theory indicating that the set of cases that settle and the set of cases that proceed to trial are distinct in terms of parties' expectations and stakes. George L. Priest & Benjamin Klein, *The Selection of Disputes for Litigation*, 13 J. LEGAL STUD. 1, 4 (1984). This Article focuses on procedure at trial; however, changes at trial will affect settlement rates. *Id*. The proposed process provides a straightforward way to introduce evidence of this changing selection effect. *Id.*

95. *See, e.g.*, FLA. STAT. § 766.106 (2022).

Figure 5. Counterfactual Worlds with Distinguishable Harm.[96]



For Figure 5, let the circles with asterisks represent worlds where plaintiffs introduce individuating evidence. Note that this signal is not 100% accurate: some worlds not satisfying causation have patterns (3/80), and not all worlds satisfying causation have patterns (only 9/20). However, the patterns do provide some evidence for a jury to infer whether the plaintiff belongs to the inevitable or avoidable classes. Indeed, even with the imperfect existence of

96. As in Figure 4, the circles represent 100 counterfactual worlds where harm occurs. The dotted circles represent states of the world in which harm is inevitable and the striped circles represent states where harm occurs only due to negligence. The asterisk represents states of the world where ex-post individuating evidence is available. Note that individuating evidence is not perfectly correlated with recoverable status. Unlike in Figure 4, harm is somewhat distinguishable in the inevitable and recoverable states.

individuating evidence, the jury is better informed about a plaintiff's class membership.[97]

3. Benefits of the Personalize/Operationalize Process

The proposed personalize/operationalize process can be summarized by Figure 6. The first step focuses the jury on determining the best attributable risk rate based on the observable features of the plaintiff. By choosing b_i and d_i, the jury essentially chooses a diamond formation to represent the plaintiff. The second step asks the jury to identify whether the harm is the realization of the risk imposed by negligence. In Figure 6, this essentially asks whether, within the chosen diamond formation, the current case represents a dotted or striped circle. If the harm is distinguishable, the second inquiry incorporates the presence or absence of ex-post individuating evidence. As shown in Figure 6, even for small attributable risk rates, a jury may be highly confident that the current case corresponds to a striped circle due to the presence of individuating evidence.[98]

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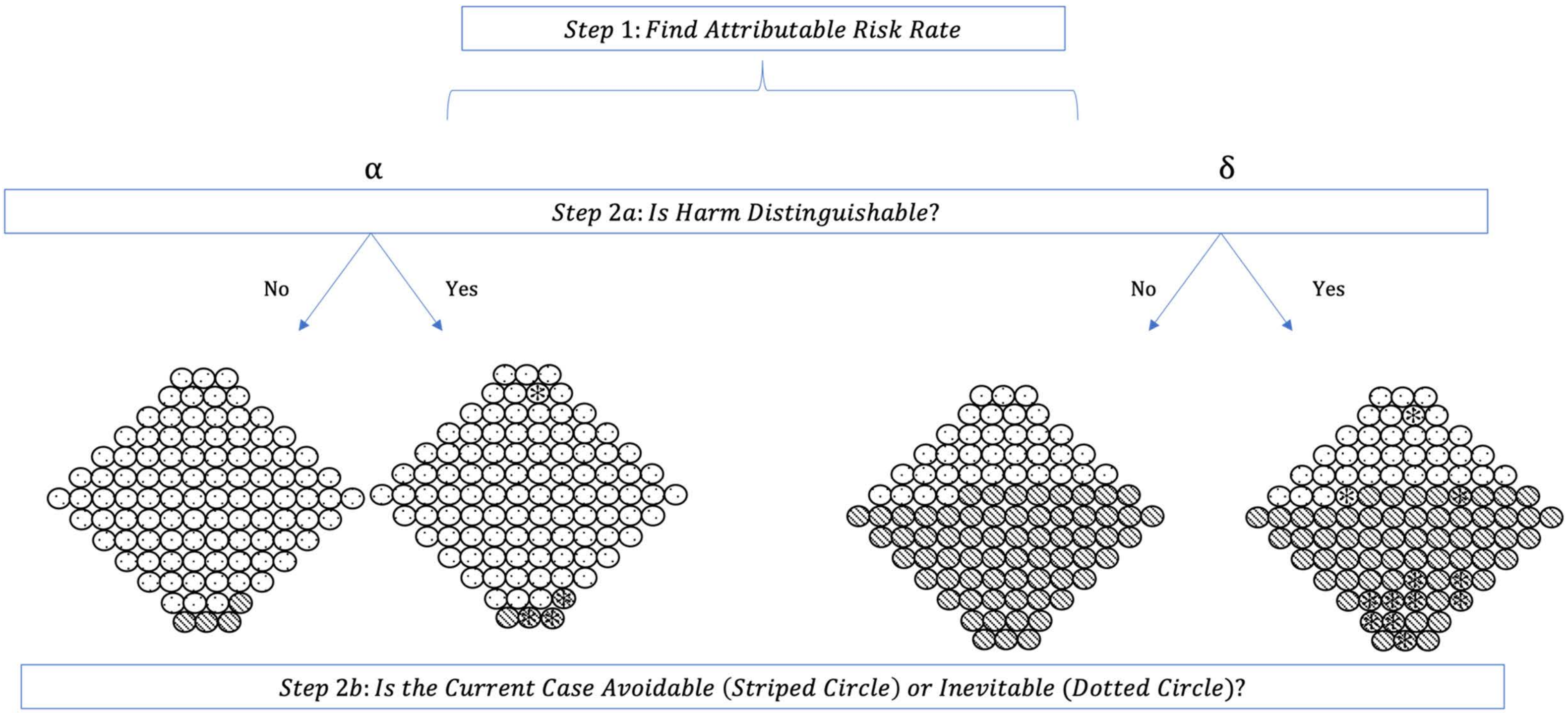
97. Conditional on seeing patterns, the likelihood that the event satisfied causation is 75% (9/12). This can be seen directly from the figure or from the more formal Bayesian analysis. $P(Causation|Pattern) = \frac{P(Pattern|Causation)*P(Causation)}{P(Pattern|Causation)*P(Causation)+P(Pattern|\sim Causation)*P(\sim Causation)} = \frac{\frac{9}{20}*\frac{20}{100}}{\frac{9}{20}*\frac{20}{100}+\frac{3}{80}*\frac{80}{100}}$. For cases without the pattern, the new probability of causation is ~12.5% (11/88). The point of computing this updated posterior probability is not to suggest that juries undertake this calculation (indeed, the motivation for the personalize/operationalize process is that this will be typically infeasible). Instead, this calculation demonstrates that even low average probability (~33.3%) can yield high posterior probabilities (75%). While proportional recovery based on this updated probability would be statistically optimal, the personalize/operationalize process is skeptical of juries' ability to perform Bayesian updating. Moreover, the necessary statistical information about the distribution of individuating evidence is unlikely to be available to a jury and is more likely to be made in a qualitative fashion. For this reason, the personalize/operationalize process moves the jury through the intuition of a Bayesian updating process but retains the binary judgment for harmony with the larger torts system.

98. For example, even though Alpha's attributable risk rate is low (4%), the pattern of ex-post evidence is so reliable that, conditional on seeing individuating evidence, the probability of causation is 75%. This can be seen directly from the figure or from the more formal Bayesian analysis. $P(Causation|Pattern) = \frac{P(Pattern|Causation)*P(Causation)}{P(Pattern|Causation)*P(Causation)+P(Pattern|\sim Causation)*P(\sim Causation)} = \frac{\frac{3}{4}*\frac{4}{100}}{\frac{3}{4}*\frac{4}{100}+\frac{1}{96}*\frac{96}{100}} = \frac{3}{4}$.

Figure 6. Illustration of Personalize/Operationalize Process.[99]



99. Figure 6 uses two attributable risk rates from Figure 3 as examples of the personalize/operationalize process. Step 1 focuses the jury on the most appropriate attributable risk rate for the plaintiff. The specifics of Step 2 depend on whether harm is distinguishable, but asks whether, out of the possible worlds implied by the attributable risk rate, the current case is an avoidable state of the world (striped circle) or not (dotted circle). If harm is distinguishable, individuating evidence (indicated by asterisks) allows juries to update their beliefs about the relevant class.

Readers may astutely note that the personalize/operationalize process described above can be boiled down to a single inquiry: based on all available evidence, after acknowledging both the heterogeneity in attributable risk rates and the indeterminacy over counterfactual states of the world, did negligence cause the harm?

The reason for splitting this into two steps is threefold. Most importantly, the personalize/operationalize process acknowledges that for any attributable risk rate between zero and one, there are a range of counterfactual outcomes (i.e., there are striped circles in each diamond). Given that a lawsuit is not concerned with average outcomes but with the specifics of the case at hand, a jury may be sufficiently confident that the current case falls into one category based on ex-post evidence.

Second, the type of evidence required at each stage differs: the first stage requires reconciliation of the existing literature on baseline risk and the negligence effect with the observable and unobservable features of the plaintiff. This requires an expert to testify to the customization of average rates to the plaintiff at issue and provides a basis for the jury to assess that testimony. The second question is an examination of the case-specific evidence on the sequence of events. Delineating these two questions guards against conclusory expert opinions detached from reality.

Finally, acknowledging the personalize/operationalize process makes clear the distortions caused by screening cases based on an average attributable risk rate. Given how specific the relevant inquiry is, an average attributable risk rate is often not even responsive to the causation inquiry. Once a plaintiff-specific attributable risk rate is calculated, however, screening remains problematic. While cases involving indistinguishable harm are best characterized by the plaintiff-specific attributable risk rates, a hard threshold cut-off still systematically ignores a predictable level of recoverable injuries. For injuries with distinguishable harm, the plaintiff-specific attributable risk rate is simply not sufficient to characterize the causation inquiry.

This framework introduces the concerns relevant to identifying the attributable risk rate faced by a specific plaintiff and shows how to address this rate in a way that is congruent with statistics (both in contexts where individuating evidence is expected and where it is not). While this is generally noncontroversial from a statistical perspective, the subsequent Section reconciles these principles with legal requirements.

III. RECONCILING STATISTICS WITH LEGAL PRINCIPLES

While the personalize/operationalize process clearly sets out the requisite steps for aligning statistics with legal inquiries, this Section discusses how such a framework would be implemented within our existing legal system.

The prior Section notes that causality is difficult to infer from observational data. However, juries generally are not themselves parsing through published studies; instead, in the context of medical malpractice cases, causation often relies on expert witness testimony.[100] Courts generally require that causation experts testify to a reasonable degree of medical certainty[101] and divulge some basis for the opinion.[102] The admissibility of expert testimony is often governed by *Daubert* in theory; however, despite adopting *Daubert* for general expert testimony, some state courts exempt medical malpractice from general *Daubert* principles.[103] Regardless, the proposed personalize/operationalize process does not materially affect the use of experts or the gatekeeping function of courts. The personalize/operationalize process merely provides a framework for organizing the substance of the testimony, aiding courts in understanding the concerns that the testimony must attempt to address.

A. Step One: Personalizing the Applicable Attributable Risk Rate

For the first step, experts will present evidence as to the appropriate attributable risk rate, addressing barriers to creating a plaintiff-specific rate.

At times, causation experts rely on review of the existing published literature, in which case their synthesis of the literature should account for

100. *See, e.g.*, Easterling v. Kendall, 367 P.3d 1214, 1226 (2016) ("Although expert testimony is not expressly required to establish causation in medical malpractice cases, 'such testimony is often necessary given the nature of the cases. Expert testimony is generally required because the causative factors are not ordinarily within the knowledge or experience of laymen composing the jury.'" (internal citation omitted) (quoting Coombs v. Curnow, 219 P.3d 453, 464 (Idaho 2009))).

101. *See, e.g.*, Morales-Hurtado v. Reinoso, 230 A.3d 241, 243 (N.J. 2020), *reconsideration denied*, 230 A.3d 981 (N.J. 2020) ("As in other settings, any expert's or treating physician's opinion on which the life care expert relies 'must be couched in terms of reasonable medical certainty or probability.'" (quoting Creanga v. Jardal, 886 A.2d 633 (N.J. 2005))).

102. *See, e.g.*, Arnold v. Turbow, 848 S.E.2d 698, 702 (Ga. Ct. App. 2020) ("But [] '[i]n presenting an opinion on causation, the expert is required to express some basis for both the confidence with which his conclusion is formed, and the probability that his conclusion is accurate.'" (quoting Ga. Clinic, P.C. v. Stout, 747 S.E.2d 83, 91 (Ga. Ct. App. 2013))).

103. *See* Monica Lynne Coscia, Note, *"Trust Me, I'm a Doctor": Medical Malpractice as a* Daubert-*Free Zone*, 108 GEO. L.J. 1761, 1763 (2020). While this practice often concerns expert testimony about the standard of care, some involve causation as well. *Id.* at 1770.

the selection effects noted in Section aa.1.[104] When the expert purports to produce a plaintiff-specific probability, the considerations discussed in that subsection should serve as a roadmap for assessing whether the quoted probability is sufficiently tailored to the plaintiff. Insofar as experts are asked to rely on their professional experience in reviewing a medical record, these concerns are potentially even more pressing. Without large sample studies serving as a basis, subjective probabilities (even from an expert) can be seriously flawed based on the patient populations the professional generally sees. If a medical professional sees a disproportionately sick population for whom the standard of care treatment is less effective, the professional's assessment of the difference in survival rates for the plaintiff may be an underestimate. If medical professionals are more likely to remember extreme cases,[105] their assessment of prevalence is also suspect. Insofar as medical professionals' observations of outcomes are affected by socioeconomic factors or unobserved genetic factors, this should be acknowledged.

This is not to suggest that expert testimony is irrelevant or inherently unreliable; however, given how specific the inquiry must be at trial, and how many confounding factors must be addressed to understand the causal relationship, experts should be clear about which of these factors they are incorporating into their assessment and which they are excluding. Insofar as the subjective probability stated falls prey to the selection effects outlined above, the testimony is not fully tailored to the relevant question of causation. The lack of complete specification is not itself a weakness, particularly when accompanied by an explanation of remaining factors not reflected in the estimate. The danger is merely in the jury taking the statistic as personalized when it is not.

Once expert testimony has been introduced, issues of witness credibility are generally left to the jury.[106] As prior research suggests that information

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104. *See, e.g.*, Marcantonio v. Moen, 937 A.2d 861, 865 (Md. Ct. Spec. App. 2007), *rev'd*, 959 A.2d 764 (Md. 2008) (noting that the expert testified to a survival rate of between 30% and 85%, choosing 50% to 60% for the plaintiff).

105. Behavioral economics classifies this as "availability bias." Adam Hayes, *Recency (Availability) Bias*, INVESTOPEDIA (Feb. 22, 2022), https://www.investopedia.com/recency-availability-bias-5206686#:~:text=In%20behavioral%20economics%2C%20the%20recency,events%20over%20the%20long%20run [https://perma.cc/D3QU-R4AN].

106. *See, e.g.*, Gros v. Lammico, 316 So.3d 61, 70 (La. Ct. App. 2020) ("Hence, the weight of the findings of the MRP is subject to credibility determinations, which are to be made by the jury."); Anne Bowen Poulin, *Credibility: A Fair Subject for Expert Testimony?*, 59 FLA. L. REV. 991, 1001 (2007). Significantly, this is very similar to the approach of courts following the Second Restatement of Torts. RESTATEMENT (SECOND) OF TORTS § 323 (AM. L. INST. 1965). However, it

source is a significant factor in how people update their beliefs about probability,[107] allowing juries to weigh evidence about the appropriate attributable risk rate seems appropriate. In addition, given the different refinements each piece of testimony incorporates, or excludes, submitting this as evidence for a jury to synthesize is potentially more accurate—and feasible—than any mechanical aggregation.

B. Step Two: Operationalizing the Statistic

For any given attributable risk rate, however, the jury must also decide whether this specific case falls within the avoidable class. Accordingly, an expert must additionally testify to two issues. First, what sort of individuating evidence, if any, is likely to be available to a member of the avoidable class? Second, does the evidence on the record constitute such evidence? This structure will frame the question to which the preponderance of the evidence standard would apply.

For distinguishable harm contexts, in which avoidable plaintiffs would likely have access to individuating evidence, juries assess whether they believe, based on the presence of any individuating evidence and the attributable risk rate from step one, that the probability that the plaintiff belongs to the avoidable harm class exceeds 50%.[108] Because of the expectation of individuating evidence, juries have a basis on which to classify the plaintiff (regardless of attributable risk rate). A plaintiff's inability to produce such evidence can correctly lead to the inference that he or she belongs to the inevitable class. For example, after accounting for ex-post evidence of temporal links between negligence and harm, a jury may well feel that the likelihood of belonging to the avoidable class exceeds 50%, despite an attributable risk rate of less than 50%. Conversely, based on the absence of such evidence, a jury may well feel that the likelihood is less than 50%, despite an attributable risk rate of greater than 50%.

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does not depend on the existence of a voluntary undertaking. While duty is established by the voluntary undertaking (through the professional-patient relationship), the relevant harm is the worse condition caused by the negligence. The treatment of probabilistic harm does not rely on the source of the duty in this framework.

107. *See, e.g.*, W. Kip Viscusi, *Alarmist Decisions with Divergent Risk Information*, 107 ECON. J. 1657, 1657 (1997).

108. As noted above, any discrete threshold has the potential to introduce distortions. Taking the probability-based conception of burden of proof as given, however, the personalize/operationalize process lessens this distortion by imposing the threshold on the relevant inquiry: the probability of belonging to the avoidable class, conditional on all evidence, including—but not necessarily fully characterized by—available statistical rates.

For indistinguishable harm contexts, in which "avoidable" plaintiffs are not expected to have access to individuating evidence, a path congruent with legal principles is more difficult. If a jury is told that *x* times out of 100, negligence caused the harm, they can decide whether they believe that this current case falls within that category. Even if they are wrong 100% of the time, deterrence will be optimal so long as damages are awarded *x*% of the time. Statistics is indifferent between awarding damages *x*% of the time and awarding proportional damages[109] (*x*% of damages).

Insofar as allowing a jury to award full damages some proportion of the time for indistinguishable harm is untenable,[110] however, proportional liability would be an acceptable route, almost identical to the loss of chance doctrine. As before, however, proportional liability would need to be awarded regardless of attributable risk rate level; the prudence of this route does not depend on the level of the attributable risk rate but on the indistinguishability of the harm. Moreover, the rationale for proportional recovery is entirely distinct from the loss of chance doctrine. It does not treat the lost chance as a property interest; the proportional recovery is in acknowledgement of the fact that the avoidable states of the world are indistinguishable from the inevitable states.

Allowing proportional recovery is most controversial at attributable risk rates of 50% or less. However, this is not unprecedented, even outside of the loss of chance doctrine. Alternative causation, made famous in *Summers v. Tice*,[111] allows a plaintiff to establish causation despite an equal probability that more than one defendant was responsible. With a 50% chance that one of two defendants caused the harm, traditional tort principles would have restricted liability.[112] Alternative causation relaxes this harsh result by allowing the plaintiff to shift the burden of proof to the defendant to prove he was not the cause.[113] Indeed, the Third Restatement notes that where "the plaintiff has done all that is reasonably possible by way of gathering and presenting evidence of causation," "many courts are lenient about the

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109. Richard Wright and Ingeborg Puppe suggest that either proportional liability or burden shifting in this context is appropriate but are hesitant to allow this on purely statistical evidence. Richard W. Wright & Ingeborg Puppe, *Causation: Linguistic, Philosophical, Legal and Economic*, 91 CHI.-KENT L. REV. 461, 492–93 (2016).

110. Indeed, it may be difficult to suggest that choosing to award full damages x% of the time, based solely on an attributable risk rate, inspires more than 50% confidence in any one inquiry (particularly for attributable risk rates below 50%).

111. Summers v. Tice, 199 P.2d 1, 2–3 (Cal. 1948).

112. *Id.* at 5.

113. *Id.* at 4. Similar relaxations occur with the market share liability doctrine, though this has largely been restricted to products liability cases. *See, e.g.*, Sindell v. Abbott Lab'ys, 607 P.2d 924, 937 (Cal. 1980).

plaintiff's proof of causation."[114] The proposed treatment of probabilities is consistent with such tort principles.

IV. COMPARING THE RULES: A CONCRETE EXAMPLE

A concrete example can help illustrate the strengths and weaknesses of each rule. This illustration by no means sketches all potential conditions, but rather illustrates how potential rules compare under a relatively reasonable example. Revisiting

Figure 3 and Table 3, there are 30 total avoidable cases (and 90 injuries total). Valuing each injury at $100, optimal deterrence is satisfied when damages are $3,000. This example walks through the effects of the four strategies a court can take in addressing probabilistic harm:

1. Traditional causation: Applying the rule from *Cooper v. Sisters of Charity*,[115] correctly interpreted through the framework discussed in Section **Error! Reference source not found.**, courts could require an attributable risk rate of 50% for full recovery (with no recovery for attributable risk rates below 50%).
2. Loss of chance: Courts could allow for proportional recovery through loss of chance doctrine only for cases in which the attributable risk rate is below 50% and full recovery for attributable risk rates above 50%.
3. Full proportional recovery: Courts could require proportional recovery for all cases, including those in which the attributable risk rate is above 50%.
4. Personalize/operationalize process: Courts allow evidence on the relevant attributable risk rate, distinguishability of harm, and any ex-post evidence to be submitted to the jury as evidence by which they can determine whether negligence caused harm. For indistinguishable harm, juries would award proportional damages.

Suppose the court takes the population average as a screening mechanism. The average attributable risk rate in

Figure 3 is 33.33%, which is less than the 50% required by the traditional causation rule. Accordingly, even though 30 patients' injuries are caused by

114. RESTATEMENT (THIRD) OF TORTS: LIABILITY FOR PHYS. & EMOT. HARM § 28 (AM. L. INST. 2010).

115. 272 N.E.2d 97, 104 (Ohio 1971), *overruled by* Roberts v. Ohio Permanente Med. Grp., Inc., 668 N.E.2d 480 (Ohio 1996).

negligence in a population of 100 patients, no patient can recover. Traditional causation ignores these predictable 30 cases.

Under loss of chance, using the population average, while none of the affected population would be able to seek recovery under traditional causation, all injured patients could bring a claim for loss of chance. Assuming a proportional recovery of 33.33%, this population would satisfy optimal deterrence.[116] Theoretically, the ten uninjured patients should also have a claim under loss of chance, though this has largely not been acknowledged by courts. Full proportional recovery, similar to loss of chance, would award $33.33 to all ninety patients and satisfy optimal deterrence. Under the personalize/operationalize process, the population average would not be used as a screening device.

Suppose instead that courts do not use the population average to screen out cases. Assume further that the specific population likelihood of belonging to the avoidable class is accurately identified. For traditional causation, only plaintiffs in subpopulation Delta would be able to recover. Under traditional causation, even if the jury compensated all injured members of the Delta group, only twenty-three people would be compensated. This would result in underdeterrence, as thirty people satisfy true causation ($3,000 total). A situation in which traditional causation results in overdeterrence is similarly imaginable.

This example illustrates that many conditions must be met in order for the dichotomous 50% threshold inquiry to be socially optimal. In particular, the expected harm associated with groups with attributable risk rates above 50% (here, patients belonging to the Delta group) must be equal to the expected harm associated with parties belonging to the avoidable class. Even if we manipulated the numbers to achieve this,[117] there may still be distributional effects. Insofar as there are important differences across these groups, we would also be concerned about the distributional effects of this allocation.

116. There are other ways to calculate loss of chance damages, which may result in different deterrence results; however, this example assumes proportional recovery.

117. We can do this with the following table:

	b_i: Inevitable Harm	d_i: Avoidable Harm	Unharmed	Attributable Risk Rate
Alpha (α)	21	1	5	~5%
Beta (β)	18	5	1	~22%
Gamma (γ)	9	6	2	40%
Delta (δ)	12	18	2	60%
Total	60	30	10	33.33%

The total injured in Delta (12 + 18) is equal to the number of recoverable cases in the population.

For example, if the Delta group consists of people in the top 1% of the socioeconomic groups, the fact that they are the only ones being (over)compensated for harm would violate some equal-access norms.

More troublingly, even if the level of deterrence under traditional causation were equal to optimal deterrence, incentives to take care would not be sufficient insofar as the plaintiffs who would win at trial are observably distinct at the time of treatment from those who would lose. If this were the case, healthcare providers may be less likely to take care for cases they know have no chance of recovery at trial.[118]

For loss of chance, if all injured members of the Delta subpopulation are afforded full recovery and the other groups are awarded proportional damages for loss of chance, total compensation is $2,300 for Delta and $1,496 for all other groups combined.[119] In total, defendants pay $3,796 rather than $3,000.

With full proportional recovery for attributable risk rates both below and above 50%, insofar as attributable risk rates are known for the subpopulations (as assumed), total recovery will be the socially optimal $3,000.

The personalize/operationalize process will vary by whether harm is distinguishable or indistinguishable. For indistinguishable harm, Personalize/Operationalize Process will produce the same outcome as Full Proportional Recovery through proportional recovery. For distinguishable harm, experts will testify to the specific attributable risk rate for the plaintiff (addressing relevant confounders) and the ex-post evidence supporting the plaintiff's membership in the avoidable class. Rather than expect the jury to then synthesize this evidence into an updated attributable risk rate, the personalize/operationalize process notes that probabilities affect the range of potential states of the world and that ex-post evidence can make it more likely that the current case falls into an avoidable state of the world. After that, it merely allows the jury to use all available evidence to determine whether the plaintiff belongs to the avoidable class.

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118. Courts have acknowledged this danger. In *Roberson v. Counselman*, the Kansas Supreme Court stated that the traditional rule:

> declares open season on critically ill or injured persons as care providers would be free of liability for even the grossest malpractice if the patient had only a fifty-fifty chance of surviving the disease or injury even with proper treatment. Under such rationale a segment of society often least able to exercise independent judgment would be at the mercy of those professionals on whom it must rely for life-saving health care.

686 P.2d 149, 160 (Kan. 1984).

119. Specifically, the Alpha group pays $96 (4% x $100 x 24 injured), the Beta group pays $500 (20% x $100 x 25 injured), and the Gamma group pays $900 (50% x $100 x 18 injured).

The optimality of deterrence for the personalize/operationalize process depends on how well juries infer probabilities from the relevant evidence. As long as the jury awards a full award 4% of the time for the Alpha group, 20% for the Beta group, 50% for the Gamma group, and 65% for the Delta group,[120] it does not matter if they accurately identify the wronged parties.

From this one illustration, a few things become clear. First, in all but very specific circumstances, the traditional causation approach will likely result in either systematic under- or over-compensation of plaintiffs (and, accordingly, incorrect deterrence for defendants). This reality has been acknowledged by courts as they adopt the loss of chance.[121]

Second, loss of chance runs the risk of systematic overcompensation to plaintiffs and overdeterrence of defendants. This is because plaintiffs unable to demonstrate a greater than 50% likelihood of causation will recover proportionally while those able to meet the traditional causation standard will recover all damages. As an example, let uncontroverted evidence suggest that the harm is distinguishable, that the plaintiff belongs to the Beta population, and that he does not have access to individuating evidence. Under the personalize/operationalize process, the jury would be able to infer that the probability that the plaintiff is part of the "avoidable" class is lower than 20%. The ultimate issue on causation would still go to the jury with the updated probability of causation, however. Under loss of chance, however, this plaintiff—unable to establish traditional causation—could instead pivot to loss of chance and recover 20% of damages. In doing so, plaintiffs get two shots at imposing liability. Given the relative scarcity of suits relative to incidents of malpractice, however, perhaps overdeterrence is not as big of a concern yet. A bigger concern, instead, is the damage done to judicial perceptions of statistical evidence from treating only events associated with high probabilities as occurring.

Third, the example demonstrates that full proportional recovery and the personalize/operationalize process track in the context of indistinguishable harm, only diverging with distinguishable harm. This can lead to questions about whether full proportional recovery is the better solution even in contexts of distinguishable harm. The reasons against this are two-fold. First, proportional recovery's merits as a more accurate form of recovery depends on how competently a factfinder can

120. Notably, this condition on trial outcome is sufficient for optimal deterrence. *But see* Emily Spottswood, *Proof Discontinuities and Civil Settlements*, 22 THEORETICAL INQUIRIES IN LAW 201, 201 (2021) (noting that translating jury beliefs into trial outcomes is not straightforward, depending on burden of proof rule).

121. *See, e.g.*, Herskovits v. Group Health Coop. of Puget Sound, 664 P.2d 474, 477 (Wash. 1983) (en banc).

isolate the probability of liability conditional on certain evidence and incorporate ex-post evidence into an updated probability. If society trusts juries to synthesize data to assign a specific probability more than to synthesize data to assess a binary outcome, the full proportional recovery choice is superior.[122] Such updating is nontrivial, however, and requires jury numeracy; submitting evidence of specific attributable risk rate and the ex-post evidence to the jury to determine ultimate liability may be more feasible.[123] For this reason, the personalize/operationalize process attempts to preserve dichotomous decisions where possible. Second, in order to harmonize probabilistic and non-probabilistic contexts, the pivot to proportional recovery would need to apply to all cases involving harm. This requires a much more revolutionary change to legal systems that seems less feasible in the short term.

Finally, the example illustrates the importance of incorporating the decision to file suit as a signal. The above predictions rely on the assumption that all injured cases would file and go to trial. This is demonstrably not true in the medical malpractice field,[124] but merely simplifies the illustration. If the sample of cases proceeding to trial is systematically different than those not filing, this selection effect should be incorporated as ex-post evidence.[125]

122. Another option would be to bypass the jury in constructing such probabilities and instead allow some governmental body to assign average probabilities to types of harms. This has some appeal, as it lessens transaction costs in awarding recovery. This solution would require significant structural change, however. First, a government entity would need to be established to assign, and bind courts, by such probabilities. Second, in anticipation of litigation, this entity would need to prepare and update these rates for all potential harms, correcting for difference in selection of cases being brought to trial over time. Indeed, in the face of any proportional recovery, case filing behavior would likely change. If the assignment of rates were confined to the medical malpractice context, for the sake of feasibility, it would deepen the chasm between so-called probabilistic and non-probabilistic contexts. The personalize/operationalize process instead attempts to work within the existing system, by merely adjusting flaws in statistical thinking.

123. *See e.g.*, Lisa M. Schwartz et al., *The Role of Numeracy in Understanding the Benefit of Screening Mammography*, 127 ANNALS INTERNAL MED. 966, 969 (1997).

124. *See* BAKER, *supra* note 94, at 22–36.

125. *See supra* discussion in note 94. Again, this Article does not discuss settlement in depth, but just as filing behavior might change, so might settlement behavior. As settlement is a function of expectations at trial, *see* Priest and Klein, supra note 94, changes in ability of plaintiffs to recover will likely affect settlement rates. The personalize/operationalize process allows parties to introduce evidence on these new selection effects.

V. ASSESSING THE PERSONALIZE/OPERATIONALIZE PROCESS

Not only does the proposed process improve the relationship between legal principles and statistics, but it also boasts three additional benefits. First, this approach harmonizes the treatment of causation in the probabilistic and non-probabilistic harm contexts, avoiding applying a heightened standard in the former context. This is important insofar as courts begin to acknowledge the probabilistic nature of causation in other contexts due to greater availability of statistical information. Second, while the approach removes a bright-line rule on which to limit liability, other elements of the negligence claim are better suited to provide this limitation. Finally, the proposed process's explicit acknowledgment of the difficulties in applying statistical evidence to legal questions affords statistical evidence the authority and limitations it deserves.

A. Personalize/Operationalize Process Harmonizes Treatment of "Probabilistic" and "Non-Probabilistic" Harm

The proposed framework is consistent with the way causation is assessed in purportedly non-probabilistic contexts. Importantly, while courts acknowledge probabilities only in certain contexts, potentially because of the ready availability of nominal rates, the probabilistic/non-probabilistic distinction is an illusion. Insofar as statistical evidence becomes incorporated into more domains, the difference in causation standards will become more obvious and problematic.

While accident scenarios are often seen as deterministic,[126] the underlying nature of any inquiry into causation is probabilistic. Revisiting the speeding example,[127] in which a recent study suggests that an increase in speed of 1% results in a 2% increased chance of crash,[128] a court would require evidence that the driver was going more than 105 in a 70-mph zone to satisfy the requirement of 50% attributable risk rate. Intuitively, this requirement would miss many circumstances where even speeding alone would been seen as

126. Courts' discomfort with probabilities has been noted by Glen O. Robinson. Glen O. Robinson, *Probabilistic Causation and Compensation for Tortious Risk*, 14 J. LEGAL STUD. 779, 780 (1985). ("While there are good practical reasons to be cautious about these methods of proof, I think that the uneasiness of the legal system concerning probabilistic proof goes deeper than practical caution and reflects an intellectual uneasiness about probabilistic concepts themselves. That uneasiness may well be reinforced because causal determinations are made ex post where the retrospective investigation of events tends to induce a belief in their inevitability—a belief that Baruch Fischhoff has aptly labeled 'creeping determinism.'").

127. *See supra* text accompanying note 10.

128. Aarts & Van Schagen, *supra* note 10, at 223.

causing the crash. Notably, the speed necessary to infer causation is likely greater than the speed necessary to determine negligence. It is worth noting that the study authors would likely be uncomfortable screening on this average effect.[129]

This incompatibility demonstrates how our intuitive understanding of causality may not correspond to current legal probability thresholds. If the submission of evidence used to compute a probability would have provided a reasonable basis for finding causation, merely acknowledging the probability should not keep this question from a jury.[130] Suppose, for example, that a car driving without headlights in the rain 10 mph above the speed limit results in an attributable risk rate of 45%. Insofar as the underlying facts (e.g., speeding in the rain without headlights) would be sufficient for a reasonable jury to find causation, acknowledging an intermediate probability should not produce a different outcome. This observation does allow for the possibility that causation is too often satisfied in non-probabilistic contexts (rather than too-rarely satisfied in probabilistic contexts). However, the specificity required of attributable risk rates, and researchers' imperfect ability to capture this,[131] may weigh against prioritizing probabilities over the underlying evidence. Regardless, however, using such average probabilities to screen out cases is incompatible with statistical principles.[132]

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129. *Id.* ("Still, the exact relationship between speed and crash frequency depends on the actual road and traffic characteristics . . . including road width, junction density, and traffic flow. These are most likely mediating factors in that they both affect the crash frequency directly and by their effect on speed. . . . The review also showed that, in addition to average speed, large speed variance at a particular road is related to high crash rates.") (internal citations omitted).

130. Courts skeptical of the use of "naked statistics" in the context of loss of chance have tried to prohibit the use of statistics alone, especially to submit to a jury. Tory A. Weigand, *Lost Chances, Felt Necessities, and the Tale of Two Cities*, 43 SUFFOLK U. L. REV. 327, 372 (2010). However, this is itself an overreaction. While the most available statistic often does not speak directly to the probability that the negligence caused the harm, it is relevant.

131. *See supra* Part II.B(1).

132. A related concept involves the idea of "self-proving causation," a class of causation cases in which evidence of negligence is sufficient to make a prima facie case on actual causation, under the rationale that all negligent conduct increases the risk of harm. Kenneth S. Abraham, *Self-Proving Causation*, 99 VA. L. REV. 1811 (2013). The relationship of this concept to the proposed framework is interesting. The Article's classification of indistinguishable harm could be seen as the purest form of this phenomenon; if harm is truly indistinguishable, only the evidence about the negligent act can be produced. On the other hand, the proposed framework requires more than evidence about the existence of negligence: it requires evidence of the magnitude of increased risk to the plaintiff (i.e., the attributable risk rate). For distinguishable harm, ex-post evidence is available, though it may be classified as "circumstantial." Abraham notes that causal inferences are always circumstantial and discusses in what circumstances

Probabilities in such non-probabilistic contexts are currently largely ignored. Increasingly, however, such data may become available, and courts may have to confront the probabilistic state of the world in accident contexts as well. Their ability to interpret such data is vital.

B. Limiting Liability

Critics may correctly note that the framework undermines one bright-line rule on which defendants can be granted summary judgment, denying defendants respite from frivolous claims. This critique is often motivated by the concern for excessive tort liability for health care practitioners.[133] The response to this criticism is three-fold. First, the effect on summary judgment is limited to issues of nominal probability data on actual causation, on which automatic relief is simply unwarranted by statistical principles. Second, despite this, if some level of automatic relief is desired, proximate cause is a more theoretically sound way of providing such automatic relief. Third, damage valuation remains a more targeted way of guarding against excessive liability.

1. Summary Judgment for Actual Causation

Summary judgment serves a valuable function for quickly eliminating unviable claims. While the proposed process would not allow summary judgment to be triggered on actual causation grounds merely due to level of attributable risk rates, it improves accuracy and retains other grounds for granting summary judgment based on causation.

By design, the proposed process allows cases that would have otherwise been resolved under summary judgment instead to proceed to trial. For the reasons mentioned in Part II.B.d.2, the preservation of such suits may be an unambiguous positive for society. Injuries that are avoidable on a predictable (but less than 50%) basis, will no longer be ignored by the legal system.

This is not to say that summary judgment cannot be granted on actual causation grounds. The personalize/operationalize process merely requires

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"circumstantial evidence" is sufficient to create a question of fact. *Id*. at 1814, 1849. The proposed framework would allow causation to go to the jury with evidence of the attributable risk rate, distinguishability of harm, and any ex-post evidence (circumstantial or otherwise) to create a question of fact for the jury.

133. *See* Gooding v. Univ. Hosp. Bldg., Inc., 445 So.2d 1015, 1019–20 (Fla. 1984) ("Health care providers could find themselves defending cases simply because a patient fails to improve or where serious disease processes are not arrested because another course of action could possibly bring a better result.").

that the reason be more than the nominal level of the attributable risk rate. For example, if both parties agree that the attributable risk rate is very low and that harm is distinguishable, if the plaintiff does not introduce any individuating evidence, summary judgment may well be warranted. This process better incorporates statistical evidence without subscribing to convenient legal fictions.

For jurisdictions accepting loss of chance, the removal of the bright-line rule does not create a new burden on defendants. In these jurisdictions, claims with evidence of attributable risk rates below 50% could proceed to the jury under the loss of chance doctrine. Accordingly, defendants face the same burden; however, the reason for the burden is better theorized under the personalize/operationalize process.

Some worry that the proposed process is unnecessary because the adversarial style of litigation ensures that summary judgment would only be granted for unworthy cases. Because each party is incentivized to introduce the strongest evidence for their case, the only cases which are vulnerable to summary judgment are those in which the plaintiff cannot produce evidence of an attributable risk rate greater than 50%. This criticism implicitly assumes that cases with attributable risk rates less than or equal to 50% are not credible. Part II.B.d.2, however, presented several scenarios in which a jury could reasonably find causation by the preponderance of the evidence, despite an attributable risk rate of less than 50%. For distinguishable harm, even though both parties may agree that the attributable risk rate is below 50%, one party may introduce ex-post evidence that elevates this rate to a level for which a jury could reasonably find causation. For cases of indistinguishable harm, the case for recovery (proportional or otherwise) is not significantly less credible with an attributable risk rate of 49% than 51%. Indeed, the adversarial process does not change the implementation of the personalize/operationalize process. While the adversarial process is adept at producing information for juries to weigh, the personalize/operationalize process focuses this process by identifying the relevant pieces of information: the considerations necessary for an accurate attributable risk rate, the distinguishability of harm, and relevant ex-post evidence.

2. Proximate Causation

Because any probability threshold has the potential to create distortions, this Article does not endorse the establishment of any discrete probability threshold on which to screen cases from the jury; however, insofar as society demands a bright-line probability threshold, this is better established through proximate causation.

Despite the distortionary effect of any discrete threshold, society may nonetheless want to provide respite for defendants from sufficiently attenuated consequences. Actual causation, however, is not the best element on which to load such limits. Actual causation refers to the factual question of whether one event impacts the existence of an outcome. Indeed, the relevant question is not whether the negligence was *the* cause but merely *a* cause of the harm.[134] The proximate causation element instead sifts through the various actual causes and determines which causes are too attenuated from ultimate harm to hold as liable. Proximate causation is an exercise in line drawing between recoverable and non-recoverable factors.[135] The explicitly policy-based proximate causation inquiry is a more appropriate element by which to screen out *de minimis* causes of harm, rather than pretending this is required by statistical principles.[136]

Embracing the explicitly policy-based grounds for establishing a probability threshold also allows for more context-specific thresholds. In essence, the traditional causation requirement labels any cause associated with an attributable risk rate less than 50% a *de minimis* cause. While there may be a level of attributable risk rate below which—for policy reasons—society prefers liability not be available, 50% is a relatively high threshold for this. Using proximate causation allows more specific limits to liability.

3. Damage Valuation

Rather than impose any discrete cut-offs on recovery based on probability levels, this Article suggests that adjusting damages is a better way to limit liability. This whole argument has thus far largely ignored the question of damage valuation, focusing only on the issue of causation.[137] The reason for this is that causation and damages are correctly treated distinctly. Causation concerns whether one event is consequentially linked to another. Damages capture the value of such consequences.

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134. RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM § 26 cmt. c (AM. L. INST. 2010).

135. RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM § 29 cmt. a (AM. L. INST. 2010); Palsgraf v. Long Island R. Co., 162 N.E. 99, 103–04 (N.Y. 1928) (Andrews, J., dissenting).

136. Complicating this issue is the fact that the term proximate causation has had an inconsistent usage by courts. Some courts bundle the actual causation and proximate causation inquiries into one and label it proximate causation. RESTATEMENT (THIRD) OF TORTS: PHYS. & EMOT. HARM § 29 cmt. b (AM. L. INST. 2010). According to traditional tort principles, however, these are two separate inquiries.

137. A key exception is the consideration of proportional damages for indistinguishable harm, *see supra* Part II.B(2)(a).

The courts' rationale for limiting causation seems to be the concern that practitioners will be held responsible for patients who would have eventually died of natural causes.[138] Notably, however, the idea of excessive tort liability has largely not been supported by empirical work. Prior studies of medical malpractice incidence suggest that medical malpractice suit is rare, relative to the incidence of medical malpractice.[139] In the wake of states passing a variety of tort reform measures to address the "malpractice crisis," this access to courts issue is likely only exacerbated. Against this backdrop, encouraging suit is likely not yet going to result in overdeterrence. However, insofar as excess liability will be a future concern, damage valuation is a more targeted way to address this issue.

The estimation of the value of harm is always a tricky subject, and scholars have proposed multiple approaches to valuing probabilistic harm.[140] Normal damage valuation will consider issues of life expectancy that seem to motivate courts in restricting access. For patients whose death was hastened by negligence, valuation would incorporate the shorter life expectancy in the wrongful death action. The practical benefits of incorporating baseline probability of survival into damages rather than as a threshold for establishing causation is that the magnitude of liability scales smoothly with the forgone future of a given plaintiff, rather than bluntly denying any recovery through causation.

C. Feasibility of the Personalize/Operationalize Process

Finally, this Article makes clear the arduous process of bringing statistics to bear on causation. Perfect refinement of attributable risk rates is impossible; however, this fact does not undermine—but rather highlights—the need for this personalize/operationalize process.

The specificity required of probabilities for causation, as well as the inherent noisiness of this estimate, is currently unacknowledged. In ignoring this, available—but not necessarily appropriate—probabilities are used. This is precisely why this personalize/operationalize process is necessary. First, courts must acknowledge how observable and unobservable factors lead to

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138. *See, e.g.*, *Gooding*, 445 So.2d at 1019–20.

139. BAKER, *supra* note 94, at 22–36.

140. For loss of chance, damages can be calculated in multiple ways, the most popular of which includes a proportional valuation (depending on the survival probability lost) or a jury assessment of the probability lost. *See, e.g.*, King, *supra* note 88; Rhee, *supra* note 53, at 41. For normal wrongful death cases, life expectancy, future wages, and hedonic damages are often considered. See the discussion between W. Kip Viscusi, *The Flawed Hedonic Damages Measure of Compensation for Wrongful Death and Personal Injury*, 20 J. FORENSIC ECON. 113 (2007) and Eric A. Posner & Cass R. Sunstein, *Dollars and Death*, 72 U. CHI. L. REV. 537 (2005).

different attributable risk rates. This acknowledgement will then require the party introducing the rates to address which of the considerations their estimated rate addresses and which it has not yet incorporated. Juries should be extremely skeptical of testimony that purports to incorporate all relevant factors. Second, courts must acknowledge that, conditional on any attributable risk rate, features of the case can make a jury believe that the plaintiff belongs to the avoidable class. By refining this inquiry, experts will then be asked to testify as to whether such individuating evidence is likely to exist for the given harm, and if so, what evidence supports such a conclusion.

By understanding the work required to get relevant probabilities, and subsequently how to interpret them, courts can better assess the probative value of the statistical evidence presented. Only by understanding the limitations associated with such estimates can the judicial system start to take probabilities seriously. This Article demonstrates, in light of these considerations, how inappropriate probabilities are as gatekeepers. While statistics are often helpful pieces of evidence, ignoring the work necessary to adequately refine the probabilities reduces our institutional ability to interact with such evidence.

CONCLUSION

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No factfinder is perfect. No rule results in zero error. The purpose of this Article is not to nitpick the admirable efforts of courts to parse statistical evidence. Fully believing in the value of empirical evidence to ground legal concepts like causation, this Article is even more concerned that the empirical evidence be properly contextualized.

With an eye toward the future, the legal system's ability to deal with probabilistic causation will be vital. As big data allows us to get more information on previously unknown phenomena, the ability to use such information hinges on an accurate understanding of the intricacies and confounding effects of observational data. Insofar as expert testimony relies on such data, as it has been suggested would be helpful, the way the expert weighs the confounders is important for a jury to assess its credibility. Courts will never be experts in assessing statistics; however, it is vital for judicial resilience for courts to understand how to frame the relevant causation inquiry and the potential gap between that inquiry and the information presented as evidence.

Legal fictions such as a 50% threshold as a screening device do more harm than good. Probabilities do not follow the same discrete thresholds that the law imposes. Indeed, treating chances as protected interests somewhat feeds into this distortion: insofar as it furthers the belief that only events with sufficiently high probabilities occur, society as a whole—and the legal system more specifically—is vulnerable to systematic statistical error.

The proposed framework aims to bolster this judicial robustness. Eschewing arbitrary probability thresholds and ignoring irrelevant statistics, it identifies the attributable risk rate as the relevant causation metric at trial. In operationalizing this metric, the Article provides a process that first customizes the attributable risk rate for a plaintiff's observable ex-ante characteristics and then demonstrates how to parse through the counterfactual states of the world implied by the specific attributable risk rate, depending on the nature of the harm. Despite its simplicity, the process is not only faithful to statistical principles but also consistent with existing legal standards. Most importantly, the process harmonizes the treatment of causation in a so-called probabilistic context with that of causation in a non-probabilistic context. Armed with this simple process, courts need not fear the addition of statistical evidence in other contexts.