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Proving Causation: Probability versus Belief

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Proving Causation: Probability versus Belief[1]

RICHARD W WRIGHT

I. INTRODUCTION

One of the frequently assumed major differences between civil law and common law systems is the standard of persuasion applied by each in civil (non-criminal) cases. In most civil law jurisdictions, it is commonly assumed that the standard of persuasion is the same for criminal and civil proceedings. The plaintiff in a civil case, as well as the prosecutor in a criminal case, must provide sufficient proof to convince the trier of fact of the truth of the facts at issue on the particular occasion. This is phrased in France as a requirement that the trier of fact must have an *intime conviction*, an inner, personal, subjective conviction or belief in the truth of the facts at issue. The German courts have stated that a degree of conviction is required that silences doubts for practical purposes without completely eliminating them. Both of these standards are sometimes interpreted as being equivalent to the common law standard of proof beyond a reasonable doubt. Although it is recognised that absolute certainty is impossible to achieve, the required degree of belief is often expressed in terms of a virtual certainty, or at least a very high probability. However, a mere statistical probability, no matter how high, will not suffice in the absence of the required conviction or belief in the truth of the facts at issue.[2]

[1] This chapter includes substantial material from my prior papers on this topic. See RW Wright, 'Causation, Responsibility, Risk, Probability, Naked Statistics, and Proof: Pruning the Bramble Bush by Clarifying the Concepts [Pruning] (1988) 73 *Iowa Law Review* 1001, 1044–67; RW Wright, 'Liability for Possible Wrongs: Causation, Statistical Probability, and the Burden of Proof' [Possible Wrongs] (2008) 41 *Loyola Los Angeles Law Review* 1295; RW Wright, 'Proving Facts: Belief versus Probability' [Proving Facts] in H Koziol and BC Steininger (eds), *European Tort Law 2008* (Vienna, Springer-Verlag, 2009) 79.

[2] eg BGH, 17 February 1970 ('Anastasia Decision'), 53 BGHZ 245, 256 (German Federal Court of Justice) (interpreting s 286 of the German Code of Civil Procedure as requiring 'full judicial conviction in the form of a degree of certainty that silences doubt for practical purposes, even if it does not eliminate them entirely'); FHS Bridge, *The Council of Europe French-English Legal Dictionary* (Strasbourg, Council of Europe, 1998) 173 (defining *intime conviction* as 'reasonable conviction; reasonable certainty; state of being satisfied beyond reasonable doubt (personally convinced); personal conviction of the court (after considering all the evidence)'); KM Clermont and E Sherwin, 'A Comparative View of Standards of Proof' (2002) 50 *American Journal of Comparative Law* 243, 245–46, 250, 256, 271; D Demougin and C Fluet, 'Preponderance of Evidence' (2006) 50 *European Economic Review* 963, 964; C Engel, 'Preponderance of the Evidence versus *Intime Conviction*: A Behavioral Perspective on a Conflict Between American and Continental European Law' (2009) 33 *Vermont Law Review* 435; J Kokott, *The Burden of Proof in Comparative and International Human Rights Law* (Dordrecht, Kluwer Law International, 1998) 18–19; H Nagel, 'Evidence, Law of' in 7 *Encyclopædia Britannica, Macropædia*,

In common law jurisdictions, there is an explicit distinction between the standard of persuasion in criminal and civil proceedings. In criminal proceedings, the standard is very high: the prosecutor must prove the defendant's guilt 'beyond a reasonable doubt'. In civil proceedings, however, the plaintiff generally only needs to prove his case by the much lower standard of a 'preponderance of the evidence' (the usual formulation in the United States) or a 'balance of probability' (the usual formulation in the British Commonwealth and Scandinavia). Both the 'preponderance of the evidence' standard, which is commonly rephrased or interpreted as a 'more likely than not' standard, and the 'balance of probability' standard are often interpreted by academics, and sometimes by judges, as merely requiring a 50+ per cent probability.[3] For both standards, as so interpreted, it would be better to employ the term 'standard of proof' rather than 'standard of persuasion', since the latter implies an element of conviction or belief that is lacking when all that is involved is a class-based statistical probability.

Common law lawyers find it hard to understand why the very high standard of persuasion required for a criminal conviction should also apply in a civil action.[4] Some of them also believe that the civil law's rejection of proof by statistical probabilities and its insistence that the trier of fact instead be convinced of the truth of the facts at issue in the particular case is naïve, irrational, 'strange' and 'very odd,' especially when such conviction is interpreted as requiring virtual certainty. They note that nothing is certain, that all evidence merely gives rise to probabilities regarding the facts at issue, and that the 50+ per cent probability standard best serves the assumed goal of minimising errors.[5] They also question the focus on conviction, belief, and truth in civil law jurisdictions given the limited means for acquiring relevant evidence in those jurisdictions.[6]

Conversely, many civil law lawyers believe that it is naïve to believe that aggregate statistical probabilities can establish what actually happened in a particular case, and they find it hard to understand why a defendant should be held civilly liable based merely on such aggregate class-based probabilities, in the absence of evidence sufficient to convince the trier of fact of what actually happened in the particular case. Believing that the common law's 'preponderance of the evidence' and 'balance of probability' standards allow such proof, they reject both standards, at least as so interpreted.[7]

I have argued that the supposed major differences between the standards of persuasion in common law and civil law jurisdictions are greatly overstated.[8] I retrace that argument in section II below. I conclude that, in general, the common law as well as the civil law continues to view the applicable standards of persuasion in civil as well as criminal actions as requiring the formation of a belief in the truth of the facts at issue in the particular case, rather than a mere class-based statistical probability, and that concrete 'particularistic

15th edn (Chicago, Encyclopædia Britannica, 1974) 1a, 2b; R Zőller, *Zivilprozessordnung* (Cologne, Verlag Dr Otto Schmidt, 1999) ('Less than the conviction of truth is not sufficient for a proof . . . Standards that are based on a measure of likelihood do not find any support in the law.').

[3] eg Clermont and Sherwin (n 2) 243, 251–52 and fn 39, 257, 261 fn 86; Demougin and Fluet (n 2) 964; Kokott (n 2) 18–20.

[4] eg Clermont and Sherwin (n 2); Engel (n 2).

[5] eg E Adeney, 'The Challenge of Medical Uncertainty: Factual Causation in Anglo-Australian Toxic Tort Litigation' (1993) *Monash University Law Review* 23, 57, 59–62; Clermont and Sherwin (n 2) 243–44, 251–52, 258–59, 267, 271, 273–74.

[6] Clermont and Sherwin (n 2) 249–50; see Wright, Proving Facts (n 1) 80.

[7] eg M Taruffo, 'Rethinking the Standards of Proof' (2003) 51 *American Journal of Comparative Law* 659, 663–64, 667–71.

[8] Wright, Proving Facts (n 1) 82–90.

evidence' specific to the particular case is necessary to support such a belief. Although the available evidence is slim, I also conclude that in the civil law as well as the common law the strength of the required belief is lower in civil actions than in criminal actions.

The distinctions between belief and probability and between particularistic evidence and statistical evidence have been questioned. As the proponents of proof by mere statistical probability argue, given our limited knowledge of causal laws and the circumstances of particular situations, nothing is certain. All evidence, including concrete evidence specific to the particular occasion – for example, fingerprint evidence and eyewitness testimony – merely gives rise to a probability regarding the facts at issue.[9] Does it then make any sense to distinguish between probability and belief? I address these points and questions in section III below, in which I argue that the holding of a belief regarding what actually happened in a particular situation is very different from being willing to place a bet on what happened, and that while class-based statistics are very useful for the placing of the bet, they are insufficient and generally unhelpful for the formation of the belief, for which instead particularistic evidence is essential because only it is capable of converting possibly applicable causal generalisations (with their associated statistical frequencies) into actually instantiated causal laws.

Finally, in section IV, I apply the lessons of sections II and III to the various types of problematic causal situations that courts around the world have struggled to deal with in recent decades. Clear recognition of the issues in these cases and their proper resolution has often been hindered by an unanalysed assumption that the standard of persuasion in civil actions is a mere statistical probability standard, which however is not consistently applied, since doing so would generate significant problems and paradoxes. The considerable confusion that now exists could and should be greatly reduced simply by replacing the highly misleading phrases 'more likely than not' and 'balance of probability', and even the less misleading phrase 'preponderance of the evidence', with 'a minimal belief'.

II. THE STANDARDS OF PERSUASION

A. The Civil Law

Italian law professor Michele Taruffo notes that 'no rule, in any civil law system, requires the courts to apply in civil cases the same standard of proof that is applied in criminal cases.'[10] Instead, the relevant code provisions merely state the need for the triers of fact to be convinced regarding the truth of the facts at issue. They do not provide any standard for reaching that conviction or require that whatever standard is employed be the same in criminal and civil proceedings. To the contrary, they emphasise the judge's discretion in reaching that conviction based on his or her 'free evaluation' of all the available evidence, unconstrained by rigid rules of legal proof, such as the hearsay rules in the common law and the weighting of different types of evidence and mathematical calculation of 'full

[9] The difficulties of attributing a specific piece of evidence to a particular source are examined in National Research Council, *Strengthening Forensic Science in the United States: A Path Forward* (Washington DC, National Academies Press, 2009).

[10] Taruffo (n 7) 665.

proof' that existed under the French regime of *preuve légale* prior to the adoption of the civil codes.[11]

Changes to the French Code of Criminal Procedure, beginning in 1983, explicitly state that a civil action can proceed, in the criminal court or the civil court as appropriate, despite the acquittal of the defendant in the criminal action.[12] This makes little sense unless the civil standard, as in the common law, is lower than the criminal standard. While the difference could be in the degree of fault required rather than the standard of persuasion, the relevant changes to the Code of Criminal Procedure do not refer to any change in the required degree of fault, which previously was assumed to be the same in criminal and civil actions: an acquittal in the criminal action precluded any civil action.

In Italy, the Supreme Court of Cassation has explicitly adopted the 'beyond a reasonable doubt' standard for criminal actions and the 'more probable than not' standard for civil actions:

> As this Court has previously stated, the main difference [between the penal and civil processes] is in the standards of proof that each system requires (Cass. Pen., S.U., 11.09.2002, n. 30328).
>
> The Penal Code requires proof 'beyond a reasonable doubt' while the Civil Code merely requires 'more probable than not.' The different standards correspond to the different values at stake in each system (Cass. 16.10.2007, n. 21619; Cass. 18.04.2007, n. 9238; Cass. 05.09.2006, n. 19047; Cass. 04.03.2004, n. 4400; Cass. 21.01.2000, n. 632).[13]

In many civil law jurisdictions, there is little discussion by the courts, or even by academics, of the content of the standards of persuasion. However, anecdotal evidence indicates that the standards of persuasion in France, even in criminal proceedings,[14] vary depending on the discretion of the judge. This is also said to be the case in Germany.[15] Kevin Clermont and Emily Sherwin, at the end of an article generally assuming otherwise, eventually conclude that the supposed identity of the (presumed very high) criminal and civil standards of persuasion in civil law jurisdictions is a myth, which they argue is purposely maintained by the courts to shore up their legitimacy.[16] They state that 'civil-law judges likely apply a haphazardly variable civil standard of proof',[17] and they cite scholars who believe that the civil standard is closer to the 'more likely than not' standard than the 'beyond a reasonable doubt' standard.[18]

[11] ibid 666–67; Nagel (n 2) 1b, 3a; see Wright, Proving Facts (n 1) 83–84; n 20 below. The judge's 'free evaluation' is not completely unconstrained. In addition to the substantial limitations on the power of the parties or the judge to obtain access to relevant evidence, some legal proof rules continue to exist, especially in France. See Clermont and Sherwin (n 2) 249; R Vouin, 'The Exclusionary Rule: France' (1961) 52 *Journal of Criminal Law, Criminology, and Police Science* 275. But *cf Taruffo* (n 7) 661, 674–75.

[12] eg Code of Criminal Procedure arts 4-1, 371, 372, 470–71.

[13] Cass Civ Sez Un 581 [2008] s 3.9 (translated by Claudia DiMarzo, University of Palermo). The concept of 'probabilistic certainty' is discussed in Wright, Proving Facts (n 1) 95–96.

[14] See eg, M Foucault, *Abnormal: Lectures at the Collège de France* 1974–1975 (G Burchell transl) (New York, Picador, 2003) 8–11.

[15] PL Murray and R Stürner, *German Civil Justice* (Durham, Carolina Academic Press, 2004) 310–11; P Gottwald, 'Fact Finding: A German Perspective' in DL Carey Miller and PR Beaumont (eds), *The Option of Litigating in Europe* (London, British Institute of International and Comparative Law, 1993) 67, 77 (stating that German courts apply a preponderance standard 'with regard to prima facie cases, to causation, to negligence and to assessment of damages').

[16] Clermont and Sherwin (n 2) 258–59, 269–73.

[17] ibid 273.

[18] ibid 261, citing, among other sources, *ALI/UNIDROIT Principles and Rules of Transnational Civil Procedure,* Discussion Draft No 3 (St Paul, American Law Institute, 2002) P-18A, R-31E. See also Murray and Stürner (n 15) 310–11.

However, contrary to Clermont and Sherwin's identification of the 'preponderance of the evidence' and 'more likely than not' standards with a mere 50+ per cent statistical probability,[19] civil law judges and lawyers, as noted above, generally reject such identification and instead insist that the trier of fact must be convinced (believe) that the alleged causal connection actually existed in the particular case. Although the codes do not specify any specific standard of persuasion in (or criminal) cases, the references to the judge's 'conviction' in the French *intime conviction* standard and other civil code provisions, for example, the German criminal and civil code provisions,[20] provide a *minimum* standard of persuasion: the judge is required to have a *conviction* – a belief – regarding the truth of the facts at issue. This is the core of the civil law approach to proof, which is thought to be absent in the common law's 'preponderance of the evidence', 'more likely than not', and 'balance of probability' standards.[21]

Civil law courts generally insist that mere statistical probabilities are insufficient evidence to support a belief in what actually happened in a particular case. Instead, evidence specific to the particular case is necessary.[22] For example, in a continuation of the language quoted above from the recent decision of the Italian Supreme Court of Cassation, the Court stated:

> The [European] Court of Justice CE has recently stated that causation cannot be based on probabilities (CGCE 13.07.2006, n. 295; CGCE 15.02.2005, n. 12).
>
> The concept of 'probabilistic certainty' [in Italian law] is a standard that is necessary in all civil cases. The mere statistical likelihood that one act or omission caused certain harm is not enough to impose liability. Probabilistic certainty also requires evidence from the specific case to support that statistical likelihood.[23]

B. The Common Law

No-one, other than die-hard mathematical probabilists, argues that the 'beyond a reasonable doubt' standard of persuasion for criminal liability should be, or is, interpreted or applied as a mere (very high) statistical probability. Less commonly appreciated nowadays is that the 'preponderance of the evidence', 'more likely than not', and 'balance of probability' standards of persuasion for civil liability traditionally also have been understood by judges and presented to juries as requiring the formation of a minimal belief regarding the

[19] Clermont and Sherwin (n 2) 265.

[20] Section 261 of the German Code of Criminal Procedure states: 'The court shall decide on the result of the evidence taken according to its free conviction gained from the hearing as a whole'. CJM Safferling, 'Terror and Law – Is the German Legal System able to deal with Terrorism? – The *Bundesgerichtshof* (Federal Court of Justice) decision in the case against *El Motassadeq*' (2004) 5 *German Law Journal* 515, 520. Subsection 1 of section 286 of the Code of Civil Procedure states: 'The court shall decide at its free discretion, by taking into account the whole substance of the proceedings and the results of any evidence taking, whether a factual allegation should be regarded as true or untrue. The grounds which prompted the court's conviction shall be stated in the judgment'. SL Goren, *The Code of Civil Procedure Rules of the Federal Republic of Germany of January 30, 1877 and the Introductory Act for the Code of Civil Procedure Rules of January 30, 1877* (Littleton, Fred B Rothman & Co, 1990) 73; see Wright, Proving Facts (n 1) 82–83, 94.

[21] Taruffo (n 7) 675.

[22] See eg, BGH, 6 October 1998, 1999 NJW 860 (German Federal Court of Justice) (upholding the lower courts' decision that a 70 per cent statistical probability that prompt diagnosis and treatment of the patient's illness would have prevented the patient's injury was insufficient proof of causation of the injury by negligent non-diagnosis); Taruffo (n 7) 659, 663–64, 667–71; n 2 above (quote from Zoller).

[23] Cass Civ Sez Un 581 [2008] s 3.9 (translated by Claudia DiMarzo, University of Palermo). The Italian court's concept of 'probabilistic certainty' is discussed in Wright, Proving Facts (n 1) 95–96.

truth of the fact(s) at issue, rather than a mere 50+ per cent statistical probability. My arguments in support of this conclusion are based primarily on an analysis of relevant materials in the United States. However, the situation appears to be the same in the other common law countries, as is indicated especially by the recent judgments of the United Kingdom Supreme Court in *Sienkiewicz v Greif (UK) Ltd*.[24]

A highly respected source of jury instructions in the United States defines the 'preponderance of the evidence' standard of persuasion as follows:

> To 'establish by a preponderance of the evidence' means to prove that something is more likely so than not so. In other words, a preponderance of the evidence in the case means such evidence as, when considered and compared with that opposed to it, has more convincing force, and produces in your minds belief that what is sought to be proved is more likely true than not true. This rule does not, of course, require proof to an absolute certainty, since proof to an absolute certainty is seldom possible in any case.[25]

The core of this instruction is essentially identical to the standards of persuasion that are stated in the German codes of criminal and civil procedure.[26] While the American instruction does not include the 'free evaluation of the evidence' principle that is stressed in the German code provisions, it has the same focus on the required formation of a conviction (belief) in the truth of the facts at issue. Moreover, unlike the German code provisions, code provisions and jury instructions in the United States generally specify the required degree of belief. For example, section 115 of the California Evidence Code states:

> 'Burden of proof' means the obligation of a party to establish by evidence a requisite degree of belief concerning a fact in the mind of the trier of fact or the court. . . . The burden of proof may require a party to raise a reasonable doubt concerning the existence or nonexistence of a fact or that he establish the existence or nonexistence of a fact by a preponderance of the evidence, by clear and convincing proof, or by proof beyond a reasonable doubt. Except as otherwise provided by law, the burden of proof requires proof by a preponderance of the evidence.[27]

As this code provision states, the default required degree of belief in a civil case in the United States is by a mere 'preponderance of the evidence', that is, the slightest degree of belief,[28] rather than the much stronger degrees of belief required under the 'clear and convincing evidence' or 'beyond a reasonable doubt' standards, which are more literally worded belief standards.

Civil jury instructions in the Unites States often refer to proof that the disputed fact is 'more probably *true* than not true,' rather than simply 'more likely than not' as a matter of

[24] [2011] UKSC 10 [2011] 2 WLR 523; see text to nn 41–48 below; Adeney (n 5) 56–59 (discussing Australian cases). Adeney incorrectly equates my insistence on the formation of a minimal belief with insistence on absolute certainty. Adeney (n 5) 59–60.

[25] EH Devitt et al, 3 *Federal Jury Practice and Instructions (Civil)*, 4th edn (St Paul, West Publishing Co, 1987) s 72.01 at 32 (emphasis added); see State Bar of Nevada, *Nevada Pattern Jury Instructions – Civil* (Charlottesville, Michie, 1986) s 3.00.1 ('The term "preponderance of the evidence" means such evidence as, when *weighed* with that opposed to it, has more *convincing* force, and from which it appears that the greater probability of *truth* lies therein'.) (emphasis added); Wright, Pruning (n 1) 1065 and fns 337–39.

[26] See n 20 above.

[27] *California Evidence Code* (St Paul, West Publishing Co, 2010) s 115.

[28] See eg, *Livanovitch v Livanovitch* (1926) 131 A 799, 800 (Supreme Court of Vermont) ('If . . . you are more inclined to believe from the evidence that he did so deliver the bonds to the defendant, even though your belief is only *the slightest degree* greater than that he did not, your verdict should be for the plaintiff'. (quoting the trial court's jury instructions)).

mere statistical probability.[29] When 'more likely than not' or some similar phrase is employed, it is usually clear from the surrounding language that the phrase is not being used to refer to a mere 50+ per cent statistical probability, but rather to refer to the formation of a minimal belief in the truth of what actually happened on the particular occasion. In a famous case involving an unidentified bus that forced an oncoming automobile off the road, in which the statistical probability that it was the defendant's bus was very high, the Supreme Court of Massachusetts stated:

> It has been held not enough that mathematically the chances somewhat favor a proposition to be proved; for example, the fact that colored automobiles made in the current year outnumber black ones would not warrant a finding that an undescribed automobile of the current year is colored and not black, nor would the fact that only a minority of men die of cancer warrant a finding that a particular man did not die of cancer. The weight or ponderance of evidence is its power to convince the tribunal which has the determination of the fact, of the actual truth of the proposition to be proved. After the evidence has been weighed, that proposition is proved by a preponderance of the evidence if it is made to appear more likely or probable in the sense that actual belief in its truth, derived from the evidence, exists in the mind or minds of the tribunal notwithstanding any doubts that may still linger there.[30]

Similarly, in the more recent, also well-known *Cipillone* case involving cancer allegedly caused by cigarettes, the US Court of Appeals for the Third Circuit questioned attempts by some courts and commentators to use mathematical probability to define and prove 'but for' causation:

> We are not convinced that when a jury determines that 'but for' a defendant's conduct, the injury would not have occurred, it is determining that the chances of that injury being the result of defendant's conduct are 50% or greater. Traditionally, jury instructions have been in words, not numbers.[31]

When asked to do so by researchers, many judges similarly object to interpreting standards of persuasion in terms of quantitative probabilities.[32] In one survey, 80 out of 255 judges refused to specify a probability sufficient for a 'preponderance of the evidence' finding.[33] Of the judges who were willing to do so, only about three-fifths chose a probability of 50 to 55 per cent; about two-fifths chose a probability of 60 per cent or greater, almost one-fifth a probability of 70 per cent or greater, one-tenth a probability of 80 per cent or greater, and one-twentieth a probability of 90 to 100 per cent.[34] The distribution of

[29] eg *Judicial Council of California Civil Jury Instructions* (Matthew Bender, 2010) No 200 ('more likely to be true than not true'); Illinois Supreme Court Committee on Pattern Jury Instructions in Civil Cases, *Illinois Pattern Jury Instructions: Civil* (St Paul, West Publishing Co, 2006) s 21.01 ('more probably true than not true'); LB Sand et al, 4 *Modern Federal Jury Instructions* (Newark, LexisNexis, 2007) s 73.01, Instruction 73–2 (stating that 'by a preponderance of the evidence' means 'more likely true than not true,' considering the 'weight' and 'quality and persuasiveness' of the evidence).

[30] *Sargent v Massachusetts Accident Co* (1940) 29 NE 2d 825, 827 (Supreme Court of Massachusetts) (citations omitted).

[31] *Cipollone v Liggett Group Inc* (1990) 893 F 2d 541, 561 fn 17 (United States Court of Appeals, Third Circuit). I am grateful to my colleague, Kathy Baker, for bringing this footnote to my attention.

[32] CMA McCauliff, 'Burdens of Proof: Degrees of Belief, Quanta of Evidence, or Constitutional Guarantees?' (1982) 35 *Vanderbilt Law Review* 1293, 1332; RJ Simon and L Mahan, 'Quantifying Burdens of Proof: A View from the Bench, the Jury, and the Classroom' (1971) 5 *Law and Society Review* 319, 329 (quoting judges as stating that '[p]ercentages or probabilities simply cannot encompass all the factors, tangible and intangible, in determining guilt – evidence cannot be evaluated in such terms').

[33] McCauliff (n 32) 1325 fn 184, 1330.

[34] ibid 1331; Simon and Mahan (n 32) 324–25, 327 table 7.

probabilities was about the same for the 'more probable than not' standard.[35] Laypersons – jurors and students – were even less willing to interpret the preponderance standard as a mere 50+ per cent probability. About four-fifths of the laypersons chose a probability of 70 per cent or greater, half a probability of 80 per cent or greater, and more than one-tenth a probability of 95 to 100 per cent.[36] Over 90 per cent of the judges and about two-thirds of the laypersons were opposed to having jurors simply make a probability finding, which the judge would then use to determine liability.[37] Trial consultants advise American plaintiffs' lawyers that '[m]any jurors will not agree to decide on the basis of 80 percent or 70 percent or 60 percent certainty', but rather 'expect you to prove your case beyond a reasonable doubt, and you won't change their minds by explaining preponderance'. Instead, the trial consultants advise, repeatedly get witnesses to testify that something is 'more likely right than wrong' and, 'beyond that,' that they are 'certain' of the truth of the fact at issue.[38]

Courts in the United States also usually agree with the civil law courts that, to prove what actually happened in a particular case – to establish what the facts actually were in that case – the party with the burden of persuasion regarding those facts must employ evidence specific to that particular case, rather than mere statistical probabilities. In *Day v Boston & Maine Railroad*, the Supreme Court of Maine famously stated:

> Quantitative probability, however, is only the greater chance. It is not proof, nor even probative evidence, of the proposition to be proved. That in one throw of the dice there is a quantitative probability, or greater chance, that a less number of spots than sixes will fall uppermost [on both die] is no evidence whatever that in a given throw such was the actual result. Without something more, the actual result of the throw would still be utterly unknown. The slightest real evidence that sixes did in fact fall uppermost would outweigh all the probability otherwise.[39]

Jury instructions often refer to the 'weight' of the evidence.[40] Abstract statistics do not have 'weight'. Concrete evidence specific to the particular case does have 'weight'.

The recent judgments of the United Kingdom Supreme Court in *Sienkiewicz* similarly warn against literally interpreting the 'balance of probability' standard of persuasion as merely requiring a statistical 50+ per cent probability. Lord Rodger's judgment is the clearest and most emphatic. Discussing a hypothetical situation in which reliable statistical evidence established that exposure to a substance more than doubled the risk of a specific injury, he stated:

> It is important to recognize that in such a case the claimant would not have proved, on the balance of probability, that his exposure to the [substance] actually caused [the injury]. . . . [B]y leading the epidemiological evidence, the only "fact" that the plaintiff can prove and offers to prove, on the balance of probability, is that *in most cases* the [injury] *would have been* related to the [exposure].

[35] McCauliff (n 32) 1331.

[36] Simon and Mahan (n 32) 327 table 7; see also DK Kagehiro and WC Stanton, 'Legal vs. Quantified Definitions of Standards of Proof' (1985) 9 *Law and Human Behavior* 159, 164, 169 (discussing an empirical study demonstrating a divergence between subjects' findings under the preponderance standard and a quantified 51 per cent standard, with results closer to those obtained under the preponderance standard even when the two standards were combined in the same instruction).

[37] Simon and Mahan (n 32) 329, 330 fn 8. See also GL Wells, 'Naked Statistical Evidence of Liability: Is Subjective Probability Enough?' (1992) 62 *Journal of Personality and Social Psychology* 739 (finding that laypersons and trial judges are unwilling to base liability on mere statistical probability, requiring instead evidence specific to the particular situation that gives rise to a belief in the truth of the asserted facts).

[38] D Ball, 'Making Preponderance Work' (March 2008) *Trial* 38–40.

[39] *Day v Boston & Maine Railroad* (1902) 52 A 771, 774 (Supreme Court of Maine).

[40] See eg, nn 25 and 29 and text to n 30 above.

> So, if the judge accepts the evidence, it may legitimately satisfy him, on the balance of probability, not that the plaintiff's [injury] was caused by the [exposure], but that, in the absence of any evidence that the claimant is atypical, it is more probable than not that his [injury] was caused by the [exposure]. In short, the chances are that it was. Whether, in any particular case, the claimant's [injury] was actually caused by the [exposure] is a matter of fact – and one that remains unknown, if the only available evidence is statistical. . . .
>
> Of course, it is possible to conceive of a legal system which chose, as a matter of policy, to make defendants liable for all the damages which a court was satisfied, on the balance of probability, they had probably caused. But only the legislature could alter English or Scots law so as to introduce a general rule to that effect, which would change the very nature of the system and completely alter its balance. . . . [I]n civil proceedings for damages the role of the judge is to decide, on the balance of probabilities, what actually happened.[41]

Baroness Hale stated:

> I do agree with Lord Rodger that doubling the risk is not an appropriate test of causation. . . . Risk is a forward looking concept – what are the chances that I will get a particular disease in the future? . . . But if the disease materialises, the existence of a statistically significant association between factor X and disease Y does not prove that in the individual case it is more likely than not that factor X caused disease Y. . . .
>
> But as a fact-finder, how can one ignore these statistical associations? Fact-finding judges are told that they must judge a conflict of oral evidence against "the overall probabilities" coupled with objective facts and contemporaneous documentation. . . . Yet judges do not define what they mean by "the overall probabilities" other than their own particular hunches about human behaviour. Surely statistical associations are at least as valuable as hunches about human behaviour. . . . Most judges will put everything into the mix before deciding which account is more likely than not. As long as they correctly direct themselves that statistical probabilities do not prove a case, any more than their own views about the overall probabilities will do so, their findings will be safe.[42]

Lord Mance also cautioned against sole reliance on statistical evidence to prove what actually happened in a particular case:

> I share a reluctance to place too much weight on such evidence. . . . [T]he law is concerned with the rights or wrongs of an individual situation, and should not treat people and even companies as statistics. . . . [A]n attribution of liability based substantially on statistical evidence, that, viewing the relevant population or group as a whole, it is more likely than not that the particular defendant was negligent or causatively responsible, appears to me most undesirable.
>
> That epidemiological evidence used with proper caution, can be admissible and relevant in conjunction with specific evidence related to the individual circumstances and parties is, however, common ground and clearly right. What significance a court may attach to it must depend on the nature of the epidemiological evidence, and of the particular factual issues before the court.
>
> Whether and if so when epidemiological evidence can by itself prove a case is a question best considered not in the abstract but in a particular case, when and if that question arises. If it can, then, I would hope and expect that this would occur only in the rarest of cases.[43]

Lord Kerr stated that he 'shared the misgivings expressed' by the other judges and that '[i]t is an essential and minimum requirement . . . that there be evidence connecting avowedly relevant statistical information produced by the epidemiological studies to the facts of the case'.[44]

[41] [2011] UKSC 10 [156] (citation omitted) and [158]; see ibid [143], [153]–[160].
[42] ibid [170] and [172]; see ibid [171].
[43] ibid [190]–[192].
[44] ibid [204] and [205]; see ibid [206].

Lord Dyson acknowledged the distinction between 'fact probability' based on a mere 50+ per cent statistical probability and 'belief probability' based on an actual belief in what actually occurred in a particular case:

> In my view, this is an important distinction and it is of particular relevance in relation to causation in toxic torts. It is often the basic impossibility of proving individual causation which distinguishes toxic tort cases from ordinary personal injury cases. . . . [E]pidemiology is based on the study of populations, not individuals. . . . [I]n an individual case, epidemiology alone cannot *conclusively* prove causation. At best, it can establish only a certain [statistical] probability that a randomly selected case of disease was one that would not have occurred absent exposure.
>
> Ultimately, questions of burden and standard of proof are policy matters for any system of law. It is trite law that our system requires a civil claim to be proved by a claimant on the balance of probability. It is a matter of policy choice whether, and, if so, in what circumstances the courts are willing to find causation proved on the balance of probability on the basis of epidemiological evidence alone. . . .
>
> [I]t is not necessary for the resolution of the present appeal to decide whether epidemiological evidence alone suffices. . . . It seems to me, however, that there is no *a priori* reason why, if the epidemiological evidence is cogent enough, it should not be sufficient to enable a claimant to prove his case without more. Our civil law does not deal in scientific or logical certainties. The statistical evidence may be so compelling that . . . the court may be able to infer belief probability from fact probability. To permit the drawing of such an inference is not to collapse the distinction between fact probability and belief probability. It merely recognises that, in a particular case, the fact probability may be so strong that the court is satisfied as to belief probability.[45]

Lord Brown did not address the statistical evidence issue.[46] Only Lord Phillips expressed a willingness to treat adequate and reliable epidemiological evidence (which he and the other judges agreed was lacking in *Sienkiwicz*) as being generally sufficient, by itself, to satisfy the 'balance of probability' standard of persuasion, although he acknowledged, as did all the other judges, that doing so would be supportable only as a matter of judicial policy, since such statistical evidence is insufficient to establish actual causation in a particular case as a matter of scientific fact,[47] and he stated that a statistical probability only minimally greater than 50 per cent would be 'a tenuous basis for concluding that the statistical probable cause of a disease was also the probable biological cause, or cause in fact', since 'the balance of that probability is a very fine one'.[48]

In sum, contrary to what is commonly thought, I believe that there is strong agreement between civil law and common law jurisdictions regarding the standards of persuasion. In both systems, the plaintiff generally must provide evidence sufficient to convince the trier of fact of the truth of the facts at issue in the particular situation; a mere statistical probability, no matter how high, generally is insufficient. Moreover, in both systems, the required degree of belief varies in criminal actions and civil actions, given the different interests at stake in each action. For criminal actions, a very high degree of belief is required: no reasonable doubt can remain. For most issues in civil actions, however, the standard of persua-

[45] ibid [217]–[222].

[46] The closest Lord Brown came was his observation that '[t]here is rough justice about the law of personal injury liability as a whole. To compensate a claimant in full for a lost finger because there was a 60:40 chance that he would have worn protective gloves had they been made available to him may be regarded as rough justice for the defendants. But it is balanced by the denial of compensation to a plaintiff who cannot establish that he probably would have worn the gloves'. ibid [187].

[47] ibid [6], [9]–[10], [26], [52]–[54], [78]–[106].

[48] ibid [83].

sion is much lower: all that is required is the formation of a minimal personal belief (*intime conviction*) by the trier of fact in the truth of the facts at issue.

III. PROVING CAUSATION

Proof of a singular instance of causation requires proof of (1) a scientifically valid causal generalisation that contains in its antecedent an abstract condition that is at least partially instantiated by the putative cause, the so-called 'general causation' or causal capacity issue, and (2) complete instantiation of the allegedly relevant causal generalisation and its underlying causal laws on the particular occasion, the so-called 'specific causation' issue.

Causation is an empirical relation between concrete conditions. A singular instance of causation consists of the complete instantiation of one or more causal laws by concrete conditions on a particular occasion. A causal law is a law of nature; it describes an empirically based, invariable, nonprobabilistic relation[49] between some minimal set of abstractly described antecedent conditions and some abstractly described consequent condition, such that the concrete instantiation of all the antecedent conditions will always immediately result in the concrete instantiation of the consequent condition. Any concrete condition that is part of the instantiation of the completely instantiated antecedent of the causal law is a cause of (contributed to) the instantiation of the consequent.[50]

Our knowledge of causal laws generally is incomplete, and even when it is complete we rarely refer to completely specified causal laws, since such complete specification would be extremely burdensome and unnecessarily detailed and lengthy. We rather employ causal generalisations, which refer to only some of the antecedent conditions in the relevant causal laws and have only as much specificity as is possible and needed in the particular situation. Moreover, the generalisations that we employ usually refer elliptically to a large number of simultaneously or successively operative causal laws. However, when we make an assertion regarding a singular instance of causation, we are implicitly asserting that all the unstated as well as the stated conditions in the relevant causal generalisations and all the unknown as well as known conditions in the causal laws underlying the causal generalisations were instantiated on the particular occasion.[51]

In the bash/crash/slash physical trauma situations that once dominated tort litigation and are still common, causal capacity usually is assumed and need not be alleged or proven.[52] However, modern tort litigation often involves complex and poorly understood biological and chemical processes, so that the issue of causal capacity is contested and must be proved through expert scientific evidence. To establish causal capacity, scientists typically rely on controlled experiments (eg toxicology) or observation and statistical analysis of uncontrolled events (epidemiology).

[49] In a radically indeterministic world, in which nothing was even weakly necessary or sufficient for anything else, the concept of causation likely would not exist. RW Wright, 'The NESS Account of Natural Causation: A Response to Criticisms', chapter 14 in this volume, III.G.

[50] ibid II.

[51] ibid.

[52] But see *Vosburg v Putney* (1890) 47 NW 99, (1891) 50 NW 403 (Supreme Court of Wisconsin), frequently used to teach liability for intentional injury in the United States, in which the capacity of a traumatic blow to cause osteomyelitis was the major contested issue. See ZL Zile, '*Vosburg v Putney*: A Centennial Story' 1992 *Wisconsin Law Review* 877, 910–14, 933–42, 956–64.

Toxicological experimentation is limited by ethical restrictions on research on humans and other animals, by the frequent need to use doses of the substance being tested that are much higher than the actual or projected exposure levels in order to get meaningful results within reasonable time-frames using a reasonable number of tests or samples, and by the difficulty of extrapolating from effects on nonhuman species to effects on humans and from effects at high doses to effects at much lower doses.

Scientists therefore often rely on the uncontrolled 'natural experiments' that occur in ordinary life without their intervention. Assessment of these natural experiments relies on epidemiology: the use of statistical methods to attempt to discern statistically significant correlations. However, this method often requires very large sample populations which either do not exist or cannot practically be evaluated. Moreover, as scientists recognise, a statistically significant correlation between A and B is insufficient by itself to establish a causal relationship between A and B, since the correlation may be spurious – that is, due to some antecedent common cause of both A and B, with no causal relation existing between A and B themselves. For example, my neighbour may take the train to work every morning exactly one hour after I take the train. The perfect correlation does not prove or demonstrate that my catching the train is a cause of his catching the train one hour later; rather, both of our actions are independently caused by other factors, including the occurrence of certain times of the day.[53] To avoid attributing a causal relation based on such spurious correlations, scientists generally require that A occur before B, that other possible explanations for the correlation be ruled out, and that there be some explanation or theory indicating how A causes B.[54]

Since a causal generalisation is not a complete specification of the underlying causal laws, instantiation of all of the antecedent conditions in the causal generalisation provides only a probability, rather than a certainty, that the underlying causal laws were completely instantiated and, thus, that the condition at issue actually was a cause of (contributed to) the relevant consequence. This probability is what I have called an ex ante causal probability. The statistical probability provided by an epidemiological study will provide only a lower bound, and perhaps even a negative value, for the ex ante probability of causation, since it will not take into account situations involving causal overdetermination, in which the condition at issue contributed to the occurrence of the consequence but the consequence would have occurred anyway owing to other duplicative or preempted conditions. Thus, a requirement that exposure to a substance more than double, or even increase, the risk of a certain injury is too strict when applied to the issue of general causation or causal capacity (the existence of a relevant causal generalisation linking such exposures to such injuries).[55]

More significantly for our purposes, the ex ante causal probability is a non-individualised, class-based probability that describes, on average or in the aggregate, the frequency of actual causation by the causal process at issue in the totality of situations in which the antecedent of the causal generalisation is completely instantiated. As was recognised by the United Kingdom

[53] See Wright (n 49) III.C.

[54] AB Hill, 'The Environment and Disease: Association or Causation?' in (1965) 58 *Proceedings of the Royal Society of Medicine* 295; 'Symposium on Legal and Scientific Perspectives on Causation in Mass Tort Litigation' (1991) 1 *Courts, Health Science & the Law* pt 3.

[55] See KJ Rothman, S Greenland, and TL Lash, *Modern Epidemiology*, 3rd edn (Philadelphia, Lippincott, Williams and Wilkins, 2008) 62–64; S Greenland and J Robins, 'Epidemiology, Justice, and the Probability of Causation' (2000) 40 *Jurimetrics* 321, 326–27. I am grateful to Alex Broadbent for bringing Greenland's work to my attention. For discussion of duplicative and preemptive causation, see Wright (n 49) III.D and III.E.

Supreme Court in *Sienkiewicz*,[56] this ex ante causal probability does not describe an individualised probability of instantiation for the specific situation at issue, which will vary widely depending on the state of the antecedent conditions in the underlying causal laws that are not included in the causal generalisation. For example, the individualised probability that smoking cigarettes or exposure to some other carcinogen or toxin will cause (or has caused) the death of a specific individual will vary widely depending on that individual's genetics and lifestyle. The aggregate statistical probability provided by an epidemiological study of a certain exposed population over a certain period of time will not constitute an accurate individualised probability even for a person in the studied population, much less for a person with a different exposure during a different period of time.[57]

Nevertheless, as recognised by the judges in *Sienkiewicz*,[58] ex ante causal probabilities are useful, indeed necessary, for causal prediction or 'postdiction' – predicting, in the absence of further evidence, what is likely to happen in the future or the most likely cause of an already occurred event.

However, as all the judges in *Sienkiewicz* also recognised,[59] ex ante causal probabilities are insufficient for establishing what actually happened in a particular situation, that is, which of the possibly applicable causal generalisations actually applied in the particular situation. Indeed, as only Lord Rodger perhaps realised,[60] apart from its possible use in implying (but being neither necessary nor sufficient for proving) a possibly applicable causal generalisation, the ex ante causal probability is neither useful nor relevant in establishing what actually happened in a particular situation, since it provides no information on whether the abstract elements in the underlying causal laws that are not included in the causal generalisation actually were instantiated on that occasion. It merely states that, on average or in the aggregate, X per cent of the time that the abstract elements specified in the causal generalisation are instantiated, the unspecified abstract elements required to complete the underlying causal laws are also instantiated. It does not help us determine whether this particular occasion is one of the X per cent in which the underlying causal laws were fully instantiated, or instead is one of the 100–X per cent in which they were not. The ex ante causal probabilities can be used to place a bet on what happened, but they cannot be used to resolve the bet. If a horse wins 90 per cent of its races or the odds are 90 per cent that a spin of a roulette wheel will not result in the ball's landing on a certain number, no-one who placed a bet either way in either situation will consider themselves to have won or lost the bet in the absence of specific evidence of the actual outcome of the particular race or spin of the wheel. Moreover, on the issue of what actually happened such specific evidence of the actual outcome is all that counts; the ex ante causal probabilities are irrelevant (apart from their possible usefulness in implying general causal capacity). This is the point made

[56] See [2011] UKSC 10 [83], [96]–[103] (Lord Phillips); ibid [152] (Lord Rodger); ibid [170] (Baroness Hale): ibid [205] (Lord Kerr); ibid [223] (Lord Dyson); text to n 47 above.

[57] See eg, R Goldberg, 'The Contraceptive Pill, Negligence and Causation: Views on *Vadera* v. *Shaw*' (2000) 8 *Medical Law Review* 316, 331–35 (noting the court's failure to particularise evidence to the individual patient, a 22-year-old Asian woman with no history of health problems, who suffered a stroke within six weeks of administration of the 'second generation' oral contraceptive, Logynon).

[58] See, eg [2011] UKSC 10 [7] (Lord Phillips); ibid [163] (Lord Rodger); text to nn 41–48 above.

[59] See ibid [6]–[10] (Lord Phillips); text to nn 41–48 above. Although Lord Dyson correctly observes that a very high statistical probability may cause the trier of fact to form a belief in actual causation in the particular instance, see ibid [222], it would not be a soundly based belief, for the reasons I state in the following text.

[60] Compare Lord Rodger's comments at ibid [153]–[156] with his comments at ibid [163]; see text to nn 41–48 above.

in the previously quoted language from the Supreme Court of Maine's opinion in *Day v Boston & Maine Railroad*:

> Quantitative [ex ante] probability, however, is only the greater chance. It is not proof, nor even probative evidence, of the proposition to be proved. That in one throw of the dice there is a quantitative [ex ante] probability, or greater chance, that a less number of spots than sixes will fall uppermost [on both die] is no evidence whatever that in a given throw such was the actual result. Without something more, the actual result of the throw would still be utterly unknown. The slightest real [particularistic] evidence that sixes did in fact fall uppermost would outweigh all the [ex ante] probability otherwise.[61]

In the dice throwing hypothetical, there are six competing causal generalisations – 'throwing a die causes six (five/four/three/two/one) spots to fall uppermost (on average or in the aggregate, given a sufficient number of throws) one-sixth of the time' – that, for heuristic purposes only,[62] can be rephrased when a pair of dice are thrown as two competing causal generalisations: (1) 'throwing a pair of dice causes a pair of sixes to fall uppermost 1/36th of the time' and (2) 'throwing a pair of dice causes something other than a pair of sixes to fall uppermost 35/36th of the time'. The ex ante causal probabilities associated with these two causal generalisations – 3 per cent and 97 per cent, respectively – provide a strong basis for a causal prediction, 'postdiction', or bet that the second causal generalisation was much more likely to be instantiated on this particular occasion and every other occasion considered separately. Nevertheless, they provide no information at all on which of the two causal generalisations actually was instantiated on the particular occasion.

Legal fact-finders are not told that they merely need to place a bet on the existence of some fact, but rather are instructed that they must determine whether the fact actually existed. As we have seen, both civil law and common law courts generally insist that the finders of fact be convinced, to the required degree of belief, of the truth of the asserted facts in a case, and they further insist that such belief must be supported by concrete evidence that is specific to the particular case, rather than mere ex ante statistical probabilities. To prove what actually happened in a particular case – whether an allegedly applicable causal generalisation and its underlying causal laws were fully instantiated – it must be proved, to the required degree of belief, that all the abstract elements in that causal generalisation and its underlying causal laws were instantiated. As all or almost all of the judges in *Sienkiewicz* apparently realised,[63] only particularistic evidence can establish such instantiation. Thus, the demand for particularistic evidence is not based on the notion that such evidence is 'uniquely highly probabilifying,'[64] but rather on the fact that it is uniquely instantiating.

[61] See text to n 39 above. See also, eg, *Johnston v United States* (1984) 597 F Supp 374, 412 (United States District Court, Kansas) (holding that a greater than 50 per cent statistical probability that the plaintiff's cancers were caused by radiation exposure was insufficient proof of specific causation); *United States v Shonubi* 103 F 3d 1085 (1997) (United States Court of Appeals, Second Circuit) (rejecting the attempt by maverick federal district judge Jack Weinstein, the leading judicial proponent of the statistical probability interpretation of standards of persuasion, to use statistics on typical amounts of illegally smuggled heroin to establish, for sentencing purposes, the amounts actually smuggled by the defendant on prior occasions, and insisting instead on proof by evidence specific to each instance of smuggling). The proponents of statistical evidence have been especially apoplectic regarding the Second Circuit's reining in of Judge Weinstein in the *Shonubi* case. See eg, *United States v Shonubi* 962 F Supp 370 (1997) (Federal District Court, Eastern District of New York) (Judge Weinstein); P Tillers, 'If wishes were horses: discursive comments on attempts to prevent individuals from being unfairly burdened by their reference classes' (2005) 4 *Law, Probability and Risk* 33.

[62] See Wright, Pruning (n 1) 1059–60.

[63] See text to nn 41–48 above.

[64] See J Thomson, 'Liability and Individualized Evidence' (Summer 1986) 49 *Law and Contemporary Problems* 199, 206 and fn 14 (criticising the language from the *Day* case quoted in the text to nn 39 and 61 above).

Of course, we rarely, if ever, will have knowledge of the multitude of necessary abstract elements in the causal laws underlying a possibly relevant causal generalisation, much less direct particularistic evidence of instantiation of each of those elements. Instead, instantiation of the unknown elements, and even some or many of the known elements, will have to be inferred circumstantially from particularistic evidence of instantiation of the network of causal relationships that encompasses the particular occasion, which fit coherently into a story of what happened on the particular occasion. The degree of coherence of the particularistic evidence with the relevant causal story (coherent network of possible causal generalisations and underlying causal laws in the particular situation) is what I have previously inaptly and misleadingly referred to as an ex post causal probability. As I have previously emphasised, rather than being some quantitative statistical or mathematical probability, the inaptly referenced 'ex post causal probability', which is better described as a degree of coherent fit, is an unquantified judgment of the degree of coherence of the particularistic evidence with a possibly applicable causal story of what happened on the particular occasion.[65]

When analysing what actually happened on the particular occasion, we compare the coherence of the particularistic evidence with the various possibly applicable causal stories. The more particularistic evidence there is that fits with a possibly applicable causal story, the greater the fit, although the assessment of the level of fit also depends on the relative significance of the abstract element being instantiated in the overall causal story and particularly with respect to the central causal issue. Direct particularistic evidence of the presence or lack of some necessary condition in the causal generalisation at issue is especially significant; indeed, proof of the lack of instantiation of some necessary element in a causal generalisation or one of its underlying causal laws renders inapplicable the causal generalisation at issue. So-called proof by exclusion proves the applicability of a particular causal generalisation not by direct or even circumstantial proof of its instantiation, but rather by proof of lack of instantiation of all the competing causal generalisations. When the coherence of the particularistic evidence with one of the possibly applicable causal generalisations and the overall causal story in which it is embedded is sufficiently greater than its coherence with competing causal generalisations and the causal stories in which they are embedded, according to the subjective judgment of each individual rather than a uniform criterion, that individual forms a minimal belief in the truth of the first story. The greater the difference in degree of coherence, the stronger the degree of belief. This is the method of argument and proof employed by lawyers and judges in actual litigation.[66]

In the dice-throwing example, at the time of the throwing of the dice the only particularistic evidence that we have is evidence – eg, a video recording or the testimony of an eyewitness – of the throwing of the dice, which instantiates the single known abstract antecedent condition – 'throwing a pair of dice' – in each of the competing causal generalisations and thus does not distinguish among them in terms of coherent fit. However, the subsequent particularistic evidence, from the same or a different video recording or eyewitness, that a pair of sixes actually fell uppermost, fits only the 'throwing the dice causes a pair of sixes to fall uppermost' causal generalisation; it negates, to the extent it is reliable,

[65] Wright, Pruning (n 1) 1050–52.

[66] ibid 1046, 1049–52. See also, eg, RJ Allen, 'The Nature of Juridical Proof' (1991) 13 *Cardozo Law Review* 373; CJ Miller and RS Goldberg, *Product Liability*, 2nd edn (Oxford, Oxford University Press, 2004) paras 17.10 and 17.11 (discussing the Privy Council's employment of case-specific circumstantial evidence to compare competing causal stories in *Grant v Australian Knitting Mills* [1936] AC 85); N Pennington and R Hastie, 'A Cognitive Theory of Juror Decision Making: The Story Model' (1991) 13 *Cardozo Law Review* 519; RJ Rhee, 'Probability, policy and the problem of reference class' (2007) 11 *International Journal of Evidence and Proof* 286.

any fit of the available particularistic evidence with the competing causal generalisation(s). The reliability of the video recordings or eyewitnesses will affect the assessment of the degree of fit, but it will do so only by affecting our judgment of the overall coherence of the particularistic evidence with the competing causal stories rather than through some (eg, Bayesian) modification of the ex ante causal probabilities.[67]

The mathematical probabilists reject the distinctions that the courts and lay persons draw between particularistic evidence and its coherence with the elements of competing causal stories, on the one hand, and ex ante causal probabilities and even naked statistics (which are mere ad hoc distributions not related to any causal generalisation), on the other hand. Indeed, some assert that such distinctions violate principles of rational decision-making by ignoring the lessons of mathematical probability theory.[68]

Much of the debate has focused on Jonathan Cohen's paradox of the gatecrasher. Cohen hypothesises a situation in which 1000 people attended a rodeo, but only 499 paid for admission, so that 501 were gatecrashers. He further assumes that no tickets were issued and that there is no other way to establish who actually paid and who was a gatecrasher. Given the happenstance that over half of the spectators were gatecrashers, there is a 50.1 per cent naked statistical probability that any particular spectator was a gatecrasher. If the standard of persuasion is interpreted as merely requiring a 50+ per cent statistical probability, then the naked statistics are probative and, indeed, determinative: it supposedly has been adequately proven that every one of the 1000 spectators was a gatecrasher.[69] However, no court would hold any of the spectators liable, even if only 50 paid for admission, so that there was a 95 per cent statistical probability that any particular spectator was a gatecrasher. The courts properly refuse to treat the naked statistics as probative.[70]

[67] Michael Green claims that my 'formalist concern' about distinguishing between statistical probabilities and particularistic evidence 'collapses when all we have after a plaintiff develops a disease is an epidemiological study and no other evidence about the plaintiff's exposure to competing causes to differentiate the plaintiff from the study subjects'. MD Green, 'The Future of Proportional Liability: The Lessons of Toxic Substances Causation' in MS Madden (ed), *Exploring Tort Law* (New York, Cambridge University Press, 2005) 352, 363. This is a non sequitur. He also offers an alleged counterexample:

> I wonder how Wright would respond to a case in which a high quality statistical study showed a very high risk – in excess of 90 percent – that someone exposed to an agent would contract the disease from which the plaintiff suffers and in which an eyewitness claims to have observed the plaintiff contract the disease from an alien bite. The point is that most of us would find the *ex ante* probabilistic evidence far more probative than the *ex post* particularistic evidence Wright advocates.

ibid 362 fn 38. Green's hypothetical ignores the requirement that particularistic evidence must instantiate an element in a proven or accepted causal generalisation, which he seems to assume is not true here, since that assumption is what gives force to his argument. If there were a proven or accepted alien-bite-causes-this-disease causal generalisation, then we would have two competing causal generalisations, with a non-specified ex ante causal probability for the alien-bite causal generalisation. Even if the ex ante causal probability for the alien-bite causal generalisation were much lower than the 90+ per cent ex ante causal probability for the toxic-agent causal generalisation, the difference in ex ante causal probabilities, as in the dice-throwing example, would only enable us to place a bet on which causal generalisation and its underlying causal laws was actually instantiated; it would not enable us to resolve the bet. The degree of fit of the available particularistic evidence with each causal generalisation is equal, consisting solely in exposure to the relevant causal agent. If, on the other hand, as Green seems to assume, there is no proven or accepted alien-bite causal generalisation and no other possibly applicable causal generalisation, then the only possibly applicable causal generalisation with at least some particularistic instantiation in the particular situation is the toxic-agent causal generalisation, which fact could support the formation of a belief that it was the causal process actually at work in the particular situation.

[68] Wright, Pruning (n 1) 1054–62.

[69] LJ Cohen, *The Probable and the Provable* (Oxford, Oxford University Press, 1977) 75.

[70] See Wright, Pruning (n 1) 1050 and fn 271.

For the most part, the mathematical probabilists agree that there should not be liability in this type of situation. Many of them heroically insist that there is nothing manifestly unjust about holding defendants liable when the statistical probability is indeed greater than 50 per cent, but they argue that the probability in each instance of this type of situation is actually less than 50 per cent. Allegedly, the fact-finder discounts the objective 50.1 per cent probability because of concern that the plaintiff, in relying on the naked statistics, is concealing, or has insufficient incentive to discover and produce, probative evidence other than the naked statistics.[71]

This response clearly is inadequate. First, it does not explain why the jury is not even allowed to consider the naked statistics, rather than being allowed to consider and possibly discount the statistics. Second, it does not explain why the plaintiff, rather than the defendant, is being charged with failure to supply other types of evidence. Third, it at least implicitly admits that other types of evidence are more probative than naked statistics; otherwise, why insist on more than the naked statistics? Fourth, it fails to explain why there is no liability even when the objective probability is much higher than 50 per cent – for example, when only 50 of the 1000 spectators paid for their tickets. In this situation, even when the objective 95 per cent probability is discounted, the subjective probability almost certainly is greater than 50 per cent. Fifth, it fails to address the hypothetical as Cohen presented it, which assumes that no other evidence is available.[72]

The mathematical probabilists assert that naked statistics and ex ante causal probabilities should be taken into account as initial base rates in Bayes' Theorem to adjust the judgment regarding causation derived from the reliability of the particularistic evidence. For example, in the gatecrasher hypothetical, assume that only one of a thousand spectators paid, the ticket seller identifies A as the one who paid, and there is a 2 per cent probability that the ticket seller is mistaken. Using the naked statistic that 99.9 per cent of the spectators were gatecrashers as the initial base rate in Bayes' Theorem, the revised probability that A was a gatecrasher, even after taking into account the ticket seller's particularistic identification testimony, would still be over 95 per cent.[73] The mathematical probabilists assert that A almost surely was a gatecrasher, and indeed should be held criminally liable under the 'beyond a reasonable doubt' standard as well as civilly liable under the preponderance standard, despite the ticket seller's 98 per cent reliable testimony that A was not a gatecrasher.[74]

This conclusion not only is counterintuitive, but also is clearly incorrect. The problem is not Bayes' Theorem itself, which is a valid mathematical probability theorem. Rather, the problem is the use of abstract base rates, whether naked statistics or ex ante causal probabilities, to impugn the judgment about what actually happened in the particular case based on the particularistic evidence in that case. The mathematical probabilists are mixing apples and oranges. The base rates merely describe the overall distribution of occurrences in a class. They provide no information about any particular occurrence. Only particularistic evidence can

[71] ibid 1055 and fn 288, 1057. Judge Richard Posner endorses this 'missing evidence' argument in *Howard v Wal-Mart Stores Inc* (1998) 160 F 3d 358, 359–60 (United States Court of Appeals, Seventh Circuit). Nevertheless, without recognising the reason for its relevance – its status as particularistic evidence that has differing fit with the two possibly applicable causal stories (causation of a spill by an employee versus a customer of the defendant) – Judge Posner relies on an item of particularistic evidence (the absence of the item from which the liquid spilled) to uphold a verdict against the store and in favour of the plaintiff, who was injured when she slipped on the spilled liquid.

[72] Wright, Pruning (n 1) 1055–56 and fns 289–294, 1058.

[73] ibid 1061 and fn 321.

[74] ibid 1061, fn 322.

give us information about the particular occurrence. When the proposition to be proved is what actually happened, using base rates – which provide no information about what actually happened – as initial probabilities in Bayes' Theorem is an example of the computer programmers' maxim: 'garbage in, garbage out.' The fact that judges, jurors, and lay persons ignore the base rates and instead focus on the particularistic evidence is, contrary to the assertions of the mathematical probabilists, highly rational.

The mathematical probabilists have confused the betting odds that a person is willing to accept on the existence of a certain fact with the degree of belief that the person has in the actual existence of that fact. As Jonathan Cohen has persuasively demonstrated with the gatecrasher example and other examples in which paradoxical results are reached using mathematical probability theory, beliefs regarding what actually happened in a particular situation are not determined by statistical or mathematical probability, but rather by abductive consideration of the fit of the relevant particularistic evidence with the competing possible causal stories.[75] Additional problems created by attempting to apply mathematical probability theory to causal explanation, rather than causal prediction or 'postdiction', are discussed in section IV below.

IV. PROBLEMS AND PARADOXES

A. Indistinguishable Alternative Tortious Causes

In both common law and civil law jurisdictions, an alternative causation doctrine is commonly applied in situations like the typical hunting accident situation, in which two or more defendants each fire in the direction of the plaintiff, who was hit by only one pellet, and it is impossible for the plaintiff to prove which defendant fired the pellet that injured him. In order to achieve a second-best just result in situations like this, when each defendant behaved tortiously and may have thereby caused the plaintiff's injury but it is impossible for the plaintiff to prove which defendant actually caused her injury, the courts shift the burden to each defendant to prove that she did not injure the plaintiff and hold each defendant who is unable to do so jointly and severally liable for the plaintiff's injury.[76]

However, if there are more than two defendants and the standard of persuasion is satisfied by a mere 50+ per cent mathematical probability, each defendant ordinarily would easily be able to prove that she was not the cause of the injury, even though it is certain that one of them caused the injury. For example, if there were three defendants, each equally likely to have been the cause of the plaintiff's injury, each defendant can 'prove' that she was not the cause, since there is a 67 per cent probability that she was not the cause, which leads to the paradoxical result that it can be 'proven' that none of the defendants was the cause, even though we know that one of them was the cause.

[75] Cohen (n 69) 49–120.

[76] *Restatement of the Law Third, Torts: Liability for Physical and Emotional Harm* [Restatement Third] (St Paul, American Law Institute, 2010) §28(b) and comments d(1) and e and related reporters' notes; *Restatement (Second) of Torts* [Restatement Second] (St Paul, American Law Institute, 1965) ss 433B(2)–(3); C van Dam, *European Tort Law* (Oxford, Oxford University Press, 2006) 287–88; W van Gerven, J Lever and P Larouche, *Cases, Materials and Text on National, Supranational and International Tort Law* (Oxford, Hart Publishing, 2000) s 4.4.3; Wright, Possible Wrongs (n 1) 1299–1301.

Conversely, by employing Mark Geistfeld's 'evidential grouping' argument,[77] the mathematical probability interpretation of the standard of persuasion can be employed iteratively to achieve the opposite paradoxical result: 'proof' that all but one of the initial multiple defendants, each approximately equally likely (or unlikely) to have been the actual cause, was the actual cause. At each step in the iteration, a smaller group consisting of most of the defendants in the prior group can be carved out of the prior group, and the mathematical probability interpretation of the standard of persuasion can be used to 'prove' that this smaller group contains the defendant who actually caused the plaintiff's injury, until we are down to only two defendants, one of whom can be 'proved' to have been the actual cause if there is even a 'scintilla' of evidence to tip the probability one way or the other – for example, if the shotgun cartridge fired by one of the hunters contained one more pellet than the cartridge fired by the other hunter.[78]

The courts avoid each of these contrary paradoxical results by refusing to allow such naked statistics as proof or disproof of actual causation. As the reporters for the American Law Institute's *Restatement Third of Torts* state (despite their acceptance elsewhere of the mathematical probability interpretation of the preponderance standard[79]):

> Defendants would be able to satisfy their burden of production [under the alternative causation doctrine] when three or more defendants are subject to alternative liability [sic] in one of two ways: a defendant might show *why* it was not the cause of plaintiff's injury or it might show *which one* of the other defendants was the cause.[80]

To show *why* she was not the cause or *which one* of the other defendants was the cause, the defendant must produce evidence of the actual causal effect of another defendant's shot or the lack of causal effect of her own shot. To do this, she must provide particularistic evidence specific to the particular occasion, rather than mere ex ante causal probabilities or non-causal naked statistics, neither of which provide any information about what actually happened on the particular occasion. When the preponderance standard is properly understood as requiring the formation of a minimal belief in the truth of a disputed fact, based on particularistic evidence specific to the particular occasion, the logical inconsistency that results from using the statistical probability interpretation of the preponderance standard in the alternative causation cases disappears. As Geistfeld states:

> [T]he plaintiff has provided particularistic evidence showing that each defendant belongs to the group of [possible] tortfeasors that caused the harm, whereas each defendant [using the mathematical probability argument] only relies upon 'quantitative probability' or 'the greater chance' that the other defendants caused the injury. That evidence, however, is not probative of what actually happened on this particular occasion. . . . To avoid liability, a defendant must instead provide [particularistic] evidence rebutting the plaintiff's particularized proof.[81]

A further paradox would be produced by use of the statistical probability interpretation of the standard of persuasion when the same defendants are repetitively implicated as having possibly caused a particular type of injury. The Supreme Court of Oregon confronted

[77] MA Geistfeld, 'The Doctrinal Unity of Alternative Liability and Market Share Liability' (2006) 155 *University of Pennsylvania Law Review* 447, 464–65, 466, 469.

[78] See Wright, Possible Wrongs (n 1) 1312 fn 64, 1330, 1332–33.

[79] Restatement Third (n 76) §§26 comment l and illus 5, comment n, 28 comment a reporters' note.

[80] ibid §28 comment j reporters' note at 565 (emphasis added). While causation is alternative in these situations, liability is joint and several rather than alternative.

[81] Geistfeld (n 77) 468.

such a situation in a case involving an injurious DPT vaccine that was supplied by one of two defendants, one of which had a 73 per cent share of the market for the DPT vaccine. Literally applying the statistical probability interpretation of the preponderance standard would paradoxically result in its being 'proven' that the defendant with the 73 per cent market share, who presumably was responsible for only approximately 73 per cent of the DPT-related vaccine injuries, caused 100 per cent of those injuries. Although apparently accepting the statistical probability interpretation of the preponderance standard, the Court, referring to articles discussing the 'naked statistics' issue, did not allow either of the two defendants to be held liable, even under the alternative causation doctrine.[82]

The courts in the United States may have faced a similar situation in the cases involving women who developed clear cell adenocarcinoma of the vagina as a result of their mothers' taking the drug diethylstilbestrol (DES) when pregnant with them. It has been stated that one company, Eli Lilly, may well have supplied, directly or indirectly, more than half of the marketed DES.[83] It thus is worth noting how carefully the Supreme Court of California, in the leading American case, phrased its statements on proof of causation of the plaintiff's injury. The Court observed that an inference of causation (based on statistical probability) would fail '*if* we measure the chance that any one of the defendants supplied the injury-causing drug by the *number* of possible tortfeasors'[84] (rather than by relative market share). Like the Oregon Court, the California Court also was unwilling to apply the alternative causation doctrine in this type of situation, since doing so would result in each defendant – even those with a small share of the market for the drug – being held fully liable for all of the many DES-related injuries, even though the portion of the injuries that each defendant actually caused presumably approximated its share of the DES market.[85]

However, unlike the Oregon court, the California Court devised a new second-best liability doctrine in an attempt to have each defendant be liable, approximately, for the share of the total DES-related damages that it presumably actually caused, by holding each defendant proportionately liable in each case for a share of the damages in that case equal to its share of the DES market.[86] This seems to me to be a defensible, just result.[87] A few other courts have imposed similar liability in the DES cases and some, in both common law and civil law jurisdictions, have imposed more extensive (and thus, in my view, normatively problematic) liability, but all of the courts, including the California court, have done so as a matter of normative policy while recognising that it is impossible to prove who actually caused the plaintiff's injury in each case.[88] A similar proportionate liability scheme was adopted on similar normative grounds (albeit on a flawed risk contribution rather than probability of causation theory[89]) by the British House of Lords in the asbestos cases,[90] but

[82] *Senn v Merrell-Dow Pharmaceuticals Inc* (1988) 751 P 2d 215, 216 fn 1, 222 (Supreme Court of Oregon).

[83] See AM Levine, '"Gilding the Lilly": A DES Update' (December 1984) 20 *Trial* 18, 19–20.

[84] *Sindell v Abbott Laboratories* (1980) 607 P 2d 924, 931 (Supreme Court of California) (emphasis added); see ibid at 936–37.

[85] ibid 930–31.

[86] ibid 936–37.

[87] See Wright, Possible Wrongs (n 1) 1326–30.

[88] *B v Bayer Nederland BV*, Hoge Raad 9 October 1992, [1994] Nederlandse Jurispruzentie (NJ) 535 (CJHB); *Collins v Eli Lilly Co* (1984) 34 NW 2d 37 (Supreme Court of Wisconsin); *Martin v Abbott Labs* (1984) 689 P 2d 368 (Supreme Court of Washington); see Ewoud Hondius, 'A Dutch DES Case–Pharmaceutical Producers Jointly and Severally Liable' (1994) 2 *European Review of Private Law* 409; R Goldberg, *Causation and Risk in the Law of Torts: Scientific Evidence and Medicinal Product Liability* (Oxford, Hart Publishing, 1999) 75–80.

[89] See Wright, Possible Wrongs (n 1) 1295–96; text to n 103 below.

[90] *Barker v Corus (UK) plc* [2006] UKHL 20, [2006] 2 AC 572.

was converted into a 'draconian' full (joint and several) liability scheme by the British Parliament.[91]

B. Toxic Exposures: the Doubling of the Risk Doctrine

Although phrases such as 'more likely than not' or 'balance of probabilities' have long been used when describing the standard of persuasion in civil cases in common law jurisdictions, it is only in fairly recent years that these phrases have frequently come to be understood as mere statistical probability statements. A major locus of this shift in understanding is the toxic tort cases, in which proof often depends on, and often consists solely of, statistical epidemiological evidence. As was discussed in section III above, such evidence is very useful, although neither necessary nor sufficient, in establishing that exposure to a substance is capable of causing a particular kind of injury – the causal capacity or 'general causation' issue – and, if such causal capacity has been sufficiently established, in predicting possible results ex ante or comparing possible causes ex post for purposes of remedial treatment. However, such evidence has also incorrectly come to be viewed by many courts, especially in the United States, as being sufficient to prove 'specific causation' – the actual occurrence of the relevant causal process on a particular occasion – if exposure to the substance more than doubles, on average or in the aggregate, the frequency of occurrence of that kind of injury, so that it can be said, whenever that kind of injury occurs following exposure to the substance, that the injury was (statistically) 'more likely than not' caused by the exposure to the substance.[92] Some courts even erroneously believe that such 'doubling+' is necessary to establish specific causation.[93]

As in the indeterminate defendant cases, the statistical probability interpretation of the standard of persuasion produces odd results in the toxic exposure cases. When exposure to a substance more than doubles the risk, the 'doubling+' doctrine will result in defendants being held liable for every instance of the injury that occurs following exposure to the substance, even if there is no evidence that the substance actually caused the injury on any particular occasion, and even though exposure to the substance could only have caused a portion of the injuries. For example, if exposure to the substance barely doubles the frequency of occurrence of the injury, so that just over half of the injuries that occur following exposure to the substance are caused by that exposure, defendants nevertheless will be held liable in every case, for all of the injuries. Conversely, when, as is usually the case, exposure to the substance does not more than double the frequency of occurrence of the injury, no defendant will be liable for any of the injuries that occur following exposure to the substance, no matter how many may actually have been caused by such exposure, even though as many as half of the injuries may be due to exposure to the substance. It is remarkable that such a miniscule difference in statistical probability should be thought to result in such a dramatic difference in the supposed proof of specific causation and resulting liability.[94]

[91] See *Sienkiewicz* [2011] UKHL 10 (n 24) [57] and [58] (Lord Phillips).

[92] eg *Daubert v Merrell Dow Pharmaceuticals Inc* (1995) 43 F 3d 1311, 1313–14, 1318–22 (United States Court of Appeals, Ninth Circuit); *Marder v GD Searle & Co* (1986) 630 F Supp 1087, 1092 (United States District Court, Maryland), affirmed, (1987) 814 F 2d 655 (United States Court of Appeals, Fourth Circuit); Restatement Third (n 76) s 28 comment c(4).

[93] See Green (n 67) 365–70; text to n 69 above.

[94] Clermont and Sherwin dismiss this objection as an 'appealing but unsound lay intuition' that conflicts with the supposed basic goal of minimising erroneous judgments. Clermont and Sherwin (n 2) 252; see ibid 258. As

Some courts recognise this. As was discussed in section II.B above, a substantial majority of the United Kingdom Supreme Court in *Sienkiewicz* rejected, albeit in dicta, treating a mere statistical probability, under the 'doubling of the risk' doctrine or any other doctrine, as sufficient to establish causation.[95] In the United States, 'numerous jurisdictions have rejected medical experts' conclusions based upon a "probability," a "likelihood," and an opinion that something is "more likely than not" as insufficient medical proof,' and instead have required that the expert express a 'reasonable medical certainty' about the fact at issue.[96] Unfortunately, 'reasonable certainty' standards are not employed and have no meaning in the medical and scientific communities, so the plaintiff's attorney can and often does fill the semantic void, and the plaintiff's expert then employs the required terminology.[97]

Doctors and scientists understand that a mere statistical probability, while useful for prediction and diagnosis, is insufficient to establish what actually happened in a particular case. Thus, if an expert's opinion regarding actual causation, whether couched in terms of 'reasonable certainty', 'more likely than not', or 'preponderance of the evidence', is based only on a statistical probability (as is usually true in the toxic exposure cases), a good defence attorney will ask the expert, 'Can you say whether the plaintiff's exposure to the [relevant substance] actually caused the [relevant specific harm] in this case?' The expert – if honest – will reply, 'No', and be chagrined for having been made to appear to have contradicted her earlier testimony.

C. Professional Malpractice: Lost Chances

In many common law and some civil law jurisdictions, the courts, applying the statistical probability interpretation of the standard of persuasion, assume that if a doctor's negligence in diagnosing or treating an ill patient deprived the patient of a 50+ per cent statistical probability of avoiding the injury that subsequently occurred (generally, death), then the doctor's negligent causation of the injury has been proven; however, if the patient was deprived of a less than 50+ per cent statistical probability of avoiding the injury, the

Lord Salmon observed in *McGhee v National Coal Board* [1973] 1 WLR 1, even odder results occur when the statistical probability interpretation of the standard of persuasion is combined with the 'but for' test of actual causation:

> Suppose . . . it could be proved that men engaged in a particular industrial process would be exposed to a 52 per cent risk of contracting dermatitis even when proper washing facilities were provided . . . [and] that that risk would be increased to, say, 90 per cent when such facilities were not provided. . . . [W]ithout the negligence, it would still have been more likely than not that the employee would have contracted the disease – the risk of injury then being 52 per cent. If, however, you substitute 48 per cent for 52 per cent the employer could not escape liability, not even if he had increased the risk to, say, only 60 per cent. Clearly such results would not make sense; nor would they, in my view, accord with the common law.

ibid 12. In *Sienkiewicz* [2011] UKHL 10 (n 24), Lord Phillips stated that, although he could 'understand why Lord Salmon considered that to base a finding of causation on such evidence would be capricious', he could not understand why Lord Salmon 'considered that to do so would be contrary to common law. The balance of probabilities test is one that is inherently capable of producing capricious results.' ibid [26]. This lack of understanding was no doubt due to his admitted failure to understand Lord Salmon's allegedly 'cryptic' comment that 'the approach by the courts below confuses the balance of probability test with the nature of causation'. ibid.

[95] See text to nn 41–48 above.

[96] *Sterling v Velsicol Chemical Corp* 855 F 2d 1188, 1200–01 (United States Court of Appeals, Sixth Circuit) (1988); see Restatement Third (n 76) § 28 comment a.

[97] Restatement Third (n 76) s 28 comment a and reporters' note.

defendant's negligent causation of the injury is not deemed to be proven (indeed, theoretically it is disproven) and the defendant is not liable.[98] The same result is reached in German law, on more defensible normative grounds rather than by the invalid assumption of proof of actual causation, through a rule shifting the burden of proof on (lack of) causation to the defendant doctor in cases of gross medical negligence that deprived the plaintiff of a 50+ per cent statistical probability of avoiding the injury.[99] Under either approach, all-or-nothing liability again arbitrarily turns on a trivial difference in statistical probability.

Some courts, in both common law and civil law jurisdictions, while supposedly adhering to the usual requirement that the plaintiff prove the defendant's tortious causation of the plaintiff's injury, but influenced by the statistical probability interpretation of the standard of persuasion and perhaps by the arbitrary distinction under that standard between trivial differences in statistical probability, have been willing to treat any significant increase in risk (or its converse, loss of any significant chance of avoiding the injury) as proof of, or as being equivalent to, actual causation of the injury and thus as supporting holding the defendant fully liable for the injury.[100]

Other courts, including many courts in the United States, while treating the defendant's depriving the plaintiff of a 50+ per cent chance of avoiding the injury as proof of actual causation and consequent full liability, acknowledge that causation is not proven when the plaintiff had less than a 50+ per cent chance of survival, but purportedly hold the defendant liable for having caused a newly recognised legal injury, the plaintiff's 'lost chance' of avoiding the tangible injury that actually occurred, with liability being imposed for a portion of the tangible injury equal to the lost chance.[101] The same theory is followed in France whether the probability is greater or less than 50 per cent.[102] This approach (except in France) continues to base significant, albeit reduced, substantive differences in liability on mere trivial differences in statistical probability. Moreover, even in France, it erroneously equates statistical probabilities of avoiding the tangible injury with the particular plaintiff's probability of avoiding that injury in the particular situation, which will vary depending on his particular genetic makeup and other relevant conditions, and, while claiming to impose liability for having caused the lost chance, it actually imposes liability not for the lost chance – the mere imposition of risk whether or not the risk is realised in a tangible injury – but rather for the plaintiff's tangible injury, in the acknowledged absence of proof of causation of that tangible injury. No liability is imposed for the lost chance in the absence of the occurrence of the tangible injury, and the liability that is imposed when there is a tangible injury (which may or may not have been affected or caused by the lost

[98] See eg, *Kramer v Lewisville Memorial Hospital* (1993) 858 SW2d 397, 399–400 (Supreme Court of Texas); Restatement Third (n 76) §26 comment n (assuming proof of causation, and thus full liability, if 'the probability of a better outcome was in excess of 50 per cent'); van Dam (n 76) 295–97.

[99] BGH, 6 October 1998, 1999 NJW 860 (German Federal Court of Justice); see van Dam (n 76) 296.

[100] F Stella, 'Criminal omissions, causality, probability, counterfactuals: Medical-surgical activity' (http://works.bepress.com/richard_wright/35/) 1–2 (translation by F Stella of 'Causalità omissiva, probabilità, giudizi controfattuali: l'attività medico-chirurgica' in F Stella, *Il Giudice Corpuscolariano. La Cultura delle Prove* (2005) 201–43; Wright, Pruning (n 1) 1067–72. Examples of the widely varying standards that have been employed by the Italian courts with respect to the causation issue in medical malpractice cases are provided in a forthcoming paper by Claudia DiMarzo: Trib Florence 2222 [1999] ('reasonable certainty'); Cass Civ 11522 [1997] ('concrete, actual and not hypothetical possibility of a favorable outcome'); Cass Civ 4725 [1993] ('reasonable certainty about the existence of a not insignificant probability'); Cass Civ 4044 [1994] ('moral certainty'); Cass Civ 1286 [1998] ('reliable and significant possibility of a favorable outcome').

[101] Wright, Pruning (n 1) 1067–72.

[102] van Dam (n 76) 293–94. The lost chance theory is applied widely in France. ibid. In many other jurisdictions – especially in the United States – it is applied only in medical malpractice cases.

chance) generally is not for the value of the lost chance, however that might be calculated, but rather for the damages resulting from the tangible injury multiplied by the lost chance or the probability of causation.[103]

Oddly, in the United Kingdom, the lost chance doctrine is applied with respect to financial losses in contractual relationships, including the attorney-client relationship, but not in medical malpractice cases.[104] The English position is even odder when one considers that the usual justification for employing the lost chance doctrine or some other second-best liability rule is the inherent impossibility of proving causation.[105] In legal malpractice cases, the trial that did not occur or that was botched can be relitigated – 'a trial within a trial', as occurs in the United States – to determine whether the plaintiff would have won or lost; there is no need for a lost chance doctrine. This is not true in medical malpractice cases.

The British House of Lords' decision in the *Hotson* medical malpractice case[106] is a dramatic example of the perverse results that can be caused by the statistical probability interpretation of the standard of persuasion when combined with a myopic focus on the 'but for' test of actual causation.[107] The plaintiff fell from a tree and ruptured some of the blood vessels in his left femoral epiphysis. The defendant's negligent delay in diagnosing and treating his injury caused a swelling of the epiphysis that compressed the remaining intact blood vessels and thus shut off the supply of blood from those blood vessels. As a result of the combined loss of blood from the initial fall and ruptures and the subsequent compression of the remaining blood vessels, the epiphysis became distorted and deformed, resulting in permanent injury to the boy's left hip and leg. However, the trial court determined that there was a 75 per cent chance that the permanent injury would have happened anyway even if the defendant had not been negligent, owing to the loss of blood from the ruptured blood vessels. Focusing on this statistical finding, the House of Lords held that the defendant was not liable due to a lack of ('but for') causation, which as a past fact is determined by the 'balance of probabilities'.[108] Adding insult to injury, the Court further held that there could be no recovery for any lost chance: 'In determining what did happen in the past a court decides on the balance of probabilities. Anything that is more probable than not it treats as certain'.[109]

Unfortunately, the *Hotson* court failed to recognise that it was dealing with a situation involving cumulative contribution to a possibly overdetermined indivisible injury. As both Lord Phillips and Lord Rodger noted in *Sienkiewicz*, while still not recognising that *Hotson* was such a situation, in such situations the 'but for' test produces the wrong answer; instead in the United Kingdom (and some other countries) a 'test' of 'material contribution' is used.[110] Although the plaintiff most likely would have suffered the permanent injury anyway, the defendant's negligence, by causing the loss of the blood supply from the intact blood vessels, contributed to the aggregate loss of blood that caused the permanent injury (and may have been a 'but for' cause of this happening earlier than it otherwise would

[103] See *Kramer* (n 98) 402, 405; Wright, Possible Wrongs (n 1) 1295–96.

[104] van Dam (n 76) 294–95; see *Gregg v Scott* [2005] UKHL 2, [2005] 2 AC 176, in which, however, the plaintiff had only suffered a reduction in the chance of avoiding the relevant injury, not the injury itself.

[105] See Wright, Possible Wrongs (n 1) 1295–97.

[106] *Hotson v East Berkshire Area Health Authority* [1987] 1 AC 750 (HL).

[107] See also n 94 above.

[108] See Wright, Possible Wrongs (n 1) 1322–23.

[109] *Hotson* (n 106) 785 (Lord MacKay) (quoting *Mallett v McMonagle* [1970] AC 166, 176 (Lord Diplock)); accord, *Hotson* (n 106) 792 (Lord Ackner).

[110] *Sienkiewicz* [2011] UKSC 10 (n 24) [17], [27], [75], [90], [93] (Lord Phillips); ibid [138], [144]–[146] (Lord Rodger).

have), just as stabbing a person who more likely than not already has been stabbed sufficient times to bleed to death, but who still has a significant amount of blood left and several hours to live, contributes to that person's bleeding to death (and may have been a 'but for' cause of the death happening earlier than it otherwise would have).[111] Contrary to the statements of Lord Brown in *Sienkiwicz*,[112] the problematic issues with which the British and other courts have had to deal are not the result of a failure to adhere strictly to the 'but for' test in every situation, but rather the result of a failure to recognise the inadequacy of the 'but for' test as a comprehensive test of actual causation and an understandable but erroneous literal interpretation of the misleadingly named 'more likely than not' and 'balance of probability' standards of persuasion.

D. *Res Ipsa Loquitur* and 'Prima Facie' Presumptions

The last doctrine to be discussed is the *res ipsa loquitur* doctrine, which seems to exist in every jurisdiction even though it sometimes is known by a different name (eg as the 'prima facie' evidence doctrine in Germany).[113]

The *res ipsa loquitur* doctrine, as usually stated, allows an inference of negligent causation of the plaintiff's injury by the defendant if (1) in the type of situation that existed the injury *ordinarily* does not occur unless there is negligence and (2) other possible responsible causes are sufficiently eliminated by the evidence.[114] Although condition (2) may put some limitations on the scope of the doctrine, depending on how it is interpreted,[115] the doctrine, as stated, constitutes a departure from the ordinary substantive liability and proof rules of a magnitude that is not commonly appreciated. The doctrine allows an inference of negligent conduct by the defendant, and a further inference that the inferred negligence caused the plaintiff's injury, based on a mere statistical probability. If, in the aggregate, 50+ per cent of the occurrences of this type of event are caused by negligence, then negligent causation by the defendant can be inferred without any specific evidence of negligence or causation by the defendant or anyone else on the particular occasion.

Thus, contrary to what is commonly stated,[116] it is not true that *res ipsa loquitur* is merely a fancy Latin name, employed in the particular context of proving the defendant's causal negligence, for the ordinary use of circumstantial evidence to make a straightforward factual inference. Circumstantial evidence is concrete evidence specific to the particular

[111] See RW Wright, 'Acts and Omissions as Positive and Negative Causes' in JW Neyers, E Chamberlain and SGA Pitel (eds), *Emerging Issues in Tort Law* (Oxford, Hart Publishing, 2007) 287, 295–97, 299.

[112] [2011] UKSC 10 [176], [178], [181], [183], [186] (Lord Brown): see ibid [167] (Baroness Hale). Lord Brown attempts to explain cases in which liability was based on 'material contribution' rather than 'but for' causation as not actually being exceptions to the 'but for' test, on the ground that they involved, or should have involved, apportionment of damages based on relative contribution. ibid [176]. He has confused apportionment of damages with the prior issue of causation, for which the 'but for' test fails to give the right answer in situations actually or possibly involving overdetermined injury. See Wright (n 49) II, III.D, III.E.

[113] Murray and Stürner (n 15) 311–12; van Dam (n 76) 1107; van Gerven, Lever and Larouche (n 76) s 4.2.3 at 428/16–17 (http://www.casebooks.eu/documents/tortLaw/heading4.2.3.pdf).

[114] eg Restatement Second (n 76) § 328D(1).

[115] See Wright, Possible Wrongs (n 1) 1338–40.

[116] eg WL Prosser et al, *Prosser and Keeton on Torts*, 5th edn (St Paul, West Publishing Co, 1984) s 39 at 243–44 and fn 20; Restatement Second (n 62) s 328D comment a. But see DB Dobbs, *The Law of Torts* (St Paul, West Publishing Co, 2000) s 154 at 372 (noting, correctly, that *res ipsa loquitur* cases differ 'overwhelmingly' from ordinary circumstantial evidence cases by allowing an inference of negligence (and causation) without any particularistic evidence of negligence (or causation) on the particular occasion).

occasion about the network of instantiated causal relationships leading to and flowing from the particular factual issue being litigated. For example, a person's running away from the scene of a murder immediately after it happened with blood on her that matches the victim's blood and holding a knife, the blade of which matches the victim's stab wound, is strong circumstantial evidence that she stabbed the victim. The inference of negligence allowed by the *res ipsa loquitur* doctrine as stated by many courts, interpreted literally, does not require any such case-specific evidence of what actually happened on the particular occasion, but rather only abstract statistical data (or assumptions) on what usually (50+ per cent of the time) has happened in such situations. The difference in the validity of the inference depending on whether or not the word 'ordinarily' is included parallels the distinction between the admissibility of habit evidence (allowed) and character evidence (generally not allowed) to prove what a person did on a particular occasion.[117]

The common failure to appreciate the extraordinary nature of the *res ipsa loquitur* doctrine is probably attributable to an assumption that the word 'ordinarily' in the first condition is simply an incorporation of the 'preponderance of the evidence', 'more likely than not', or 'balance of probability' standard of persuasion, which is interpreted as merely requiring a 50+ per cent statistical probability. Once again, however, taking this interpretation seriously immediately raises a logical contradiction. Why, if the first condition is satisfied, is the inference that someone was negligent only a permissive one, rather than being required? Why, in the absence of any contrary evidence by the defendant, allow the trier of fact not to draw the inference once the conditions for drawing the inference have been established, especially since this permits inconsistent verdicts by different juries in similar situations, which is a denial of formal justice?

The reason, I suspect, is a discomfort with the broad formulation of the doctrine, especially when there is a conscious realisation that it permits an inference of negligence by the defendant based merely on a statistical probability. Allowing the trier of fact not to draw the inference may be an implicit concession that she should be able to draw the inference or not depending on whether she actually *believes* the defendant was causally negligent in the particular situation. But if the existence of an actual belief is the concern, the broad formulation should be abandoned in favour of the narrow one (with the word 'ordinarily' omitted), or at least the trier of fact should be instructed that an inference of negligent causation should be drawn only if evidence specific to the particular case combines with the 'ordinarily would not happen' statistical probability to raise a minimal belief that the defendant actually was negligent in the particular situation and that such negligence contributed to the plaintiff's injury. On the other hand, if the broad formulation is meant to provide a second-best (or third-best) resolution of the factual uncertainty regarding negligent causation, it seems that decision should be consistently implemented through a rebuttable presumption.

[117] eg KS Broun et al (eds), 1 *McCormick on Evidence*, 6th edn (St Paul, West Publishing Co, 2006) ss 186, 188, 195.