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Plemel as a Primer on Proving Paternity

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ARTICLES

PLEMEL AS A PRIMER ON PROVING PATERNITY

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Within the past year or two, the supreme courts of Massachusetts,[1] Oregon,[2] and Utah[3] have held that various genetic tests may be used to prove paternity.[4] These opinions are at the crest of a wave of change that has swept aside the traditional rule that blood grouping tests may be admitted to exclude an accused man as a father, but not to prove his paternity.[5] This traditional rule made some sense when the genetic tests could exclude only a moderate

1. Commonwealth v. Beausoleil, 397 Mass. 206, 490 N.E.2d 788 (1986).
2. Plemel v. Walter, 303 Or. 262, 735 P.2d 1209 (1987).
3. Kofford v. Flora, 744 P.2d 1343 (Utah 1987).
4. In Moore v. McNamara, 201 Conn. 16, 513 A.2d 660 (1986), the Connecticut Supreme Court held that a statute providing that "[t]he results of [blood grouping] tests shall be admissible in evidence only in cases where such results establish definitive exclusion of the putative father . . ." did not bar the admission of blood grouping tests when combined with Human Leucocyte Antigen (HLA) tests. However, the court explicitly avoided deciding whether proof of paternity through HLA testing enjoys such general acceptance in the scientific community as would make it admissible under Connecticut law. The Connecticut Supreme Court also did not reach the question of "the manner of presentation of statistical probability of paternity. . . ." *Id.* at 32, 513 A.2d at 668.
5. For documentation of this transformation of the legal landscape, see Kanwischer

portion of the male population as the father.[6] However, the pano-
ply of contemporary and newly emerging genetic tests, which easily
can exclude ninety to ninety-five percent of the population in most
cases,[7] has made this traditional limitation an anachronism.

At the same time, the admissibility of genetic proof of pater-
nity raises serious questions as to the manner in which this evidence
should be presented in court. In the interests of efficiency, some
jurisdictions seem to dispense with the requirement of having an
expert appear in order to establish the chain of custody, to explain
the scientific procedures, and to interpret the laboratory findings.[8]
When an expert does testify, the interpretations of the laboratory
results may be abstruse or even misleading. For example, the judge
or jury may be deluged with talk of a mean, prior, or cumulative
probability of exclusion, a paternity index, a probability or plausi-
bility of paternity, a random man, verbal predicates, or other
esoterica.

A great many courts admitted—and still admit—such testi-
mony uncritically.[9] The newer decisions, however, recognize many
of the problems associated with the presentation and interpretation
of inclusionary test results. Among this new generation of cases,
the opinion of the Oregon Supreme Court in *Plemel v. Walter*[10] is,

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& Kaye, *The Admissibility of Genetic Testing in Parentage Litigation: A Survey of State Statutes,* —— FAM. L.Q. —— (1988) (unpublished paper).

6. *Moore,* 201 Conn. at 16, 513 A.2d at 667; Ellman & Kaye, *Probabilities and Proof: Can HLA and Blood Group Testing Prove Paternity?,* 54 N.Y.U. L. REV. 1131 (1979).

7. *Joint AMA-ABA Guidelines: Present Status of Serologic Testing in Problems of Dis-puted Parentage,* 10 FAM. L.Q. 247, 257-58 (1976) [hereinafter *Joint AMA-ABA Guide-lines*]; H. SILVER, *An Introduction to Paternity Testing,* in AMERICAN ASS'N OF BLOOD BANKS, PATERNITY TESTING vii, viii (H. Silver ed. 1978) [hereinafter PATERNITY TEST-ING]; P. Terasaki, *HLA Testing, A New 95% Paternity Exclusion Test 1* (unpublished man-uscript) (n.d.); Walker, *Probability in the Analysis of Paternity Test Results,* in Paternity Testing 69, 83 (H. Silver ed. 1978).

8. ORS 109.254(2) (1953) states that "blood test results and the conclusion and ex-planations of the blood test experts may be introduced into evidence at trial by affidavit, unless a written challenge to the testing procedure or the results of the blood test has been filed with the court. . . ." If "procedure" and "results" were construed narrowly, a party who objected to the explanation and conclusions contained in the affidavit but not to the accuracy of the underlying phenotyping could have no opportunity to cross-examine the expert. Perhaps the objecting party could subpoena the expert in these circumstances, but it would seem preferable to interpret "testing procedure or the results" as encompassing the written explanations and conclusions. Under this construction of the statute, proof by affi-davit would be available as long as there is no challenge either to the test results or the written explanations of them.

9. *See generally* MCCORMICK ON EVIDENCE § 212 (E. Cleary ed., 3d ed. 1984).

10. 303 Or. 262, 735 P.2d 1209 (1987).

in many respects, the most perceptive judicial treatment of the quantitative analyses of inculpatory test results that can be found in this nation.

I. THE GENETIC PROOF IN *PLEMEL V. WALTER*

Like many paternity cases, *Plemel v. Walter* involves three parties. A woman and the state are pitted against a man whom the mother says is the father of her illegitimate child. In this instance, Dena Plemel brought an action in Yamhill County Circuit Court to establish that Brent Walter was such a father.[11] The state intervened on the mother's side, evidently because public assistance funds were at stake.

A laboratory within the Oregon Health Sciences University drew blood from the mother, the child, and the alleged father. In 1983, Dr. Everett Lovrien, a professor of medical genetics and pediatrics, wrote a letter to the Support Enforcement Division of the Oregon Department of Justice in McMinnville. This letter stated:

> Blood samples were tested, using accepted methods, to determine genetic types for the purpose of evaluating paternity on the alleged father, Brent Walker; the mother, Dena A. Plemel; and the child. . . .
>
> . . . No exclusion of paternity was found. By calculating paternity [sic] with the test results, the odds that Brent Walter is the father . . . compared to another randomly selected man [sic], is 178 to 1. The chance that he is the correct father is 99.4%. If he is not the father, the probability that an exclusion would have been detected by the tests utilized, is 97.5%.
>
> According to the Joint AMA-ABA Guidelines, a paternity index of 178 indicates that the likelihood Brent Walter is the father is Extremely Likely [sic].[12]

An accompanying report revealed that the laboratory tested nineteen genetic systems involving red blood cell antigens, enzymes, and plasma proteins.[13] Apparently, it did not perform any Human Leucocyte Antigen (HLA) typing, although these tissue typing tests commonly are used in parentage testing and by themselves can exclude upwards of 90% of the male population as bio-

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11. *Id.* at 264, 735 P.2d at 1211.

12. Letter from Dr. Everett Lovrien to Support Enforcement Division, Oregon Dept. of Justice, McMinnville, Oregon.

13. *Plemel,* 303 Or. at 267, 735 P.2d at 1212.

logical fathers.[14] The report listed the phenotypes, the paternity index for each genetic system, and four statistics:[15]

Probability of Excluding a Falsely Accused Father 97.5%
Paternity Index 178
Chance of Paternity 99.4%
Chance of Nonpaternity 0.6%

None of the documents stated how any of these numbers were computed.[16] Four months later, Dr. Lovrien executed an affidavit attesting to the accuracy of these test results.

Although Oregon law allows genetic proof of paternity via affidavit rather than live testimony,[17] Dr. Lovrien appeared as a witness. The defendant did not object to the admission of the finding of inclusion or to the statement that the probability of exclusion was 97.5%. He did object, however, to the introduction of the paternity index, the probability of paternity, and the phrase "extremely likely" as applied to the claim that he was the father.[18] He argued that these items were irrelevant and prejudicial. Judge Devlin allowed Dr. Lovrien to testify to everything in the laboratory report. Nine of the twelve jurors agreed that Walter was the father.

II. DARKNESS IN THE COURT OF APPEALS

On appeal, the Oregon Court of Appeals affirmed. Judge Rossman expressed the appellate court's opinion that "the trial judge did not abuse his discretion in admitting the evidence."[19] The two-page opinion, however, evidenced substantial confusion over the meaning of the paternity index and its connection with the probability of paternity.

To begin with, the court of appeals held that "[t]he 'paternity

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14. Dr. Lovrien explained that "we didn't do all those tests in this case . . . simply because they weren't ordered, and it is expensive to do all those tests." Transcript of Proceedings on Appeal, State *ex rel.* Plemel v. Walter, No. 549, at 26 (Cir. Ct., Yamhill Cty., Sept. 26, 1984).

15. *Plemel*, 303 Or. at 265, 735 P.2d at 1211.

16. The report did not conform to the 1976 AMA-ABA Guidelines. *See supra* note 6. For several reasons, it also did not satisfy the more detailed Standards for Parentage Testing Laboratories developed by the Committee on Parentage Testing of the American Association of Blood Banks some years after the Oregon Health Sciences University tests. The Standards are reproduced as an appendix to *Kofford,* 744 P.2d at 1357-61.

17. *See supra* note 8.

18. *Plemel,* 303 Or. at 266, 735 P.2d at 1211.

19. State *ex rel.* Plemel v. Walter, 80 Or. App. 250, 254, 721 P.2d 474, 475 (1986).

index' measures the odds of respondent fitting within the popula-
tion of Oregon men who would be compatible with the child bio-
logically."[20] The odds that a randomly selected defendant would
fall within the group of men who, on the basis of the blood test
results alone, could be the father are one way of expressing the
probability of exclusion.

The paternity index, however, is neither a set of odds nor a
probability, as the following example will illustrate. A man accosts
a woman in a dark alley. Waving a knife, he demands money. A
police officer chances upon the robbery and orders the robber to
drop his weapon. The robber leaps at the officer, thrusting the
blade toward the officer's face. The officer shoots at the man, graz-
ing his arm. He flees, dripping blood. A man fitting his description
is apprehended in the vicinity about an hour later. Analysis of
nineteen genetic systems in the traces of blood from the alley
reveals that the types in question (abbreviated as T) occur in only
2.5% of the male population. The probability of excluding a ran-
domly picked suspect is therefore 97.5%. This figure corresponds
to the probability of exclusion of 97.5% in *Plemel*.[21] The suspect,
however, is not excluded. He has all the genetic markers found in
the robber's blood.

What, then, is the probability that the suspect is the robber? It
is not 97.5%, for that is merely the prevalence of nonincriminating
types in the population. To obtain the probability of guilt (PoG),[22]
we must first apply some elementary probability theory. The
probability of finding the incriminating characteristics (the blood
types T) on an innocent man is $Pr(T|I) = .025$, or 2.5%, since 2.5%
of all innocent men have the incriminating set of blood types. The

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20. *Id.* at 252, 721 P.2d at 475.

21. The above explanation glosses over one important distinction. According to the
Oregon Supreme Court, "[o]ne could infer from Lovrien's response to a question on cross-
examination that 2.5 percent of the male population was capable of fathering the child, but
careful reading of his testimony shows that this was not the case." 303 Or. at 268 n.3, 735
P.2d at 1213 n.3. According to the court, the 97.5% figure is the proportion of the male
population that would be excluded by this battery of tests, averaged over all possible ge-
notypes of mothers and children. Testimony as to this figure should be inadmissible, since it
has less bearing on the case than the probability of exclusion given the phenotypes of the
tested mother and child. For ease of exposition, let us assume that the specific probability
of exclusion is .975.

22. "Guilt" is used here as a shorthand term for the event that the suspect is the man
who left traces of blood in the alley. Proof of this fact suggests guilt, but other facts might
negate this conclusion. *See* Tribe, *Trial by Mathematics: Precision and Ritual in the Legal
Process,* 84 HARV. L. REV. 1329 (1971).

corresponding probability for a guilty man is $Pr(T|G) = 1$, or 100%, since there is only one guilty man, and if we test him we are sure to detect the incriminating types. Assume further that prior to the laboratory analysis, one could say that the probability of guilt is only .5. We may call this prior probability $Pr(G) = .5$, or 50%.[23] In other words, without the blood typing, the apprehended man is as likely as not to be the robber.

It is easy to prove that the incriminating evidence raises this prior probability to a much larger posterior probability. To express the magnitude of this shift in probability, it is convenient to speak in terms of odds. Probabilities, of course, are numbers that range from zero to one and that express the chance that something will or did happen. Odds are another way of expressing the chances. If the probability of an event is any number (p), the odds in favor of that event are p to $1-p$. For instance, if the probability of rain tomorrow is .8, the odds favoring rain are .8 to .2, or four to one. The formula that relates prior to posterior odds[24] is

$$\text{Odds } (G|T) = \frac{Pr(T|G)}{Pr(T|I)} \text{ Odds } (G).$$

We merely multiply the prior odds by the ratio of two probabilities.

Statisticians call this ration a likelihood ratio. In the robbery example, the prior odds are $Pr(G)/[1-Pr(G)] = .5/(1-.5) = 1$. The likelihood ratio is the probability of the incriminating results for a guilty suspect divided by the probability for an innocent suspect, or $LR_{in} = 1/.025 = 40$. If nomenclature similar to that used in paternity testing is adopted, this likelihood ratio would be called a "guilt index." The resulting posterior odds of guilt are therefore $40 \times 1 = 40$. These odds correspond to a probability of guilt of $PoG = 40/$

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23. This is somewhat implausible, for the presence of a gunshot wound on the arm would suggest a higher probability. The reason for floating the unrealistic figure of .5 will become apparent in the discussion of the probability of paternity (PoP) that corresponds to PoG.

24. The cognescenti know this formula as Bayes' theorem. This method of arriving at the posterior probability found its way into parentage testing through a 1938 paper by a Swedish anthropologist named Essen-Miller, who unknowingly re-derived the formula. *See* Aikin & Kaye, *Some Mathematical and Legal Considerations in Using Serological Tests to Prove Paternity,* in INCLUSION PROBABILITIES IN PARENTAGE TESTING 155, 156 (R. Walker ed. 1983); *cf.* BIOMATHEMATICAL EVIDENCE OF PATERNITY 8 (K. Hummel & J. Gerchow ed. 1982). Although some Oregon paternity testers seem to believe that they can compute the probability without this formula, no other method is known to modern science. *See* Kaye, OR. ST. B. BULL., Feb.-Mar. 1981, at 19 (letter to the editor).

41 = .9756. This result is remarkably close to the naive thought that the probability of guilt is 97.5%, the probability of excluding a randomly selected man. But this similarity is mere happenstance. A smaller prior probability would have yielded a posterior probability of less than .975.

Having explained how to compute the probability of guilt from the probability of exclusion and the prior probability, let us return to the paternity index. This index is a likelihood ratio similar to the guilt index, and that is why the court of appeals is wrong when referring to the paternity index as "odds." Odds are essentially probabilities. A likelihood ratio is not a probability; it is a ratio of two probabilities that pertain to an outcome conditioned on different events. A likelihood ratio can be formed in *Plemel* just as in the robbery case. The likelihood ratio for inclusion is 1/(1-.025) = 40. In other words, it is forty times more likely that the genetic testing will include Walter in the class of possible fathers if he is the biological father than if he is not.

Yet Dr. Lovrien arrived at a paternity index of not 40, but 178.[25] This was not a mistake. There is a good explanation for this calculation, and it undermines Walter's contention that anything more than the probability of exclusion is inadmissible because it conveys no information beyond that figure itself.[26] In the robbery case, all men with the same incriminating genetic markers are included as possible criminals, and all are indistinguishable as to their genetic information. The paternity index is more complicated because more than one set of genetic markers may be consistent with paternity. In the ABO blood grouping system, for instance, Dena Plemel had an A antigen, and her child had an A and a B antigen. Therefore, the biological father must have transmitted the version of the gene (the allele) that gives rise to the B antigen. Such a man could have type B or type AB blood. Walter turned out to be type AB[27]; he has a 50% chance of passing the B allele on to any child. Interestingly, a type B included man would have a somewhat larger chance of transmitting this allele.[28]

The paternity index tries to account for the fact that certain

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25. *Plemel,* 303 Or. at 265, 735 P.2d at 1211.

26. *Id.* at 266, 735 P.2d at 1211.

27. *Id.* at 268, 735 P.2d at 1212.

28. The probability is either .5 (if he has the genotype BO) or 1 (if he is BB). Because type AB blood is fairly rare, most men in the class of included men with respect to the ABO system would have a greater chance of fathering a child like Plemel's.

phenotypes of included men are more likely to be associated with the child's phenotype. The index is still a ratio of two probabilities, but these are the probability of the alleged father transmitting the alleles and the probability of selecting these alleles at random from the gene pool. Thus, the paternity index of 178 means that it is 178 times more likely that a union of Plemel and Walter would produce a child with the observed markers than would a union of Plemel and a set of alleles picked at random from men of Walter's race.

Using the paternity index of 178 in place of the simple likelihood ratio for inclusion raises the prior odds of 1 to posterior odds of 178. This, in turn, corresponds to a probability of paternity of $178/(1+178) = .994$, or 99.4%, as Dr. Lovrien reported.

The defendant challenged taking the prior odds to be one. He contended that this starting point was arbitrary and had no basis in the evidence. In responding to this argument, the Oregon Court of Appeals made its second mistake. It reasoned that the large paternity index showed that the assumption of equal prior odds "was, if anything, unduly favorable to the father."[29] This interpretation is incorrect. As with all likelihood ratios, the paternity index measures only the strength of the evidence,[30] and tells us nothing about the prior odds. By definition, these are based on evidence or assumptions apart from the genetic evidence. The paternity index changes the prior odds into posterior ones. It reveals how far we can move from a given starting point, but it does nothing to reassure us that we are starting at the right point.

If this somewhat abstract formulation of the criticism does not seem telling, consider this hypothetical variation on *Plemel*. Walter proves that he had a successful vasectomy in 1982, a year before the time of conception. The uncontradicted medical testimony is that the odds are one to a million that he could father a child. The paternity index, which relates solely to the genetic markers and certain gene frequencies, remains unchanged at 178. Would the court of appeals still insist that because the paternity index is high, it is reasonable to assume that, before considering the blood tests, Walter is at least as likely to have fathered the child as not?

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29. State *ex rel.* Plemel v. Walter, 80 Or. App. at 253, 721 P.2d at 475.

30. For a discussion of the likelihood ratio as a measure of the strength of evidence, see Kaye, *Quantifying Probative Value*, 66 B.U.L. REV. 761 (1986).

III. IN THE SUPREME COURT

Part I of Justice Lent's unanimous opinion for the Oregon Supreme Court is the best exposition of the pertinent biological and statistical principles to have emerged in any jurisdiction. Part II of the opinion begins with a careful reading of the Uniform Act on Blood Tests to Determine Paternity (UABT), which Oregon enacted in 1953. The court reasons that because the statute and the commentary to the model act are silent on the admissibility of anything more than the laboratory findings and the relative frequency of the genetic markers, the usual rules of evidence governing expert testimony must determine the admissibility of the paternity index and the probability of paternity.[31]

The court correctly and incisively rejects Walter's argument that any statistic beyond the frequency of the obligatory genotypes has no probative value and would not assist the jury because the genetic results do not justify any further distinctions among included men.[32] As previously explained, and as the court observes, this premise is simply wrong. Not all included men are genetically equal. Furthermore, the court points out that even if the other statistics did not convey additional information, it is possible that repackaging the same information might assist the jurors in their evaluation of its significance.[33] Thus, we need to consider the admissibility of (a) the probability of exclusion, (b) the paternity index (PI), (c) the probability of paternity (PoP), and (d) the expert conclusion that paternity is "extremely likely."

A. *Probability of Exclusion*

Several courts, including the supreme courts of Kansas,[34] Massachusetts,[35] and Utah,[36] have held or opined that testimony as to the probability of exclusion is inadmissible. The Kansas court reasoned that this probability is uninformative—a view that defies comprehension. The other courts have suggested that the probability of exclusion is potentially confusing and less informative than the paternity index or the probability of paternity.

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31. *Plemel,* 303 Or. at 273, 735 P.2d at 1216.
32. *Id.* at 274, 735 P.2d at 1216-17.
33. *Id.* at 274-75, 735 P.2d at 1217.
34. State *ex rel.* Hausner v. Blackman, 233 Kan. 223, 662 P.2d 1183 (1983).
35. *Beausoleil,* 397 Mass. at 206, 490 N.E.2d at 788.
36. *Kofford,* 744 P.2d at 1351.

Because there was no objection to it, the Oregon Supreme Court had no need to rule on the admissibility of the probability of exclusion. The court's analysis of the UABT makes it plain, however, that where the probability of exclusion is very high, i.e., where the obligatory genotypes are rare, evidence of the infrequency of these types is admissible. Still, the admissibility of population frequencies for inclusion does not necessarily imply the admissibility of a mathematically equivalent figure that has different and potentially confusing connotations. Indeed, the opinion notes that the probability of exclusion may be hard to interpret or may tend to mislead the jury.[37]

Nevertheless, these criticisms of the probability of exclusion (or inclusion) do not justify a flat ban on its use. Competent counsel should be able to dispel the potential confusion,[38] and the simpler probability of inclusion may be more intuitively accessible to some jurors than the more complete, but possibly more bewildering, statistics such as PI and PoP. Our knowledge of these aspects of cognitive psychology is rudimentary. In the absence of clearer indications that this statistic will be misused, Oregon Rule of Evidence 403, which requires that the danger of unfair prejudice *substantially* outweigh probative value, should not bar admission.[39] Moreover, the law of evidence should allow a qualified expert to explain his or her findings in a way that is accurate as far as it goes, and that commands some support in the scientific community. The courts should not compel an expert who desires simply to describe the test results and to give the probability of exclusion to venture into the troubled land[40] of the PI and the PoP.[41]

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37. *Plemel*, 303 Or. at 275, 735 P.2d at 1217. Evidence as to the infrequency of genotype is the flip side of the probability of exclusion.

38. *Id.* at 275 n.8, 735 P.2d at 1217 n.8.

39. OR. R. EVID. 403.

40. The propriety of using the PI and PoP to assist in evaluating a claim of paternity has been the subject of heated controversy among statisticians and other experts. *See, e.g.,* Aickin, *Some Fallacies in the Computations of Paternity Probabilities,* 36 AM. J. HUMAN GENETICS 904 (1984); Brenner, *Evidence, Probability and Paternity,* 37 AM. J. HUMAN GENETICS 836 (1985) (letter).

41. The conclusion that the probability of exclusion is admissible in itself surely is consistent with the court's opinion, which states in dictum that even if the expert chooses not to present the paternity index or the probability of paternity, or if the expert presents these statistics in an unacceptable fashion, "the probability of excluding a falsely accused father and the proportion of the relevant population excluded by the blood tests, would still be admissible." *Plemel,* 303 Or. at 279, 735 P.2d at 1219-20.

B.   The Paternity Index

Having concluded that the paternity index or related statistics have some probative value or explanatory power above and beyond the probability of inclusion, the supreme court turned to the argument that these statistics are unduly prejudicial or confusing. To minimize these risks, the court enumerated three preconditions for the admissibility of any further analysis.[42] First, the court requires an expert who wants to report the PI to explain that "the index is not the probability that the defendant is the father, but measures only the chance that the defendant is the father compared to the chance that a randomly selected man is the father."[43] The requirement of a clear and correct explanation of the PI is reasonable enough, and the court correctly decides that the testimony in *Plemel* fails this test.

Regrettably, though, the court's phrasing of this requirement is imperfect. The PI does not measure the chance of defendant's paternity compared to that of a randomly selected man. The chance that defendant is the father is the probability of paternity. This PoP is the end result of the computation that uses the PI. The PI involves the probability that a cross between the defendant and the mother would produce an offspring with the child's phenotypes and the corresponding probability for a random selection of genes from the male population.[44] It is to be hoped that experts and courts will not take the *Plemel* court's definition of the probability index literally.

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42. In a footnote, the supreme court also observed that the trial court could refuse to admit any genetic evidence of paternity "where the blood test is unable to exclude a sufficient proportion of the relevant population." *Id.* at 278 n.12, 735 P.2d at 1218-19 n.12. It is interesting to compare this rather vague requirement with the dictum in the Massachusetts decision that sets a lower bound of 90% on the exclusion probability. *Beausoleil,* 397 Mass. at 216, 490 N.E.2d at 796 (The Massachusetts court is less than clear on whether this probability is to be conditioned on the phenotypes of the mother and child or is instead a mean probability of exclusion averaged over all possible genotypes for mother and child). Since one can reach high paternity indices even without this precondition, the justification for it is not obvious. Nevertheless, it is not a serious barrier to admission. Even in isolation, HLA tests typically achieve this level of exclusions, as does the battery of red blood cell antigen and serum protein and enzyme tests used in *Plemel.* Even higher power is available with emerging techniques of DNA analysis. Hence, as the *Plemel* court notes, successful objections to admission of genetic test results for want of a sufficiently powerful battery of tests "should rarely arise." 303 Or. at 278 n.12, 735 P.2d at 1218-19 n.12.

43. *Plemel,* 303 Or. at 278, 735 P.2d at 1219.

44. The ratio may be restated as involving the probability of a true trio (father-mother-child) among all trios of the same phenotypes as the tested trio.

Of course, the fact that even the supreme court—after a painstaking reading of the record and the literature on parentage testing, and with the opportunity for reflection and review of drafts of its own opinion—found it so difficult consistently to give a correct definition of the paternity index bodes ill for the attempts of experts to do so in the course of responding instantaneously to demanding questioning put to them on the stand. Perhaps a standardized written report with judicially approved explanations of the statistics would be a helpful start to conveying accurate interpretations to the jury.

C. The Probability of Paternity

The second requirement outlined in *Plemel* comes into play if the expert chooses to testify to a probability of paternity.[45] The court writes that the expert should not present "over objection"[46] a single figure as the probability of paternity. We have seen that the prior odds, together with the PI, generate the probability of paternity. These odds are beyond the ken of the expert. As the court describes these odds, they represent the chance that the defendant is the father, given all the non-test evidence in the case, and the expert has no business evaluating these odds. The court therefore requires the expert to present the posterior probability as a function of the prior probability, for priors ranging from 0 to 100%, in increments of 10%.[47]

Applied to the results in *Plemel*, the variable prior odds approach gives the following results:

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45. In this regard, the court's statement that "Lovrien did not derive a statistic for probability of paternity," is puzzling. *Plemel*, 303 Or. at 272, 735 P.2d at 1215. It should be plain that the 99.4% figure for the "chance of paternity" is a probability of paternity computed for a PI of 178 and prior odds of one. *See Plemel*, 80 Or. App. at 253 n.2, 721 P.2d at 475 n.12. Moreover, if Dr. Lovrien did not present the probability of paternity, then the specification of conditions for admitting testimony about PoP is unnecessary to the disposition of the case, and as such, is not part of the holding of the case.

46. *Plemel*, 303 Or. at 278, 735 P.2d at 1219.

47. *Id.*

Prior Probability	Prior Odds	PI	Odds of Paternity	PoP
0%	0	178	0	0%
10	1/9	178	19.78	95.19
20	1/4	178	44.50	97.80
30	3/7	178	76.29	98.71
40	2/3	178	118.67	99.16
50	1	178	178.00	99.44
60	3/2	178	267.00	99.63
70	7/3	178	415.67	99.76
80	4	178	712.00	99.85
90	9	178	1602.00	99.94
100	∞	178	∞	100

Table 1. The Probability of Paternity (PoP) as a Function of the Prior Odds for the Paternity Index (PI) in *Plemel v. Walter*

A quick look at the resulting graph (Figure 1) shows that the test results are powerful evidence of paternity:
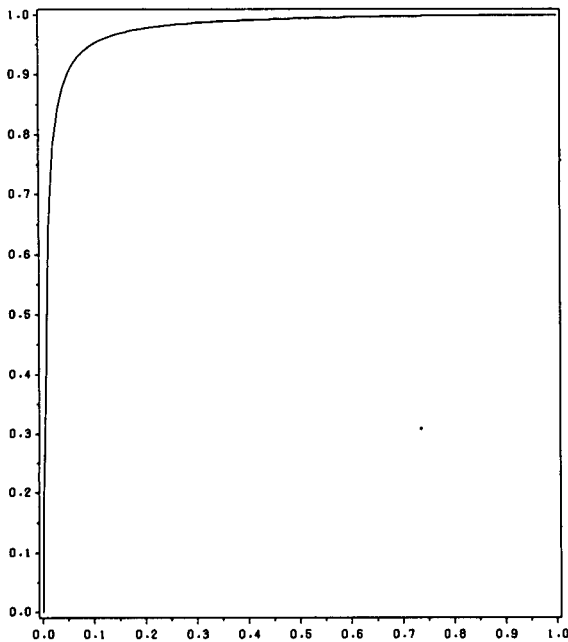

Figure 1
The Probability of Paternity
as a Function of the Prior Probability
for the Paternity Index in *Plemel v. Walter*

The Probability of Paternity as a Function of the Prior Probability for the Paternity Index in *Plemel v. Walter*

The posterior probability of paternity rises steeply as one moves the prior probability away from zero. When the prior probability is only .0056, or about half a percent, the PoP has climbed to .5, or 50%. When the prior probability is 5%, the PoP is up to 90%. Unless the non-test evidence in the case is very favorable to Walter, the genetic evidence makes it highly probable that he is the father.

Even before *Plemel,* many laboratories had adopted the suggestion of reporting the posterior probability for several values of the prior probability.[48] Nevertheless, one could question whether the chart really is a *sine qua non* of admissibility for the probability of paternity. The previous use of a prior probability of .5 was supposed to express the ignorance of the laboratory. Not knowing anything else about the case, the expert may reason that .5 is a fair or neutral starting point, since it gives half the probability to the mother and half to the alleged father.[49]

This argument is unconvincing, however, because even if .5 were an adequate representation of the laboratory's ignorance, the laboratory has no vested interest in it. It may help the jury to see some other figures as well. Furthermore, it is doubtful that .5 is an adequate representation of ignorance. Whereas the *Plemel* court treats the genetic evidence as if it were the final datum in the case, to be evaluated *after* all the non-test evidence has been assimilated into the prior probability, the neutrality argument for .5 treats the genetic findings as the very first datum, to be evaluated *before* any other evidence is available. If it does come first, at least conceptually, perhaps the fairest thing the laboratory can do is to say that as far as it can tell, considering only the untested vials of blood, the accused man is no more likely than any other male in the relevant population to be the father. Although the definition of the relevant population is obscure, if there are more than two men biologically capable of fathering the child, then the prior probability for the defendant is less than .5. The laboratory's ignorance should be represented by distributing the prior probability uniformly over all men in the relevant racial and geographic population. Any other approach gives considerable credence to the very fact of the mother's accusation, which is hardly part of the genetic analysis. This argument leads to the conclusion that the expert who wishes to testify to any probability of paternity not only should present a

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48. *See* Ellman & Kaye, *supra* note 6, at 1131.

49. *E.g.,* BIOMATHEMATICAL EVIDENCE OF PATERNITY, *supra* note 24, at 8-9.

spectrum of prior and posterior probabilities, but also should not be permitted to testify that prior odds of one are "fair," "neutral," or "unprejudiced."

A more potent objection to the variable prior odds require-ment is that using a chart to show the genetic evidence focuses too much attention on this information.[50] According to this argument, the analysis would be fine if we were to process each bit of evidence in this quantitative way, showing how the likelihood ratio would change the prior probability. However, the gain to be derived in cognitive accuracy from forcing all evidence into this mold does not seem worth the price. And if we are not willing to use the proce-dure for every bit of evidence, it may be unfair or misleading to pick out the scientific evidence for this special treatment. This is a fairly complex argument that cannot be resolved here. If, however, experts testify on the probability of paternity, then the chart ap-proach or something akin to it is essential.

Indeed, it is so essential that one should differ with the lan-guage in *Plemel* that permits an expert to ignore the requirement— to serve up a single number based on undisclosed prior odds—as the probability of paternity unless and until this sleight of hand is challenged. A court has the power to exclude evidence even in the absence of an objection, and an appellate court may reverse a trial court for "plain error" even if the opposing party fails to object. Yet *Plemel* only bars the introduction of the misleading probability of paternity "over objection."[51]

In a case squarely presenting the issue of an inadequately ex-plained PoP,[52] however, the courts should invoke the plain error doctrine.[53] Otherwise, the chart requirement will protect only those defendants who have counsel knowledgeable enough to force the expert to consider a range of prior probabilities. This much they could do without the requirement through adroit cross-examination.

The court's requirement of variable prior odds poses one addi-

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50. *Cf.* Tribe, *supra* note 22, at 1362 ("Readily quantifiable facts are easier to pro-cess—and hence more likely to be recognized and then reflected in the outcome—than are factors that resist ready quantification.").

51. 303 Or. at 278, 735 P.2d at 1219.

52. Because Walter's counsel made both a pretrial motion and a contemporaneous objection to keep the probability of paternity out of the case, any pronouncement in *Plemel* about what would have happened had there been no objection must be treated as dictum.

53. *Cf.* People v. Collins, 68 Cal. 2d 319, 438 P.2d 33, 66 Cal. Rptr. 497 (1968).

tional difficulty. The court writes that testimony as to the paternity index triggers the requirement and, in dictum, it states that an expert's failure to compute the posterior probability as a function of the prior probabilities will mandate an instruction to ignore the PI as well as "its equivalents."[54] But the PI, unlike the probability of paternity, does not change with the prior odds, as Table 1 shows. The index in *Plemel* is 178, whatever the prior odds may be. It is 178 times more likely that Walter and Plemel would have offspring with the child's phenotypes than that a random draw of paternal genes would lead to such a child. Why should the expert who wishes to state this fact, but who prefers not to speak of the posterior probability of paternity, be forced to list eleven different prior and posterior probabilities? When the proper case arises, the admissibility of the PI should be treated like the admissibility of the gene frequencies and the probability of exclusion. These statistics can stand apart from the PoP, and they can be of some assistance to the trier of fact in assessing the laboratory results. As with the gene frequencies and the probability of exclusion, the PI should not be admitted at the price of a full-blown chart introducing the PoP.

D.   The Verbal Predicates

Dr. Lovrien not only reported a single PoP of 99.4%, but he interpreted this probability as making the claim of paternity "extremely likely."[55] This phraseology is not idiosyncratic. It comes from a table in a 1976 report of a joint AMA-ABA committee.[56] The committee borrowed the terms "practically proved," "extremely likely," "very likely," "likely," "undecided," and "not useful," from the writing of Konrad Hummel,[57] who called them "verbal predicates" and used them to describe various ranges for the PoP.[58]

These terms have no objective scientific status, and supply no information that the probability of paternity does not supply more precisely. A geneticist, a statistician, or any other expert is no better than a lay juror at deciding whether a probability of 99.4% (or

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54. *Plemel,* 303 Or. at 279, 735 P.2d at 1219.

55. *Id.* at 264, 735 P.2d at 1211.

56. *Joint AMA-ABA Guidelines, supra* note 7, at 262 (Table 4).

57. Dr. Hummel is director of an institute for blood group serology in Freiburg, West Germany.

58. *Joint ABA-AMA Guidelines, supra* note 7, at 262 (citing K. HUMMEL, DIE MEDIZINISCHE VATERSCHAFTSBEGUTACHTUNG MIT BIOSTATISTISCHEM BEWEIS (1961)).

any other number) makes something a wee bit likely, extremely likely, or practically proved. It is the solemn duty of the jury or judge—and not the business of the expert—to decide whether evidence makes an ultimate issue "practically proved" or "undecided."

Yet the magic of the initials "AMA-ABA" is so powerful that they have led courts to conclude that evidence establishing a PoP of 95% is admissible, while evidence giving a probability of 94.99% is inadmissible.[59] The *Plemel* court did not succumb to this spell. It recognized that the "predicates" have no meaning independent of the statistics that they characterize.[60] Moreover, because it understood that the AMA-ABA committee's use of a prior probability of .5 as a "useful working hypothesis"[61] meant that the posterior probabilities, and hence the verbal predicates, are rooted in quicksand, it held that the expert should not use Hummel's predicates or comparable words.[62]

IV. CONCLUSION

The courts have been slow to digest genetic evidence of paternity. Over the last ten years, virtually no opinions have reflected a solid understanding of the pertinent scientific and statistical principles. Very recently, however, several notable opinions displaying a more mature understanding of the evidence have appeared. It is heartening to see that the Oregon Supreme Court's opinion in *Plemel* is preeminent among these.

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59. *See Beausoleil,* 397 Mass. at 206, 490 N.E.2d at 788; *Kofford,* 744 P.2d at 1343.

60. 303 Or. at 270-71 and n.5, 735 P.2d at 1214 and n.5.

61. *Joint AMA-ABA Guidelines, supra* note 7, at 262.

62. Other courts have expressed skepticism about the verbiage. See In re Angela B. v. Glenn D., 126 Misc. 2d 646, 482 N.Y.S.2d 971, 975 (Fam. Ct. 1984), *order rev'd sub nom.,* Barber v. Davis, 120 A.D.2d 364, 502 N.Y.S.2d 19 ("the so-called 'Hummel's predicate' . . . roughly corresponded to a form chart for parimutuel horse racing").