

DNA Paternity Tests Show Probability of Paternity of 99% in *Non-fathers*.

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Currently, the state law in Georgia presumes paternity on the basis of DNA test results showing the probability of paternity to be 97%. This level of discrimination in DNA testing allows for the man presumed to be father by law to have a genetic pattern identical to approximately 1 out of 35 individuals in the population. Recent study performed on *actual* paternity cases demonstrated that 2 of the 249 tested men who were *non-fathers had DNA test results with a probability of paternity ranging between 97% and 99.8%*. The DNA test used in the study was a 9 or 15 genetic STR loci test that is typically performed by most DNA laboratories. Only with additional DNA testing would these men be correctly identified as non-fathers. It is time to reconsider what constitutes an adequate level of testing for the establishment of parentage in the State of Georgia.

DNA results often decide the outcome of your case. It is important to understand the bottom line results on the DNA paternity test report...

Since DNA results often decide the outcome of your case, your understanding of their significance will likely determine the outcome of your case. The bottom line results of a DNA paternity test are expressed by two numbers printed on the report: (1) the combined paternity index, and (2) the probability of paternity. Another two numbers that may or may not be printed on your client's report are the random man not excluded (RMNE) and the power of exclusion (PE). A thorough understanding of the definitions of these standards is required for the appreciation of their significance.

The combined paternity index (CPI) is a ratio that depicts the likelihood of the tested man being the biological father in comparison to the likelihood of a random, unrelated man in the population being the father. Many people have difficulty understanding likelihood ratios such as the

combined paternity index. In our experience, expressing the CPI as a frequency of occurrence is much easier to understand. For example, the DNA paternity test results can be stated: “one individual in 1,000 has this genetic pattern.” This statistic is routinely calculated during the DNA testing process, and is called the random men not excluded (RMNE) statistic.

The power of exclusion (PE) statistic is another number on the DNA paternity test that gives reports the accuracy of a given DNA test. For example, the PE statistic states: “999 out of 1,000 men in the population do not have this genetic pattern and therefore they are excluded from the possibility of being the father by the DNA test”. Another way to express the PE statistic is: “This DNA test would exclude 99.9% of the male population from the possibility of being the biological father of the child”.

In practice, however, the DNA test results are often expressed in terms of the probability of paternity. Unfortunately, *the probability of paternity statistic can be intuitively misleading*. For example, a probability of paternity of 99% sounds convincing because the high percentage value gives a sense of accuracy that the level of testing performed is more than adequate, and that a false positive test result is a very rare event. However, by comparing the paternity index, the probability of paternity, and the random men not excluded statistics in Table I, you can see the extent of the intuitively misleading nature of the probability of paternity statistic (Table I).

Probability Of Paternity	Average Combined Paternity Index PI	Average number of individuals with the <i>same</i> genetic pattern (random men not excluded) RMNE
95%	20	1 out of 20
97%	35	1 out of 35
98%	50	1 out of 50
99%	100	1 out of 100
99.9%	1,000	1 out of 1,000
99.99%	10,000	1 out of 10,000
99.999%	100,000	1 out of 100,000

The combined paternity index (CPI) statistic is routinely printed in DNA paternity test reports. Although it may be difficult to appreciate the significance of this number at a first glance, notice that the combined paternity index statistic closely estimates the RMNE. For example, when the combined paternity index is 35, 1 out of approximately 35 individuals in the population has the same genetic pattern as the tested man. And, when the when the combined paternity index is 100, 1 out of approximately 100 individuals in the population has the same genetic pattern as the tested man. But, when you compare the 1 out of 35 odds and the 1 out of 100 odds to the probabilities of paternity of 97% and 99% respectively, the probability of paternity sounds fairly close to an accuracy of 100%.

Studies of *actual* paternity cases:

It has been Genetica DNA Laboratories' policy over the last 10 years to perform *very* extensive DNA parentage testing (using the restriction fragment length polymorphism method) to avoid the chance of a false positive paternity result. As a result of this policy, we have acquired a unique, large collection of samples from proven non-paternity cases to be used as a standard to test the validity of less thorough genetic testing.

In the study¹, 249 of our non-paternity cases were tested using the DNA test method that is most commonly used today by the DNA testing laboratories. DNA paternity test results were analyzed comparing 9 and 15 genetic sites tested. The 9 genetic sites tested included the following STR loci: D3S1358-3, VWA-12, FGA-4, D5S818-5, D13S317-13, D7S820-7, D8S1179-8, S21S11-21, and D18S51-18. The 15 genetic sites tested included the 9 loci listed above and the following additional 6 STR loci: THO1-11, TPOX-2, CSF1PO-5, D16S39-16, D2S1338-2, D19S433-19.

From the population of 249 non-fathers, one alleged father matched the child on all 9 genetic sites and had the probability of paternity of 99.6% (the combined paternity index = 298). A second man in this population showed the probability of paternity of 99.7% (the combined paternity index = 353) after 15 genetic sites were tested.

Genetica DNA Laboratories is not the only laboratory recently reporting false positive paternity results when testing is stopped at a probability of paternity of less than 99.9% (the

combined paternity index of 1,000). A case report was presented at the Twelfth International Symposium on Human Identification about a man accused of rape who had a DNA paternity test result with probability of a paternity of 99.3%. Only with additional testing was this man excluded as the biological father of the child resulting from the rape². Also reported at the symposium was a case from the Arizona Public Safety Crime Laboratory that identified a match between 2 unrelated offenders — a Caucasian and a Black — who shared both alleles (genetic variants) at 9 genetic loci³. In addition, a 9 genetic loci match between two unrelated individuals was also reported by the Florida State Crime Laboratory⁴.

Discussion

As recently as 10 years ago, DNA parentage testing was performed using Red Blood Cell (RBC), serum protein testing, and Human Leukocyte Antigen (HLA) testing. Throughout the 1980's and the early 1990's, it was appropriate for the state legislature to require a probability of paternity of 95.0% to 99.0% because the available tests were limited in their ability to exclude a falsely accused man from paternity. The definition of “appropriate” testing is in part determined by the development of technology. Like technology, it should evolve over time.

However, the advent of DNA technology in the late 1980's and the early 1990's has revolutionized parentage testing by dramatically increasing our ability to accurately exclude falsely accused men. In turn, when an accused man is not excluded following thorough paternity testing, his probability of paternity will typically be greater than 99.99999%, thereby removing any doubts of paternity.

In the ideal world, the laboratory would provide very extensive testing in all cases and would test to a level of certainty as high as possible, 99.9999999% or more. Currently, the technology is available to provide that level of certainty in every case. Some private attorneys routinely specify that level of testing for their private clients. Paternity testing laboratories, however, have an economic incentive to keep the level of testing as low as possible.

Considering today's technology and current economic realities, what should be the minimum level of testing? Statistical calculations predict that when the testing is stopped at the combined paternity index of 100 (probability of paternity 99%), 1 out of approximately 100

individuals in the population have the same genetic pattern as the tested alleged father. Our study's data is consistent with this prediction by revealing two false positive paternity test results.

The Uniform Parentage Act (Last Revisions Completed Year 2000)⁵ recommends that the threshold for the presumption of paternity be the probability of paternity 99%. Using this guideline, both of our non-fathers would legally be presumed to be fathers. The combined paternity indexes in these cases were 298 and 353, respectively (i.e, above 100, but below 1,000). Only by increasing the threshold for the presumption of paternity were these men correctly identified as non-fathers. Technically, in 2002, all laboratories can provide a combined paternity index of 1,000 (probability of paternity of 99.9%) in virtually all of the standard parentage cases and they can do so at a reasonable cost and turn around time. Furthermore, the evidence that the gains in adopting a minimum standard of a combined paternity index of 1,000 does indeed outweigh the costs is reflected by the fact that some states are increasing their standards for the presumption of paternity. The State of Hawaii and the State of Illinois increased the established presumption of paternity to the combined paternity index of 500 (probability of paternity 99.8%). And, the State of Louisiana has increased the established presumption of paternity with a DNA test to a minimum probability of 99.9% (a combined paternity index of 1,000).

Recommendation for the legal standard for the presumption of paternity.

Today's DNA technology and cost indicators make it clear that there is no reason to consider any standard below a combined paternity index of 1,000 (a probability of paternity of 99.9%). As seen in our study, the number of non-fathers legally presumed to be biological fathers is significant when testing is stopped below a combined paternity index of 1,000. A minimum combined paternity index of 1,000 is also important because the alleged father is identified with a higher degree of confidence with more extensive DNA testing. This increased confidence in the DNA results often translates into fewer disputes. Additionally, a more extensive DNA test is more reliable in excluding falsely accused men who are relatives of the biological father.

We strongly recommend that the legal standard should reference the combined paternity index (1,000) rather than the probability of paternity (99.9%). The combined paternity index reflects more accurately the difference between higher and lower levels of testing. To the casual

observer, the difference in going from the probability of 99% to the probability of 99.9% is not as obvious as the corresponding difference in the paternity index from 100 to 1,000. This is even more apparent when you consider that the two non-fathers in our study with probability of paternity of 99.6% and 99.7% had combined paternity indexes of 298 and 353 – significantly less than our proposed minimum combined paternity index of 1,000.

In addition to achieving a minimum paternity index of 1,000, the law should provide that a genetic test cannot establish a presumption of paternity unless that same test also excludes at least 999 out of 1,000 non-fathers (excludes at least 99.9% of the population). This is the only way for the law to insure that tests establishing a presumption of paternity will exclude some minimum percentage of the population.

Like technology, the minimum legal standard for the presumption of paternity by genetic testing must change over time. The standard of the 97% probability of paternity belongs in the past decade. In 2002, the DNA technology and economic realities require a new standard. This new standard should read: “The legal threshold for the presumption of paternity through genetic testing requires a minimum combined paternity index of 1,000 *and* a minimum exclusion of 99.9% of men in the population”. We invite your comments and questions.

ENDNOTES:

1. Research study was conducted by Genetica DNA Laboratories, Inc., Cincinnati, Ohio. This study was supported in part by Applied Biosystems.
2. Twelfth International Symposium on Human Identification. October 9-12,2001. Bio Links, Lima, Peru.
3. Twelfth International Symposium on Human Identification. October 9-12,2001. Arizona Department of Public Safety Crime Laboratory.
4. Florida State Crime Laboratory (personal communication).
5. Uniform Parentage Act (Last Revisions Completed Year 2000); National Conference of Commissioners on Uniform State Laws, January 5,2001.

