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A Post-Mortem Review of Forensic Hair Analysis – A Technique Whose Current Use in Criminal Investigations is Hanging on by a Hair

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A POST-MORTEM REVIEW OF FORENSIC HAIR ANALYSIS – A TECHNIQUE WHOSE CURRENT USE IN CRIMINAL INVESTIGATIONS IS HANGING ON BY A HAIR

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"The FBI's three-decade use of microscopic hair analysis to incriminate defendants was a complete disaster."[1]

—Peter Neufeld - Co-Founder of the Innocence Project

George Perrot languished in jail for three decades as the result of a strand of hair discovered by an FBI agent on an elderly woman's bed who had been sexually assaulted.[2] Mr. Perrot was tried for rape despite the lack of physical evidence linking him to the crime.[3] Even the victim admitted that the suspect did not resemble her attacker, who had short hair and was clean-shaven, while the defendant had long unkempt hair and a beard.[4] Nevertheless, an expert for the prosecution testified that the hair found at the scene uniquely belonged to the defendant and no one else.[5] This testimony was so convincing and cloaked in the certainties of science that the jurors had no difficulty finding the defendant guilty beyond a reasonable doubt.[6] The problem is that the expert's analysis was scientifically flawed; a fact that the FBI admitted in 2013, even though hair

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1. Spencer S. Hsu, *FBI admits flaws in hair analysis over decades*, WASH. POST, (Apr. 18, 2015), https://www.washingtonpost.com/local/crime/fbi-overstated-forensic-hair-matches-in-nearly-all-criminal-trials-for-decades/2015/04/18/39c8d8c6-e515-11e4-b510-962fcfabc310_story.html [https://perma.cc/F4Q9-H6XF] (internal quotations omitted).

2. Ed Pilkington, *Thirty Years in Jail for a Single Hair: The FBI's 'Mass Disaster' of False Conviction*, THE GUARDIAN, (Apr. 21, 2015), https://www.theguardian.com/us-news/2015/apr/21/fbi-jail-hair-mass-disaster-false-conviction [https://perma.cc/R6E8-Y6MB].

3. *Id.*

4. *Id.*

5. *Id.*

6. *Id.*

comparison analysis has been used extensively throughout the United States for decades in an untold number of criminal cases.[7]

Forensic hair analysis is a scientific method of analyzing trace evidence from a crime scene in order to identify the perpetrator.[8] Current research regarding hair analysis as a valid forensic technique demonstrates that no one can state with the proper degree of certainty how frequently particular hair characteristics are found in the human population,[9] and no uniform standard has been established for what constitutes a match.[10] This renders a forensic tool routinely used by investigators highly suspect. As noted in *Williamson v. Reynolds*, hair analysis "is irrelevant, imprecise and speculative," and "its probative value [is] outweighed by its prejudicial effect."[11] This article will explain the history of how an accepted forensic technique was built upon a house of cards that lacked a valid scientific foundation and resulted in the conviction of a number of innocent people, thereby creating one of this country's biggest forensic scandals.[12] It will conclude with an examination of the current uses of forensic hair analysis that is limited to certain DNA applications and the litigation generated by the technique that continues in a civil and criminal context.

I. THE HISTORY OF HAIR ANALYSIS

The studying of a strand of hair was recognized in the infancy of forensic science.[13] In fact, one of the first examinations of hair occurred in 1847 with the murder of Duchesse de Praslin.[14] Edmond Locard, a French criminologist,

7. Pilkington, *supra* note 2.

8. *Forensic Hair Analysis Peer-review Journal*, OMICS INT'L, https://www.omicsonline.org/forensic-research/forensic-hair-analysis-peer-review-journal.php [https://perma.cc/R2S3-LQJK] (last visited Nov. 12, 2019).

9. *Id.*

10. Carmen Drahl, *Forensic Hair Analysis Has a Long Road Back to Courtroom Glory*, FORBES, (Apr. 4, 2017), https://www.forbes.com/sites/carmendrahl/2017/04/05/forensic-hair-analysis-has-a-long-road-back-to-courtroom-glory/#24bf3f01144c [https://perma.cc/37L4-EUR3].

11. 904 F. Supp. 1529, 1558 (E.D. Okla. 1995).

12. *Elite FBI Forensic Unit Gave Flawed Testimony,* CBS NEWS, (Apr. 20, 2015), https://www.cbsnews.com/news/fbi-hair-analysis-errors-led-to-convictions-new-report-finds/ [https://perma.cc/NK8H-3XBY].

13. *Forensic Study and Analysis: History of Hair and Fiber Analysis,* FREERICE.COM, http://bhoehnforensics.blogspot.com/p/history-of-hair-and-fiber-analysis.html [https://perma.cc/9U8Z-HDG2] (last visited Mar. 27, 2019).

14. Anthony J. Bertino, *Forensic Science: Fundamentals and Investigations, Chapter Three: The Study of Hair*, NAT'L GEOGRAPHIC 50 (2009), https://ngl.cengage.com/assets/downloads/forsci_pro0000000541/4827_fun_ch3.pdf. The husband of the duchess, Charles de Choiseul, Duke of Praslin, was suspected of killing his wife, but he committed suicide shortly before trial. These circumstances were said to have contributed to the French Revolution of 1848. Marie Belloc Lowndes, *The Praslin Murder: A Famous French Mystery Case, in* 57 HARPER'S WEEKLY 112, 112–13 (George Harvey ed., 1913).

espoused the basic principle of forensic science that "every contact leaves a trace."[15] Therefore, individuals are continually picking up and transferring particles of hair, fiber, and other trace evidence without knowing it.[16] This provides the incentive for investigators to look for hair at a crime scene for comparison purposes.

The first case in the United States to consider hair analysis evidence occurred in 1882.[17] *Knoll v. State* involved a man whose body was found in a swamp about one-half mile from the defendant's residence.[18] Blood and hair were discovered in a wheelbarrow in the possession of the suspect.[19] An expert compared the hair found on the piece of equipment with the hair from the victim and determined that the "hair was precisely the same . . . in length, magnitude, color, and in every other respect," and thus the expert concluded the hairs came from the same person.[20] This evidence resulted in the defendant's conviction, but the finding of guilt was reversed on appeal with the admonition that "such evidence is of a most dangerous character."[21]

Forensic hair analysis was in its infancy at the time of the *Knoll* decision. It subsequently became a standard prosecution tool relying greatly upon the use of microscopic analysis.[22] After all, hair is a common form of trace material that is collected and submitted as evidence during criminal investigations.[23] As humans shed approximately 100 head hairs a day, a hair analysis was thought to help establish a link between individuals or between a person and a specific environment.[24]

A. The Morphology of Hair

Hair has a variety of functions based upon its location. For example, hair offers a degree of protection from the damaging rays of the sun or from debris

15. *Locard's Exchange Principle,* EVISCAN, https://www.eviscan.com/en/glossary/locards-exchange-principle/ [https://perma.cc/77B5-ULH2] (last visited Nov. 12, 2019).

16. *Id.*

17. Knoll v. State*,* 55 Wis. 249, 12 N.W. 369, 369 (1882).

18. *Id.*

19. *Id.*

20. *Id.* at 370.

21. *Id.* at 371.

22. Williamson v. Reynolds, 904 F. Supp. 1529, 1555 (E.D. Okla. 1995).

23. *Hair*, MINN. BUREAU OF CRIMINAL APPREHENSION, https://dps.mn.gov/divisions/bca/bca-divisions/forensic-science/Pages/trace-hair.aspx [https://perma.cc/2TYE-6BGW] (last visited Mar. 28, 2019).

24. *Id.*

and foreign objects that may injure the skin or enter the body.[25] It also helps regulate body temperature and facilitates evaporation of perspiration.[26]

Anatomically, hair consists of a follicle and shaft. A follicle is the club-shaped root imbedded in the skin.[27] A network of blood vessels—the papilla—attach to the follicles to provide nutrients to the hair where it is attached and growing from the source.[28] In turn, the papilla is surrounded by a bulb, which is associated with a sebaceous gland that releases oil and facilitates the conditioning of hair.[29] Hair is able to stand upright as the result of erector muscles, which connect to the bulb.[30] The nerve cells wrap around the follicle and stimulate the erector muscles as a reaction to changing environmental situations.[31]

The hair shaft is made up of keratin, a protein formed in the skin, which provides hair with its strength and flexibility.[32] The shaft itself contains three layers: the medulla, the cortex, and the cuticle.[33] The medulla is the inner most canal that forms the center of the hair shaft—similar to the lead in a pencil.[34] The cortex surrounds the medulla and is the largest portion of the shaft. It contains melanin—pigment granules responsible for the hair's color.[35] The outermost layer of the shaft is the cuticle, a transparent layer of cells that overlap and tightly layer the cortex to protect it.[36] The cuticle, which is found in the hair that is attached to the scalp, also helps remove dirt and dead cells from the area.[37]

B. The Forensic Examination

There are three main types of forensic hair analysis: (1) checking the hair shaft for drugs or nutritional shortcomings in an individual system, (2) testing

25. Molly McAdams, *What is the Function of Human Hair?*, HEALTHFULLY, (Dec. 5, 2018), https://healthfully.com/what-is-the-function-of-human-hair-4102770.html [https://perma.cc/ERG7-YF8N].

26. O'Rahilly, Muller, Carpenter, & Swenson, *Basic Human Anatomy, Chapter Four: The Skin, Hair and Nails*, DARTMOUTH MED. SCH. (2008), https://www.dartmouth.edu/~humananatomy/part_1/chapter_4.html [https://perma.cc/TY7B-RSRB].

27. Bertino, *supra* note 14, at 51.

28. *Id.*

29. *Id.*

30. *Id.*

31. *Id.*

32. Bertino, *supra* note 14, at 51.

33. *Id.* at 52.

34. *Id.*; *Forensic Science Communications,* FED. BUREAU OF INVESTIGATION (Apr. 2009), https://archives.fbi.gov/archives/about-us/lab/forensic-science-communications/fsc/april2009/review/2009_04_review02.htm.

35. Bertino, *supra* note 14, at 52.

36. *Id.*

37. *Id.*; Bilgen Erdogan, *Anatomy and Physiology of Hair*, INTECH (May 3, 2017), https://www.intechopen.com/books/hair-and-scalp-disorders/anatomy-and-physiology-of-hair [https://perma.cc/JA97-VX5T].

the DNA obtained from the hair root, and (3) microscopically examining the hair to ascertain if the sample is from a specific person or animal.[38]

A microscopic examination, the most controversial use of a forensic hair analysis, allows scientists to evaluate the morphological characteristics of the strand. These features historically provided examiners with a variety of information about the hair being analyzed.[39] By looking at a shaft of a hair, analysts can use the cuticle, cortex, and medulla to gain information about the strand. For example, examiners can determine length, color, and curliness of the hair.[40] Microscopically, the scientist can analyze scale type of the cuticle, the pattern of the medulla, and pigmentation of the cortex.[41] Examining the direction of the scales on the cuticle can also tell examiners which end of the shaft is older or younger, information which can be beneficial in determining the extent of chemical treatment to the hair, or the scales can be used to ascertain whether the hair is from a human or animal.[42]

The appearance of the medulla allows a forensic examiner to classify hair into one of five categories. The five different medulla patterns are: continuous, interrupted, fragmented or segmented, solid, and none.[43] Scientists can also classify a hair sample into one of the six types of hair that grows on the body based upon the appearance of the shaft. They are: head hair, eyebrows and eyelashes, beard and mustache hair, underarm hair, auxiliary or body hair, and pubic hair.[44] Additional information that can be gleaned includes the race of the source, whether the hair was pulled out or if it fell out naturally, and whether the hair was crushed or cut.[45]

In the past, once the basic information about the hair had been obtained, scientists compared the hair of unknown origin against a sample hair from a known source to determine if the hairs were similar and if they had originated from the same person.[46] Similarity was determined by use of a pattern-recognition process to compare the microscopic characteristics of the unknown hair to the sample hair, and then identifying similar patterns of characteristics along each part of the shafts. Examiners used this pattern-recognition process in a step-by-step manner as they moved along the shafts from one end to the

38. *Under the Microscope: Get Forensic with Hair Analysis,* CAROLINA, https://www.carolina.com/teacher-resources/Interactive/forensic-hair-analysis-activity/tr10879.tr [https://perma.cc/E39S-K3E6] (last visited Mar. 28, 2019).

39. *Forensic Science Communications, supra* note 34.

40. Bertino, *supra* note 14, at 56.

41. *Id.*

42. *Id.* at 52.

43. *Id.* at 53.

44. *Id.*

45. Paul C. Giannelli, *Microscopic Hair Comparisons: A Cautionary Tale* 2 (CASE W. RES. U. SCH. L. Working Paper No. 2010-17, April 2010), https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1588151 [https://perma.cc/7VAN-93SA].

46. *Forensic Science Communications, supra* note 34.

other.[47] No two hairs are exactly the same, so even if the strands are from the same source, there will be at least some difference in the characteristics along the length of the hairs.[48]

During the microscopic examination, the scientist examined the hair to determine which characteristics were similar to the sample and if the similarities outweighed the differences between the specimens.[49] There were usually two determinations resulting from the comparison hair of an unknown origin to a sample hair of known origin—the examiner would either determine that the specimens are "consistent with" each other or "microscopically indistinguishable."[50]

Based on whether the hairs are microscopically indistinguishable or consistent with one another, the ultimate conclusion of the analysis is: exclusion, association, or no conclusion.[51] Exclusion occurred when the differences in the microscopic characteristics of the collected strand and the known sample were greater than the similarities. The circumstances that rendered absolute exclusion, however, were limited. Two hair samples which are simply dissimilar cannot receive the absolute exclusion designation since there must be "certainty" that the two samples cannot be from the same source, such as a difference in race of the two specimens.[52] If the two hairs were simply dissimilar, the examiner noted that they were "not consistent" as originating from the same source rather than stating that they could not have come from the same source.[53] It is important to note that, although a microscopic hair comparison can show if a hair's characteristics are consistent with a hair sample, it is impossible to determine whether the hairs match.[54] In other words, the process can never result in personal identification of the hair to a source.[55]

Once an examiner made a determination concerning the microscopic hair comparison, the conclusions were to be verified by a second examiner.[56] The second examiner conducted an independent analysis of the hairs, and only if the second examiner reached the same conclusion as the first were the conclusions reported.[57] One must keep in mind, however, that the evaluation and conclusion of a microscopic hair analysis are subjective, including determining the relevant

47. *Id*.
48. *Id.*
49. Giannelli, *supra* note 45, at 3.
50. *Id.*
51. *Forensic Science Communications, supra* note 34.
52. *Id.*
53. *Id.*
54. Henry Lee and Elaine Pagliaro, *Is Hair Reliable Forensic Evidence?,* J. OF FORENSIC PATHOLOGY (Apr. 27, 2016), https://www.longdom.org/open-access/is-hair-reliable-forensic-evidence-jfp-1000e101.pdf.
55. *Forensic Science Communications, supra* note 34.
56. *Id.*
57. *Id.*

characteristics of hair as well as ascertaining the number of characteristics that are to be compared to provide well-founded results.[58] This limitation has resulted in a greater reliance on DNA testing, which has a higher scientific certainty.[59] Because no standards existed that addressed these major components of the analysis, they were left largely to the discretion of the examiner.[60] Analysts might also have weighed characteristics differently in their evaluation, or they might have used slightly different terms to describe the microscopic hair analysis—further adding to the subjectivity of the practice. Nevertheless, the FBI maintained that "if two examiners have been trained properly, possess adequate experience, and use proper procedures, they should reach the same conclusion."[61]

II. THE DOWNFALL OF MICROSCOPIC HAIR ANALYSIS

Microscopic hair analysis was commonly used by the FBI starting in the late 1970s.[62] In turn, the courts routinely allowed the introduction of such evidence through the 1990s as prosecutors used forensic experts to offer opinions about hair characteristics and comparisons, despite scientific shortcomings, and they did not perform mitochondrial DNA testing to confirm the test's results.[63] Although some flaws in microscopic hair analysis were known, the process was at times used over DNA testing, which is a far more reliable method used to link defendants to crimes.[64] This occurred when DNA testing was deemed too time consuming, too expensive, or was, for some other reason, unavailable.[65]

Government witnesses also overstated what the technique could accomplish and juries were unduly swayed by this forensic tool.[66] The problem was compounded because the courts routinely accepted hair analysis into evidence

58. Jim Norton, William E. Anderson & George Divine, *Flawed Forensics: Statistical Failings of Microscopic Hair Analysis*, SIGNIFICANCE, Apr. 8, 2016, at 27.

59. Kate Robertson, Dennis McNevin & James Robertson, *STR Genotyping of Exogenous Hair Shaft DNA*, 39 AUSTL. J. FORENSIC SCI. 107, 107 (2007).

60. Norton, *supra* note 58, at 27.

61. *Forensic Science Communications, supra* note 34.

62. Norton, *supra* note 58, at 27.

63. *Id.*; Jessica Hamzelou, *Hair Analysis on Trial After FBI Admits to Using Flawed Evidence,* NEW SCIENTIST (Apr. 20, 2015), https://www.newscientist.com/article/dn27386-hair-analysis-on-trial-after-fbi-admits-to-using-flawed-evidence/ [https://perma.cc/XS79-TQXG].

64. *FBI Testimony on Microscopic Hair Analysis Contained Errors in at Least 90 Percent of Cases in Ongoing Review*, FED. BUREAU OF INVESTIGATION (Apr. 20, 2015), https://www.fbi.gov/news/pressrel/press-releases/fbi-testimony-on-microscopic-hair-analysis-contained-errors-in-at-least-90-percent-of-cases-in-ongoing-review [https://perma.cc/JJ33-G7TG].

65. *Id.*

66. Bridget Brennon, *FBI Admits Decades of Forensic Hair Analysis Evidence Was Wrong, Hundreds of Criminal Trials to be Reviewed,* ABC NEWS (Apr. 21, 2015), https://www.abc.net.au/news/2015-04-21/fbi-admits-decades-of-forensic-hair-analysis-evidence-wrong/6410448 [https://perma.cc/PL7T-MYZC].

and would not entertain attacks on the science on the basis that the tests failed to meet the *Frye*[67] or *Daubert*[68] standards of general acceptance in the relevant scientific community. For example, the Kentucky Supreme Court took judicial notice that hair analysis was scientifically accurate,[69] and the Supreme Court of Hawaii opined that "[b]ecause the scientific principles and procedures underlying hair [analysis] are well-established and of proven reliability, the evidence . . . can be treated as 'technical knowledge.' Thus, an independent reliability determination was unnecessary."[70]

The wheels of the wagon started to fall off 2012 when *The Washington Post* published a story indicating that defective forensic hair matches may have resulted in the finding of guilt in hundreds of potentially innocent suspects since the 1970s.[71] This revelation should not have been a surprise because several critical articles had already been published and a number of convictions involving forensic hair analysis had been reversed. For instance, the DOJ maintained that forensic hair analysis was a valid and reliable scientific technique based upon three studies conducted in the 1970s.[72] This pronouncement, however, failed to note that those studies were roundly criticized by the scientific community because of flawed methodology.[73] A 1990 paper by the Royal Canadian Mounted Police Forensic Laboratory noted that the low false positive rate in forensic hair analysis could be the result of examiner bias in that the examiners were aware that the hair strands being looked at came from different people so they could be influenced to search for differences.[74]

In 1994, the DOJ set up a task force to review the cases of one overzealous government witness.[75] This analysis ascertained that FBI examiners generated inaccurate forensic evidence in court on a number of occasions. Rather than

67. *See* Frye v. United States, 293 F. 1013 (D.C. Cir. 1923).

68. *See* Daubert v. Merrell Dow Pharmaceuticals, Inc., 509 U.S. 579 (1993).

69. Johnson v. Commonwealth, 12 S.W.3d 258, 261–63 (Ky. 1999); Paul Giannelli & Emmie West, *Hair Comparison Evidence*, CASE W. RES. SCH. L.: SCHOLARLY COMMONS, 514, 520 (2001).

70. State v. Fukusaku, 946 P.2d 32, 44 (Haw. 1997); Giannelli & West, *supra* note 69, at 520–21.

71. Spencer Hsu, *FBI Admits Flaws in Hair Analysis Over Decades*, WASH. POST (Apr. 18, 2015), https://www.washingtonpost.com/local/crime/fbi-overstated-forensic-hair-matches-in-nearly-all-criminal-trials-for-decades/2015/04/18/39c8d8c6-e515-11e4-b510-962fcfabc310_story.html?utm_term=.d7e375ec943b [https://perma.cc/U2VX-EDX9].

72. PRESIDENT'S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY, EXEC. OFFICE OF THE PRESIDENT, REPORT TO THE PRESIDENT- FORENSIC SCIENCE IN CRIMINAL COURTS: ENSURING SCIENTIFIC VALIDITY OF FEATURE-COMPARISON METHODS 13, 118 (2016).

73. *Id.* at 118.

74. *Id.* at 118–19.

75. Spencer Hsu, *Convicted Defendants Left Uninformed of Forensic Flaws,* WASH. POST (Apr 16, 2012), https://www.washingtonpost.com/local/crime/convicted-defendants-left-uninformed-of-forensic-flaws-found-by-justice-dept/2012/04/16/gIQAWTcgMT_story.html [https://perma.cc/U3LP-3FYH].

notifying the involved defendants of the mistakes, the DOJ only made their findings available to the prosecutors whose cases were involved.[76] Two years later, the DOJ reported that twenty-eight people, several of whom had been convicted based upon hair analysis, had been exonerated as the result of DNA testing. An article published in 2002 discussed a review of cases between 1996 and 2000 that compared microscopic hair analysis with the results of mitochondrial DNA (mtDNA) sequencing and found that mtDNA typing is much more accurate.[77] This study concluded by noting that the best way to conduct a forensic examination is to combine a microscopic analysis with mtDNA sequencing.[78] In 2009, the National Academy of Sciences released a report which described the practice of using microscopic hair analysis to link defendants to crimes as "highly unreliable."[79] Even so, the practice of using microscopic hair analysis continued.[80]

Several court cases also highlighted the difficulties with this type of forensic evidence. One such matter involved Roger Coleman, who was executed in 1992 for a killing in which questions still persist about the defendant's innocence and the government's use of hair analysis.[81] Even though the technique's results are subjective, the district attorney told the Coleman jury that based upon the scientific evidence, and the comparison of the pubic hair, "It would be extremely unlikely that anyone else would have hair that would be consistent with this hair."[82] As the trial judge subsequently noted during an interview, the prosecution's expert never compared the hair found on the victim with anyone other than the defendant.[83]

In *People v. Linscott*, the defendant was accused of murdering Karen Phillips, who was found slain in her apartment with hairs found both in her hand and on her pubic region.[84] Linscott lived in a building immediately next to where the victim resided and gave the police a voluntary sample of his blood and hair.[85] He was subsequently arrested and convicted of the murder based upon these specimens that were said to be "consistent with" those found on the victim.[86] This conviction was reversed on appeal because of egregious statements made

76. *Id.*

77. Max Houck & Bruce Budowle, *Correlation of Microscopic and Mitochondrial DNA Hair Comparisons,* 47 J. FORENSIC SCI., 1, 1 (2002).

78. *Id.* at 4.

79. *FBI Testimony on Microscopic Hair Analysis Contained Errors in at Least 90 Percent of Cases in Ongoing Review*, *supra* note 64.

80. *Id*.

81. Coleman v. Thompson, 501 U.S. 719, 725 (1991).

82. Paul C. Giannelli, *Scientific Evidence: Splitting Hairs in the Shadow of the Gallows*, 17 CRIM. JUST. 30, 31 (2003).

83. *Id.*

84. People v. Linscott, 566 N.E.2d 1335, 1356–57 (Ill. 1991).

85. *Id.* at 1357.

86. *Id.*

by the district attorney during closing argument concerning the blood and hair comparisons. Counsel claimed that the hair found at the scene was identical to that of the defendant.[87] The state's expert, however, testified that he could not positively state the identity of the person matching the sample.[88] The prosecutor's misrepresentation about the evidence was made even worse when he stated that the mathematical probabilities that the strands discovered on the decedent's body and in her apartment came from someone other than the defendant were "minuscule."[89] No such statistical evidence for this representation existed.[90]

The death knell for microscopic hair analysis in a forensic context occurred in April 2015 when the FBI issued a bombshell admission that members of its staff had provided inaccurate testimony dealing with microscopic hair analysis for more than twenty years, thereby leading to the conviction of innocent people.[91] This statement followed a trio of exonerations in the District of Columbia between 2009 and 2012, in which the defendants were convicted based upon FBI microscopic hair comparisons which turned out to be incorrect following mitochondrial DNA examinations.[92] These exonerations led to a comprehensive review of cases involving microscopic hair analysis by the FBI and the DOJ, in collaboration with the Innocence Project and the National Association of Criminal Defense Lawyers (NACDL).[93]According to the FBI, the review was conducted to "ensure that FBI Laboratory examiner testimony regarding microscopic hair analysis met accepted scientific standards."[94] Specifically, the review consisted of cases involving FBI expert testimony and reports containing scientifically invalid statements.[95]

87. *Id.* at 1358.

88. *Id.*

89. Linscott*,* 566 N.E.2d at 1359.

90. *Id.*

91. Drahl, *supra* note 10, at 2.

92. *FBI Agents Gave Erroneous Testimony in at Least 90% of Microscopic Hair Analysis Cases,* INNOCENCE PROJECT (Apr. 20, 2015), https://www.innocenceproject.org/fbi-agents-gave-erroneous-testimony-in-at-least-90-of-microscopic-hair-analysis-cases/ [https://perma.cc/9X7Z-VPRR]; Coburn Dukehart, *Flawed Hair Evidence Leads to Convictions,* POST CRESCENT: WIS. CTR. FOR INVESTIGATIVE JOURNALISM (Apr. 30, 2017), https://www.postcrescent.com/story/news/investigations/2017/04/30/innocent-people-convicted-flawed-evidence/100974186/ [https://perma.cc/MB46-E7BD].

93. *FBI Agents Gave Erroneous Testimony in at Least 90% of Microscopic Hair Analysis Cases, supra* note 92.

94. *FBI/DOJ Microscopic Hair Comparison Analysis Review*, CRIM. JUST. INFO. SERV. (June 10, 2016), https://www.fbi.gov/services/laboratory/scientific-analysis/fbidoj-microscopic-hair-comparison-analysis-review [https://perma.cc/P577-PYR6].

95. *FBI Agents Gave Erroneous Testimony in at Least 90% of Microscopic Hair Analysis Cases, supra* note 93.

The results of the review were released along with an FBI confirmation that its "analysts committed widespread, systematic error, grossly exaggerating the significance of their data under oath with the consequence of unfairly bolstering the prosecution's case."[96] Almost 3,000 files were flagged in which FBI analysts may have submitted reports or offered testimony at trials using microscopic hair analysis.[97] Unfortunately, nine people whose findings of guilt were partially based on improper hair analysis evidence had already been executed and another five died in prison.[98] As for the cases flagged, the FBI closely evaluated approximately 500 in which FBI examiners either submitted reports or testified at trials regarding their use of microscopic hair analysis.[99] Interestingly, despite the embarrassing and erroneous testimony by its agents, the FBI opined: "It's important to note that microscopic hair comparison analysis is a valid scientific technique still conducted by the FBI Laboratory."[100] The FBI further noted that the "science of microscopic hair comparisons is not the subject of the review."[101] Rather, the focus of the evaluation is specifically whether the testimony and reporting of FBI laboratory examiners has met accepted scientific standards.[102]

This review determined that the testing by FBI examiners in at least ninety percent of the trial transcripts examined contained erroneous statements.[103] Further, the law enforcement agency found that twenty-six out of twenty-eight FBI agents/analysts provided erroneous statements in either trial testimony or in laboratory results.[104]

The FBI continued to examine its files to correct the mistakes premised upon faulty hair analysis, but these cases are only the tip of the iceberg, because the review does not include tests performed by state and local crime labs, which will only increase the numbers of those wrongfully convicted.[105] The FBI has also agreed to conduct free DNA testing in matters where there is a court order or a

96. *FBI Testimony on Microscopic Hair Analysis Contained Errors in at Least 90 Percent of Cases in Ongoing Review*, *supra* note 64.

97. *Id.*

98. Seth Augenstein, *Hair Analysis Review: Dozen States Looking at Criminal Cases*, FORENSIC MAGAZINE (Jan. 6, 2017), https://www.forensicmag.com/news/2017/01/hair-analysis-review-dozen-states-looking-criminal-cases [https://perma.cc/G2ZL-J4CY].

99. *FBI Testimony on Microscopic Hair Analysis Contained Errors in at Least 90 Percent of Cases in Ongoing Review*, *supra* note 64.

100. *FBI/DOJ Microscopic Hair Comparison Analysis Review*, *supra* note 94.

101. *Id.*

102. *Id.*

103. *FBI Testimony on Microscopic Hair Analysis Contained Errors in at Least 90 Percent of Cases in Ongoing Review, supra* note 64.

104. *Id.*

105. Todd Fries, *In the Know: FBI Admits Flaws in Hair Microscopy Testimony*, SANTA CLARA U. SCH. OF L. (May 6, 2016), https://law.scu.edu/northern-california-innocence-project/in-the-know-fbi-admits-flaws-in-hair-microscopy-testimony/ [https://perma.cc/Q8EM-XFSN].

request for DNA testing by the prosecution.[106] The DOJ took the additional remedial step of agreeing not to raise procedural objections, for example: a statute of limitations objection to petitions from defendants requesting a new trial on the basis of faulty hair evidence.[107] This agreement, however, is limited to federal cases, and each state must decide on its own whether it will follow the DOJ's determination not to raise procedural objections.[108] Jurisdictions including Iowa, Massachusetts, and Arizona have started reviews of their microscopic hair analysis cases, while some states, such as Wisconsin, have not and treat files on a case by case basis.[109] Virginia is reviewing its cases in which examiners testified that hair belonged to a specific person because that state considers such testimony to be flawed in that the science is unable to conclusively correlate any single hair specimen to a person.[110] The inherent difficulty with this review is that there are almost one million files in Virginia alone to examine between 1973 and 1994.[111]

The efforts of the FBI to review the remaining files in which forensic hair analysis may have been improperly used stopped in 2017 when Attorney General Jeff Sessions suspended the investigation at the same time that he disbanded an Obama appointed Forensic Science Commission that was trying to improve forensic science standards.[112] Instead, Sessions claimed that he was going to appoint an in-house advisor and establish an internal committee to look at ways to improve forensic analysis.[113]

106. *Microscopic Hair Comparison,* CALIFORNIA INNOCENCE PROJECT (2019), https://californiainnocenceproject.org/issues-we-face/microscopic-hair-comparison/ [https://perma.cc/DCU6-2ASA].

107. *Id.*

108. *Id.*

109. Katherine Proctor*, State Won't Review Flawed FBI Hair, Fiber Cases*, WIS. CTR. FOR INVESTIGATIVE JOURNALISM (Nov. 3, 2017), https://urbanmilwaukee.com/2017/11/03/flawed-forensics-state-wont-review-flawed-fbi-hair-fiber-cases/ [https://perma.cc/Q239-NWFW].

110. *Testimony Worth the Second Look*, DAILY PRESS, (Nov. 24, 2018), http://www.dailypress.com/news/opinion/editorials/dp-edt-dna-evidence-1125-story.html [https://perma.cc/6YZN-69FY].

111. *Id.*

112. Spencer Hsu, *Sessions Orders Justice Department to End Forensics Science Commissions, Suspends Review Policy*, WASH. POST (Apr. 10, 2017), https://www.washingtonpost.com/local/public-safety/sessions-orders-justice-dept-to-end-forensic-science-commission-suspend-review-policy/2017/04/10/2dada0ca-1c96-11e7-9887-1a5314b56a08_story.html [https://perma.cc/KE3K-JFTL].

113. Sadie Gurman, *Sessions Says Justice Department Will End Forensic Science Commission,* PBS NEWS HOUR (Apr. 10, 2017), https://www.pbs.org/newshour/nation/sessions-says-justice-department-will-end-forensic-science-commission [https://perma.cc/B5FJ-78W2].

III. CURRENT PRACTICES

Hollywood continues to solve crimes in its movies and television shows by linking a strand of hair found at a crime scene to a suspect, but law enforcement infrequently uses hair analysis as a current forensic technique. It is generally limited to those occasions when DNA can be obtained from a hair sample. For instance, starting in 2000, the FBI began using mitochondrial DNA in hair comparisons.[114] The Director of the FBI explained this change in the following manner: statements made by examiners in court "went beyond the limits of science in ways that put more weight on a hair comparison than scientifically appropriate. Hair is not like fingerprints, because there aren't studies that show how many people have identical-looking hair fibers."[115]

There are two key components of hair used for DNA purposes. The part of the hair that is visible above the skin contains much less genetic information than the invisible element under the epidermis.[116] This means that the part generally needed for DNA testing is the hair follicle.[117]

While most hairs discovered at a crime scene provide low quality and/or small quantities of nuclear DNA,[118] testing of genetic material consists of three methods. The first is Y-DNA, which looks at the male-gender-linked Y chromosome for components that are transmitted in a direct path from father to son.[119] The next method is autosomal DNA (atDNA), which analyzes the chromosomes, with the exception of the gender-linked X and Y parts of the DNA, which are examined to help link cousins across sex.[120] The last method is mitochondrial DNA (mtDNA), which looks for chromosomes that are passed by the female line from mother to children but which can only be transmitted by a daughter.[121]

Nuclear DNA cannot be extracted from the hair shaft since it is generally absent from this part of the strand. However, it can successfully be obtained from the hair root because this part includes keratinocytes: cells which are perfect for the removal of genetic material.[122] As a caveat, a cut or natural piece of hair may

114. Letter from James Comey, Director of the FBI, to U.S. State Governors, FED. BUREAU OF INVESTIGATION (June 10, 2016), https://www.fbi.gov/file-repository/second-governor-letter-061016.pdf/view.

115. *Id.*

116. Judy Russell, *DNA and The Locks of Hair*, THE LEGAL GENEALOGIST (June 3, 2012), https://www.legalgenealogist.com/2012/06/03/dna-and-the-locks-of-hair/ [https://perma.cc/9PTV-Y8QQ].

117. *Id.*

118. Robertson et al., *supra* note 59, at 107.

119. Russell, *supra* note 116.

120. *Id.*

121. *Id.*

122. Caroline Hughes, *Challenges in DNA Testing and Forensic Analysis of Hair Samples,* FORENSIC MAGAZINE (Apr. 2, 2013, 8:42 AM), https://www.forensicmag.com/article/2013/04/challenges-dna-testing-and-forensic-analysis-hair-samples [https://perma.cc/YZ38-LLX3].

under certain circumstances be suitable for nuclear DNA hair analysis. The existence of certain biologically dead cells, or keratinocytes in their final stage of separation, may make it feasible to create a DNA profile from nuclear DNA.[123] Accordingly, in examinations of crime scenes where fastidious searches by investigators locate a single hair without the root or follicle, a DNA analysis will be undertaken even though the chance of finding a match is miniscule.[124]

On the other hand, mtDNA tests the mitochondria, which are located outside of the nucleus of the cell.[125] Therefore, examiners can perform a DNA analysis on a strand of hair that does not have a root or follicle attached, a process restricted to mitochondrial DNA.[126] MtDNA has a major limitation in that it is maternally inherited so profiles are unable to individualize between maternal relatives.[127] As noted in *Reid v. State*, mtDNA testing is a type of examination which is frequently used with specimens such as rootless hair samples that are not amenable to standard nuclear DNA testing.[128] This type of specialized analysis for forensic purposes was first done by the FBI in 1996[129] and is performed to exclude individuals as contributors of samples because it is likely to obtain a DNA type; it is a mitochondrial DNA profile which has a DNA sequence. This allows the government to eliminate a suspect as the contributor of the sample.[130] The main differentiation from nuclear DNA testing is that mtDNA is not a unique identifier; unlike nuclear DNA, which is located at the center of the human cell and which is inherited from both parents, only maternal ancestry exhibits the same mitochondrial profile.[131]

A novel application of forensic hair analysis that is currently being advanced involves the ability to infer physical traits or the travel history of an unidentified criminal or victim. For example, the percentages of hydrogen and oxygen isotopes in drinking water differ from one area to another and are retained in hair.[132] This allows an isotopic examination of hair to provide clues regarding where an individual has been in the preceding months or years, depending upon

123. *Id.*

124. *Id.*

125. Russell, *supra* note 116.

126. *Id.*

127. Robertson et al., *supra* note 59, at 108.

128. Reid v. State, No. CV020818851, 2003 WL 21235422, at *11 (Conn. Super. Ct. May 14, 2003).

129. *Id.* at *15.

130. *Id.* at *11.

131. *Id.* at *11.

132. Hanae Armitage & Nala Rogers, *Hair Forensics Could Soon Reveal What You Look Like, Where You've Been*, SCI. (Mar. 8, 2016, 12:30 PM), https://www.sciencemag.org/news/2016/03/hair-forensics-could-soon-reveal-what-you-look-where-you-ve-been [https://perma.cc/68F7-BM48].

the length of the hair.[133] This water-based isotopic information has helped identify the "region of origin" of skeletal remains, resulting in the subsequent identification of people.[134] It also has application as a diagnostic tool to test for past drug use or to look for long-term drug abuse through a segmental analysis. In fact, drug-hair analysis is becoming a reasonable option to the traditional urinalysis since a urine specimen offers only short-term data about drug consumption, while hair samples offer a greater window of detection in addition to a history of use over time.[135]

IV. COURTROOM USE

The sordid history of microscopic hair analysis has resulted in the near abandonment of this technique in most forensic cases unless DNA can be retrieved from the sample. Nevertheless, courts and government officials remain actively involved in reviewing past cases involving this flawed procedure, even when decades have elapsed since a conviction. For instance, on March 4, 2019, Delaware Attorney General Kathy Jennings announced that the state's Department of Justice had hired the Prosecutors' Centers of Excellence to undertake an impartial review of that state's cases dealing with hair evidence.[136]

On May 18, 2018, Richard Beranek, a 59-year-old man who had spent two decades in prison and was serving a 243-year sentence for rape, battery, and burglary, partially based upon the faulty work of the FBI in analyzing a hair sample, was exonerated.[137] The charges were dismissed by a Wisconsin Circuit Judge days after DNA testing of the crime scene evidence "revealed a distinct male DNA profile that was not Mr. Beranek's."[138] Another case resulted in a $13.2 million verdict as the result of a man who spent more than twenty-seven years in jail based upon a flawed FBI hair analysis.[139] The facts show that during

133. *Id.*

134. *Using Isotopes in Human Hair to Reveal Personal Characteristics for Forensic Investigations*, NAT'L INSTITUTE OF JUST. (Apr. 22, 2018), https://www.nij.gov/topics/forensics/evidence/trace/Pages/using-isotopes-in-human-hair-to-reveal-personal-characteristics.aspx [https://perma.cc/SUC9-BG7D].

135. Lata Gautam & Michael D. Cole, *Hair Analysis in Forensic Toxicology*, FORENSIC MAGAZINE (Sept. 3, 2013), https://www.forensicmag.com/article/2013/09/hair-analysis-forensic-toxicology [https://perma.cc/395V-66HH].

136. Nick Ciolino, *Delaware's DOJ Reviewing Criminal Cases Involving Hair Evidence,* DEL. PUB. MEDIA (Mar. 4, 2019), https://www.delawarepublic.org/post/delawares-doj-reviewing-criminal-cases-involving-hair-evidence [https://perma.cc/7Z99-9VWG].

137. Dee J. Hall, *Wisconsin Man, Casualty of Flawed Hair Forensics, Latest To Be Exonerated*, WIS. WATCH (May 18, 2018), https://www.wisconsinwatch.org/2018/05/wisconsin-man-casualty-of-flawed-hair-forensics-latest-to-be-exonerated/ [https://perma.cc/7PEG-PRRF].

138. *Id.*

139. Seth Augenstein, *Flawed FBI Hair Analysis Leads to $13.2 Million Wrongful Conviction Lawsuit,* FORENSIC MAGAZINE (Mar. 1, 2016), https://www.forensicmag.com/article/2016/03/flawed-fbi-hair-analysis-leads-132m-wrongful-conviction-lawsuit [https://perma.cc/KHF3-VJLJ].

a 1980 trial, prosecutors and their experts maintained that there was a "1-in-10 million chance" that the hairs discovered in a stocking near the crime scene belong to someone other than the defendant.[140] The defendant was subsequently freed following a DNA analysis that demonstrated the specimen belonged to someone else.[141] The multi-million-dollar award was based not only upon the number of years the defendant spent behind bars, but also to compensate him for contracting HIV, hepatitis, depression, and a heroin addiction during his confinement.[142]

The government, however, does not automatically exonerate a defendant or grant a new trial when it is discovered that flawed hair analysis evidence was presented. The defendant in most cases must still show that there is a reasonable likelihood that the forensic expert's admittedly false testimony could have affected the judgment of the jury.[143] This burden of proof has resulted in differing results as is demonstrated by several March 2019 appellate court decisions.

United States v. Ausby involved a man who in 1972 was charged with murder and rape.[144] The government introduced the testimony of a forensic expert at trial who asserted that the hairs discovered at the crime scene were microscopically the same as those of the defendant.[145] Although the expert conceded that "microscopic hair comparisons do not constitute a basis of positive identification," he went on to state that "the questioned hairs . . . either originated from the head of Mr. Ausby or from some other person . . . whose head or pubic hairs are microscopically identical."[146]

The defense conceded in closing that the defendant had been present in the victim's apartment two weeks earlier but maintained that Ausby was not there on the day of the crime.[147] The defense also challenged the reliability of the government's forensic expert linking Ausby's hairs to those found on the victim's body, but the prosecutor countered by asserting that "microscopic hair comparison analysis 'is not a positive means of identification but it amounts to a positive means [in this case.]'"[148] The jury convicted the defendant, and he was given a life sentence, which was upheld on appeal.[149]

140. *Id.*
141. *Id.*
142. *Id.*
143. Napue v. Illinois, 360 U.S. 264, 271–72 (1959).
144. United States v. Ausby, 916 F.3d 1089, 1090 (D.C. Cir. 2019).
145. *Id.*
146. *Id.* at 1091.
147. *Id.*
148. *Id.*
149. Ausby, 916 F.3d at 1089; United States v. Ausby, 489 F.2d 1273 (D.C. Cir. 1974) (unpublished table decision).

Thirty-eight years later, the FBI and DOJ started to look at cases in which the government had introduced evidence concerning microscopic hair comparison analysis to determine if the government's expert gave false or misleading testimony that had exceeded the limits of science.[150] That undertaking revealed that the government's witness in the *Ausby* trial had misled the jury by inferring that he could positively state that the comparison hairs belonged to the defendant.[151] The government waived any statute of limitations defense, and the matter proceeded to a hearing in an attempt to vacate Ausby's conviction on the basis that the defendant's due process rights were violated by the knowing presentation of false and misleading expert hair analysis.[152] The prosecution admitted that the government's witness provided inaccurate hair identification testimony, but took no position regarding whether that testimony was material to the defendant's conviction.[153]

The court started its review by noting that the standard in these types of cases is whether the false testimony "could in any reasonable likelihood have affected the judgment of the jury."[154] This requirement does not mandate that the defendant demonstrate "that he more likely than not would have been acquitted absent the false statements. Rather, the defendant need show only that the false testimony undermines confidence in the verdict."[155] In this case, the false hair comparison evidence was not the sole element of proof relied upon by the prosecution, but the testimony was material to the verdict. The testimony was the primary evidence that contradicted the defendant's theory that he had not been in the apartment on the day of the incident.[156] Also, the agent's testimony that while microscopic hair analysis is not a positive means of identification, it amounted to a positive means in this case was emphasized during the government's closing argument.[157] In the absence of this false testimony, there is a reasonable likelihood the jury could have accepted the defendant's theory of innocence. Therefore, Ausby's conviction was vacated.[158]

A similar result was achieved in *Jones v. United States*.[159] Jones was convicted of armed robbery in 1996 partially based upon the testimony of an FBI witness who stated that the defendant's hair matched that found in a hat left at the crime scene.[160] This testimony supported the identification of Mr. Jones

150. Ausby, 916 F.3d at 1091–92.
151. *Id.* at 1092.
152. *Id.*
153. *Id.*
154. *Id.* (internal quotations omitted).
155. Ausby, 916 F.3d at 1092–93 (internal quotations omitted).
156. *Id.* at 1094–95.
157. *Id.* at 1095.
158. *Id*.
159. Jones v. United States, 202 A.3d 1154, 1157 (D.C. 2019).
160. *Id.*

as the perpetrator, which was the main issue in the dispute.[161] The court noted in its decision to vacate the conviction that in the years since the trial, the validity of microscopic hair analysis had been undermined, especially in view of DNA evidence which had contradicted those findings.[162] Furthermore, the National Research Council of the National Academy of Sciences had criticized the methodological deficiencies of hair comparison identification and opined that there is "no scientific support for the use of hair comparison for individualization in the absence of nuclear DNA."[163]

The defendant argued that his conviction violated his due process rights because it was based upon false evidence.[164] A twist in the case developed when the government was unable to find the hair evidence so that it could be produced for DNA testing, as requested by the defense.[165] In any event, the FBI's expert testified at trial that a hat found at the scene contained hairs that matched those of the defendant. He further opined that while a hair comparison "[is] 'not like a fingerprint' and 'not a basis for absolute personal identification,'" it is extremely rare to locate two people whose hairs he could not distinguish.[166]

In granting a new trial, the court noted that during the original proceeding in 1996, microscopic hair comparisons were generally accepted as a valid scientific technique.[167] This changed in 2009 when a report was issued identifying the deficiencies in the science, including the lack of a statistical foundation to support the findings.[168] In this case, the court concluded there was a reasonable possibility that the expert's misleading testimony swayed the jury to convict the defendant. The expert's unrefuted hair comparison constituted "powerful, independent, 'scientific' proof positively identifying appellant as the robber to a high degree of certainty . . . that [the defendant] had no [ability] to rebut."[169]

The following cases reached the opposite conclusion. In *People v. Jeffries*, the court ruled that a motion for DNA testing of a hair sample would not significantly advance the defendant's claim of innocence. [170] The facts reveal that two men forced their way into an apartment while the victims were sleeping and took their money and drugs.[171] Neither victim could provide a description of what the attackers looked like beyond providing an accounting of their sex,

161. *Id.*
162. *Id.* at 1161–62.
163. *Id.* at 1162.
164. Jones, 202 A.3d at 1157.
165. *Id*. at 1163.
166. *Id.* at 1157, 1168–69.
167. *Id.* at 1161.
168. *Id.* at 1161–62.
169. Jones, 202 A.3d at 1168.
170. People v. Jeffries, No. 2-16-1095, 2019 WL 1075626, at *1 (Ill. App. Ct. Mar. 5, 2019).
171. *Id.*

build, and race.[172] A police officer noticed a vehicle occupied by two men near the apartment in question and shone a spotlight on the car, which then accelerated away.[173] A chase ensued, and the car was identified as belonging to the defendant.[174] A subsequent search of the apartment uncovered a glove that contained a hair. DNA testing determined that the hair was a mixture of at least two people.[175] No other testing of the hair was performed.[176] The state built its case against the defendant entirely upon the testimony of another suspect who had pled guilty and circumstantial evidence as the result of the identification of the defendant's car during the police chase.[177] The defendant was found guilty and sentenced to two, twenty-six-year prison terms.[178]

The defendant filed a Motion for a DNA Database search in 2015 claiming that the hair on the glove should have been checked for DNA since if a genetic profile was discovered of a person other than him, it would prove his innocence.[179] The court noted that DNA testing is allowed upon a determination that the results would have the ability to provide new and noncumulative evidence materially relevant to the defendant's innocence.[180] Any such testing in this case would not significantly advance the claim of innocence by the defendant. The co-conspirator's testimony against the petitioner was corroborated by the presence of the defendant's car near the scene of the crime and the vehicle's subsequent flight during the police chase.[181]

Vasquez-Velasco v. United States involved a defendant who was convicted of aiding and abetting in the 1985 murder of two American tourists in Mexico.[182] A motion for relief was filed by the defense in 2016 based upon the false information provided by an FBI expert about hair analysis. The expert testified at the trial that fifteen characteristics are needed to make a valid hair comparison.[183] The defendant argued that this claim lacked scientific support.[184] The defendant further maintained that because the United States acknowledged in another trial that the testimony of the government witness was false, that admission should apply to his case. The court disagreed because unlike the other

172. *Id.* at *2.
173. *Id.*
174. *Id.*
175. Jefferies, 2019 WL 1075626, at *2.
176. *Id.*
177. *Id.*
178. *Id.*
179. *Id.* at *3.
180. Jefferies, 2019 WL 1075626, at *3.
181. *Id*. at *3–4.
182. No. LA CV16-09685 JAK and No. LA CR87-00422 JAK (12), 2019 WL 1359732, at *1 (N.D. Cal. Mar. 25, 2019).
183. *Id.* at *8.
184. *Id.*

case, the testimony was not used to place the defendant at the crime scene.[185] The court noted that to vacate a conviction based upon false evidence presented by the government, it must be shown that the testimony was false, the prosecution knew or should have known that is was false when presented at trial, and the false testimony was material to the conviction.[186]

The evidence presented at the defendant's trial was focused on his link to a Mexican cartel, the fact that he participated in the murders because he worked as a bodyguard for leaders of the cartel, that he participated in trafficking activities, that he took part in the beatings of the victims, and that the murders were part of a retaliation effort by the Cartel against Drug Enforcement Administration enforcement actions.[187] The FBI forensic expert did not present any testimony pertaining to these assertions.[188] Therefore, the evidence was sufficient to convict the defendant without any reference to the tainted hair analysis.[189]

V. CONCLUSION

Microscopic hair analysis has been used by the government for decades and many defendants have been found guilty based upon this forensic tool. The problem is that no one can state with a proper degree of certainty how often particular hair characteristics are discovered in the population, and no uniform determination has been made as to what constitutes a match. Nevertheless, microscopic hair analysis continued to be used despite these scientific shortcomings. In fact, the forensic test was so widely used by the prosecution that the courts routinely accepted the results into evidence and would not entertain attacks on the technique based upon the test's failure to meet the *Frye* or *Daubert* standards of general acceptance in the scientific community.

A growing number of organizations became suspicious of forensic hair analysis in the 1990s as the result of DNA sequencing and started to issue critical reports of the test's accuracy. This included the National Academy of Sciences that described the attempt to link a suspect to a crime by microscopic hair analysis as highly unreliable. The use of this investigative tool finally unraveled as the result an exposé by *The Washington Post* that disclosed a history of flawed testimony by FBI witnesses that resulted in the conviction of innocent people who were subsequently cleared by DNA testing. This prompted the FBI to admit that members of its staff had provided inaccurate testimony dealing with microscopic hair analysis for more than 20 years. Following the exoneration of a trio of defendants in the District of Columbia, a comprehensive review of

185. *Id.* at *9.
186. *Id.*
187. *Vasquez-Velasco,* 2019 WL 1359732, at *10.
188. *Id.*
189. *Id.* at *19.

thousands of cases involving forensic hair analysis was launched by the FBI and DOJ, along with the Innocence Project and NACDL, in an attempt to correct any miscarriages of justice. The repercussions of those reviews and requests by defendants to be exonerated because of faulty hair analysis evidence continue to this day, despite the passage of decades since conviction. The lesson to be learned by this scandal is that a routine investigative tool has now been relegated to the status of junk science and demonstrates how the lack of a proper foundation will eventually be exposed through scientific advancements.