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## Flawed Forensics: Cautionary Tales from Our Criminal Justice Past

Marisa Tisbo

The criminal justice system has come a long way in the investigation of crime.<sup>1</sup> From nineteenth century phrenology to today's forensics and DNA sciences, advances in technology have greatly assisted how we interpret evidence left at a crime scene in order to determine the perpetrator.<sup>2</sup> While forensic science has been able to provide indisputable evidence in many cases, it is not perfect.<sup>3</sup> More often than not, forensic science has also been tied to wrongful convictions.<sup>4</sup> Is forensic science being misapplied? Are we over-relying on a flawed science, and is it contributing to erroneous convictions of innocent people?

### WHAT IS FORENSIC SCIENCE METHODOLOGY?

Forensic science is the application of certain sciences (such as physics, chemistry, biology, computer science, and engineering) to matters of law.<sup>5</sup> Forensic science plays an important role in the criminal justice system by providing scientifically based information.<sup>6</sup> This is done through the analysis of physical evidence.<sup>7</sup> Forensic science helps to prove elements such as the existence of a crime, the perpetrator of a crime, or connections to a crime through several different factors.<sup>8</sup> These factors include the examination of physical evidence, the administration of tests, the interpretation of data, reporting, and the testimony from experts and forensic scientists.<sup>9</sup> Forensic science is an enormous field. The field is organized into Forensic Toxicology, Forensic DNA Analysis, Forensic Psychology, Trace Evidence Analysis, Forensic Entomology (the study of insects), Forensic Odontology (the study of dental knowledge),

<sup>1</sup> *Forensic Sciences*, THE NATIONAL INSTITUTE OF JUSTICE, <https://www.nij.gov/topics/forensics/pages/welcome.aspx>.

<sup>2</sup> *Id.*

<sup>3</sup> *Id.*

<sup>4</sup> *Misapplication of Forensic Science*, THE INNOCENCE PROJECT, <https://www.innocenceproject.org/causes/misapplication-forensic-science/>.

<sup>5</sup> *Id.*

<sup>6</sup> *Id.*

<sup>7</sup> *Id.*

<sup>8</sup> *Id.*

<sup>9</sup> *What is Forensics?*, CRIME SCENE INVESTIGATOR EDUCATION, <https://www.crimesceneinvestigatoredu.org/what-is-forensic-science/>.

Forensic Pathology, and many more.<sup>10</sup> The American Academy of Forensic Sciences describes forensic science as “a vital tool in the search for the truth in any legal proceeding.”<sup>11</sup> Furthermore, “scientific analyses and tests conducted by qualified forensic scientists can exonerate as well as convict an accused person.”<sup>12</sup> Generally, forensic science is used in two parts of the criminal justice system’s process: the investigation and the prosecution.<sup>13</sup> The investigation “seeks to identify the likely perpetrator of a crime, and the prosecution “hopes to prove the guilt of a defendant beyond a reasonable doubt.”<sup>14</sup> More recently, however, forensic science has also been used for challenging past convictions.<sup>15</sup>

#### HOW DOES THE APPLICATION OF FORENSIC SCIENCE GO WRONG?

Although forensic science can be a wonderful tool in assisting the criminal justice system, it also has its downfalls.<sup>16</sup> The misapplication of forensic science is the second most common contributing factor in wrongful convictions.<sup>17</sup> In fact, The Innocence Project found evidence of flawed forensic testing in 45% of DNA exoneration cases.<sup>18</sup> The Innocence Project uses the phrase “misapplication of forensic science” to describe a variety of ways that forensic testing can go wrong.<sup>19</sup> These misapplications include unreliable or invalid forensic discipline, insufficient validation of a method, misleading testimony, mistakes, and misconduct.<sup>20</sup>

Unreliability in forensics occurs because some forensic methods used cannot consistently produce 100% accurate results all of the time.<sup>21</sup> The insufficient validation of a certain forensic method has a similar problem: although some methods are capable of producing consistent and accurate results, there

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<sup>10</sup> *Id.*

<sup>11</sup> *What is a Forensic Scientist*, AMERICAN ACADEMY OF FORENSIC SCIENCES, <https://www.aafs.org/home-page/students/choosing-a-career/whats-a-forensic-scientist/>.

<sup>12</sup> *Id.*

<sup>13</sup> *Forensic Science in Criminal Courts*, PRESIDENT’S COUNCIL OF ADVISORS ON SCIENCE AND TECHNOLOGY 1, 5 (September 2016).

<sup>14</sup> *Id.*

<sup>15</sup> *Id.*

<sup>16</sup> *Misapplication of Forensic Science*, *supra* note 4.

<sup>17</sup> *Id.*

<sup>18</sup> *Id.*

<sup>19</sup> *Id.*

<sup>20</sup> *Id.*

<sup>21</sup> *Id.*

has not been enough research to establish their validity.<sup>22</sup> Also, forensic testimony can sometimes overexaggerate or oversimplify evidence, omit certain factors in analyses, or determine that something is “inconclusive.”<sup>23</sup> Testimony that is based on methods that have never been subjected to a “meaningful scientific scrutiny” also poses a problem due to a lack of research and testing to establish validity.<sup>24</sup> Additionally, forensic scientists are human, and they make mistakes.<sup>25</sup> Some of these mistakes include the mixing up of samples or possible contamination, both of which can occur no matter how developed or trusted that forensic method is.<sup>26</sup> Lastly, there have also been cases where some forensic scientists have fabricated results by lying about evidence, hiding evidence, or reporting results that have not been tested.<sup>27</sup>

#### DNA EXPERT DR. KARL REICH’S TAKE ON FAULTY FORENSICS

Dr. Karl Reich is a highly experienced and widely respected forensic scientist and DNA expert. Dr. Reich shared with me his views on methods of forensic science that go wrong and why. He stated, “There is certainly some statistical analysis of wrongful convictions that quantify the various possible errors that contributed to the conviction: eye witnesses, prosecutor misconduct, forensic analysis, etc.”<sup>28</sup> Dr. Reich then explained to me that there are various fields in forensics “that have strongly contributed to wrongful convictions – some of which are pure junk.” He says that several come to mind here: bite marks, ballistic lead analysis, and hair analysis.<sup>29</sup> These have “absolutely no scientific foundation,” he says.<sup>30</sup> Furthermore, there are fields that could be “properly used,” he explains, “but the decree of quackery is widespread; here arson and blood spatter come to mind.”<sup>31</sup>

Dr. Reich also described to me what the so-called “pattern sciences” are. Pattern sciences include tooth marks, footprints, tire impressions, fingerprints, and ballistics.<sup>32</sup> He says these methods “fundamentally lack a scientific founda-

<sup>22</sup> *Id.*

<sup>23</sup> *Id.*

<sup>24</sup> *Forensic Science in Criminal Courts*, *supra* note 13 at 6.

<sup>25</sup> *Id.*

<sup>26</sup> *Misapplication of Forensic Science*, *supra* note 4.

<sup>27</sup> *Id.*

<sup>28</sup> Interview with Dr. Karl Reich, Forensic Scientist and DNA Expert, Independent Forensics DNA Testing and Technologies (March 27, 2019).

<sup>29</sup> *Id.*

<sup>30</sup> *Id.*

<sup>31</sup> *Id.*

<sup>32</sup> *Id.*

tion and have been allowed to continue as hobbies rather than an analytical process.”<sup>33</sup> With pattern sciences, Dr. Reich explains, “the ‘pattern’ of one item is compared to the ‘pattern’ of another and some conclusions as to the similarity is opined.”<sup>34</sup> He further stated that analytical measurement is required, “but essentially non-existent in all of these fields.”<sup>35</sup> “Some method of pattern measurement is required and is completely lacking,” he explains, and “some standards for making the images that are used are required, again completely lacking of statistical support for any conclusions.”<sup>36</sup> Yet, as Dr. Reich puts it, “these ‘experts’ are anointed in all of these sub-disciplines.”<sup>37</sup>

#### POSSIBLE SOLUTIONS FOR FORENSICS LEADING TO WRONGFUL CONVICTIONS

Although forensic science can have serious downfalls, our justice system is working on combating this problem.<sup>38</sup> For example, in 2015 President Barack Obama asked his Presidential Council on Science and Technology (“PCAST”) to investigate what steps could be taken that could possibly strengthen forensic science and better ensure its validity when used in our legal system.<sup>39</sup> In a report entitled *Forensic Science in Criminal Courts: Ensuring Scientific Validity of Feature- Comparison Methods*, the Council on Science and Technology found that there are two important gaps in forensic science.<sup>40</sup> The first gap is the need for clarity “about the scientific standards for the validity and reliability of forensic methods.”<sup>41</sup> The second is the need to “evaluate specific forensic methods to determine whether they have been scientifically established to be valid and reliable.”<sup>42</sup>

Further, the PCAST report laid out the scientific criteria for establishing the foundational validity and reliability of different forensic methods.<sup>43</sup> PCAST defines foundational validity as requiring that “it be shown, based on empirical studies, to be repeatable, reproducible, and accurate, at levels that

<sup>33</sup> *Id.*

<sup>34</sup> *Id.*

<sup>35</sup> *Id.*

<sup>36</sup> *Id.*

<sup>37</sup> *Id.*

<sup>38</sup> *Forensic Science in Criminal Courts*, *supra* note 13 at 1.

<sup>39</sup> *Id.*

<sup>40</sup> *Id.*

<sup>41</sup> *Id.*

<sup>42</sup> *Id.*

<sup>43</sup> *Id.*

have been measured and are appropriate to the intended application; in other words, foundational validity requires that a method can be reliable.<sup>44</sup> There are four essential points of foundational reliability. They are as follows:

1. The report states that foundational validity “requires that a method has been subjected to empirical testing by multiple groups, under conditions appropriate to its intended use.”<sup>45</sup> The report goes on to say that the studies must first demonstrate that “the method is repeatable and reproducible, and secondly, provide valid estimates of the method’s accuracy (how often the method reaches an incorrect conclusion) that indicate the method is appropriate to the intended application.”<sup>46</sup>
2. For objective methods, the foundational validity of the forensic method can be established by “studying and measuring the accuracy, reproducibility, and consistency of each of its individual steps.”<sup>47</sup>
3. When it comes to subjective feature-comparison methods, the report explains that “because the individual steps are not objectively specified, the method must be evaluated as if it were a ‘black box’ in the examiner’s head.”<sup>48</sup> This terminology means that evaluations of validity and reliability “must therefore be based on ‘black box studies,’ in which many examiners render decisions about many independent tests.”<sup>49</sup>
4. The report concludes this section by stating that, without “appropriate estimates of accuracy,” an examiner’s statement that two samples are similar is “scientifically meaningless.”<sup>50</sup> It will be considered to have no probative value, and “also has considerable potential for prejudicial impact.”<sup>51</sup>

A forensic method must be established as foundationally valid based on appropriate empirical studies.<sup>52</sup> Once foundational validity has been established, “claims about the method’s accuracy and the probative value of pro-

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<sup>44</sup> *Id.* at 4.

<sup>45</sup> *Id.* at 6.

<sup>46</sup> *Id.*

<sup>47</sup> *Id.*

<sup>48</sup> *Id.*

<sup>49</sup> *Id.*

<sup>50</sup> *Id.*

<sup>51</sup> *Id.*

<sup>52</sup> *Id.*

posed identifications, in order to be valid, must be based on such empirical studies as well.”<sup>53</sup> Statements that claim or imply greater certainty than what is demonstrated by the empirical evidence would be scientifically invalid.<sup>54</sup> PCAST recommends that forensic scientists and examiners “should report findings of a proposed identification with clarity and restraint, explaining in each case that the fact that two samples satisfy a method’s criteria for a proposed match does not mean that the samples are from the same source.”<sup>55</sup>

Validity is defined as meaning to show “that the method has been reliably applied in practice, and that an expert has reliably applied the principles and methods to the facts of the case.”<sup>56</sup> Two tests must be satisfied to meet the scientific criteria for validity as applied:

1. First, the forensic examiner must have been shown to “be capable of reliably applying the method and must actually have done so.”<sup>57</sup> The report emphasizes that demonstrating that an expert is capable of reliably applying the method is crucial, especially for subjective methods.<sup>58</sup> This is especially important for subjective methods, as human judgment plays a fundamental and central role.<sup>59</sup> The report explains that, from a scientific standpoint, the ability to reliably apply a method is demonstrated “only through empirical testing that measures how often the expert reaches the correct answer.”<sup>60</sup>
2. Secondly, the practitioner’s assertions about “the probative value of proposed identifications” has to be scientifically legitimate.<sup>61</sup> To demonstrate this, the report states that the expert should “report the overall false-positive rate and sensitivity for the method established in the studies of foundational validity and should demonstrate that the samples used in the foundational studies are relevant to the facts of the case.”<sup>62</sup> Lastly, where applicable, the report suggests that the expert should “report the probative value of the observed match based on the specific features observed in the case, and make no claims or

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<sup>53</sup> *Id.*

<sup>54</sup> *Id.*

<sup>55</sup> *Id.*

<sup>56</sup> *Id.* at 5.

<sup>57</sup> *Id.*

<sup>58</sup> *Id.*

<sup>59</sup> *Id.*

<sup>60</sup> *Id.*

<sup>61</sup> *Id.*

<sup>62</sup> *Id.*

implications that go beyond the empirical evidence and the applications of valid statistical principles to that evidence.”<sup>63</sup>

PCAST heavily emphasizes the fact that nothing can substitute for actual evidence of foundational validity and reliability when authenticating a forensic method, not even experience, judgment, or good professional practices.<sup>64</sup> An expert’s expression of confidence that is based on personal professional experience, or other expressions of consensus among other experts in that specific field is also not a proper substitute for foundational validity and reliability.<sup>65</sup> As PCAST perfectly summarizes the point, “. . . for forensic feature-comparison methods, establishing foundational validity based on empirical evidence is thus a *sine qua non*. Nothing can substitute for it.”<sup>66</sup>

#### FORENSIC ODONTOLOGY AND BITE MARK EVIDENCE ANALYSIS

Although different types of forensic science have been tied to wrongful conviction cases, forensic odontology and the identification of bite marks is one of the most controversial of all the methods.<sup>67</sup> Forensic odontology is the application of the science of dentistry to the field of law, and it includes areas of focus such as the identification of unknown remains through dental records, bite mark comparison, and the interpretation of an oral injury.<sup>68</sup> Bite mark evidence is the process by which a forensic odontologist matches teeth marks found at a crime scene with the dental impression of a suspect.<sup>69</sup> If a victim seems to have been bitten during a crime and the police have a suspect, the odontologist can attempt to match those bite marks to the suspect’s teeth.<sup>70</sup> Although bite mark evidence is widely used in criminal prosecutions, there is no real scientific support, evidence, or research that validates its accuracy or reliability.<sup>71</sup>

<sup>63</sup> *Id.*

<sup>64</sup> *Id.* at 6.

<sup>65</sup> *Id.*

<sup>66</sup> *Id.*

<sup>67</sup> Committee on Identifying the Needs of the Forensic Sciences Community, *Strengthening Forensic Science in the United States: A Path Forward*, NAT’L ACAD. PRESS 1, 173 (2009).

<sup>68</sup> *Id.*

<sup>69</sup> *Bite Mark Evidence*, CALIFORNIA INNOCENCE PROJECT, <https://californiainnocenceproject.org/>.

<sup>70</sup> *Id.*

<sup>71</sup> *Id.*



The American Board of Forensic Odontology (“ABFO”) encompasses most forensic odontologists, offers board certification to its members, and is recognized by the American Academy of Forensic Science as a forensic specialty.<sup>72</sup> The ABFO has approved guidelines for the collection of evidence from bite mark victims, as well as suspected biters.<sup>73</sup> These guidelines list a large number of analysis methods such as transillumination of tissue, computer enhancement and digitalization of bite marks and teeth, histology, and many more.<sup>74</sup> It is not the techniques that are controversial, but rather the bite marks themselves.<sup>75</sup> Bite marks on the skin will change over time, and they are often warped and distorted by several factors.<sup>76</sup> These factors which severely limit the validity of forensic odontology include the elasticity of human skin, swelling, healing, the unevenness of a surface bite mark, and changes in the teeth of a suspect over time.<sup>77</sup> Because of these changes, even when experts use the same ABFO guidelines for bite mark analysis, different experts often produce varying results.<sup>78</sup>

Bite mark analysis is also *subjective* to the person that is evaluating that evidence.<sup>79</sup> Expert testimony on bite mark analysis is usually based on that expert’s experience and their particular method of analysis of the bite mark in question.<sup>80</sup> Similarly, there is no central repository of bite marks and bite patterns, and no thorough study has ever been done on a large population to establish any uniqueness in different bites.<sup>81</sup> Also, although bite mark analysis is often compared to DNA in terms of accuracy, there has been no actual scientific validation for the idea that a person’s bite marks and dentition are unique to them in the same way that one’s fingerprints or DNA would be.<sup>82</sup> Research is needed in order to identify the circumstances within which methods of forensic odontology can provide any probative value.<sup>83</sup>

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<sup>72</sup> Committee on Identifying the Needs of the Forensic Sciences Community, *supra* note 59 at 173.

<sup>73</sup> *Id.*

<sup>74</sup> *Id.* at 174.

<sup>75</sup> *Id.*

<sup>76</sup> *Id.*

<sup>77</sup> *Id.*

<sup>78</sup> *Id.*

<sup>79</sup> *Bite Mark Evidence*, *supra* note 61.

<sup>80</sup> Committee on Identifying the Needs of the Forensic Sciences Community, *supra* note 59 at 176.

<sup>81</sup> *Id.* at 174.

<sup>82</sup> *Bite Mark Evidence*, *supra* note 61.

<sup>83</sup> Committee on Identifying the Needs of the Forensic Sciences Community, *supra* note 59 at 176.

Lastly, as with other “experience-based” forensic methods, bite mark analysis has potential for a great amount of bias.<sup>84</sup> Bias often occurs in cases where police provide suspects for comparison analysis with a limited number of models from which to choose from in comparing that evidence.<sup>85</sup> Additionally, bite marks are often associated with highly sensationalized and prejudicial cases; these include cases of homicide, sexual assault, and child abuse.<sup>86</sup> Due to the nature of these cases, there can be an enormous amount of pressure on the forensic odontologist/expert to match a bite mark to a certain suspect.<sup>87</sup> Unfortunately, the use of a second expert and a second opinion is not widely used.<sup>88</sup>

### CONCLUSION

It is the strict adherence to authenticating different forensic methods that will ensure their validity, strength, and legitimacy. This adherence to authenticity will help us to improve how we incorporate them into our legal system. Unfortunately, the overreliance on unreliable, invalid methods is what often leads to wrongful convictions. Of course, scientific errors can never be fully eliminated, and none of these methods are infallible. Forensic science is, after all, conducted by humans, and humans err. Mix-ups, contamination, errors in reporting, and incorrect interpretation will occur, but this human error can be minimized through adherence to proper standards. It is also important to remember that many forensic methods are subjective; however, error can be minimized through multiple, appropriately designed black-box studies (as PCAST recommended in *Forensic Science in Criminal Courts*).

We must also work to scientifically validate forensic methods in order to ensure that their potential is being put to proper use and to minimize error. Our criminal justice system is forever growing and changing, and technology comes and goes. Forensic science is an invaluable tool to better assist us in seeking justice, but it must be yielded with great caution. Forensic science when tested incorrectly or conducted improperly can lead to an erroneous conviction, and that is one of the greatest miscarriages of justice that we face today.

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<sup>84</sup> *Id.* at 174.

<sup>85</sup> *Id.*

<sup>86</sup> *Id.* at 175.

<sup>87</sup> *Id.*

<sup>88</sup> *Id.*