

Review

Forensic odontology: Wrong convictions, “bad apples” and “the innocence files”

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ABSTRACT

Forensic odontology (FO) provides expert testimony; however, new criticism has identified FO as one of the fields that must strengthen its scientific foundations. The recent Netflix documentary titled “The Innocence Files”, featuring wrongful convictions, dedicates three of its nine episodes almost exclusively to bite mark identification (BMI), one of the most questioned tests performed by FO. Although most of the FO fields have an undoubted utility in forensic and juridical context, only BMI has been questioned in recent years; the derogatory expression “Junk science” is used continuously in the documentary almost as a synonym for FO. We present a scoping review of cases reported in the US National Registry of Exonerations in which FO was false or misleading forensic evidence (F/MFE) leading to wrongful convictions. Although in the 26 cases identified the only declared F/MFE was the BMI (excluding any other type of dental expertise), only in 2 cases (7.69%) was F/MFE the sole contributing factor, and in 4 cases (15.38%) there was F/MFE plus three additional factors. Official misconduct was detected in 19 cases (73.08%) and perjury or false accusation in 16 cases (61.54%). It has already been mentioned how dangerous it is to consider FO as synonymous with “bite mark identification”, or even to publicly provide incorrect or decontextualized information. This review shows that erroneous convictions have been exclusively in the field of BMI, and that FO encompasses much more than just BMI. The relationship between the media and forensic sciences has been strained. The perspective of the new culture of risk management in forensics is also discussed.

1. Introduction

For decades, forensic science has produced valuable evidence, contributing to the successful prosecution and conviction of criminals and the exoneration of innocent people. However, the inappropriate use of expert evidence has been reported as one of the main factors explaining erroneous convictions and system errors, with strong criticism of the methods used for identification.¹ In its pivotal report “*Strengthening Forensic Science in the United States: a Path Forward*”, the National Academy of Science (NAS) listed some forensic scientific disciplines that have been called into question: firearm and toolmark identification, shoeprint identification, analysis of hair evidence, questioned document examination, even fingerprint analysis (among many others). These have been questioned for their untested scientific foundations and their subjective and unverifiable natures. According to that

report, bite mark identification (BMI) has been criticized for basically the same reasons, so the report recommended that its scientific bases be strengthened to produce admissible evidence under Daubert.² BMI is just one of the areas that forensic odontology (FO) addresses, along with identification based on dental characteristics, age estimation in presumed minors, interpretation of oral injury, and dental malpractice. The NAS report clarifies from the initial definition of FO that this discipline is well established among forensic science disciplines, and that *only the field of BMI is controversial for the scientific community*.²

On April 15, 2020, the entertainment company Netflix, Inc., aired “*The Innocence Files*”, a 9-episode documentary miniseries about wrongful convictions.³ The series is based upon the work of the Innocence Project, a nonprofit legal organization founded in 1992 by Barry Scheck and Peter Neufeld. The show is brought to the screen by a starry line-up of directors -including an Oscar winner- and powerfully depicts

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not only the misapplication of science but also the effects on the lives of these victims of the system.⁴ For the audience, *"The Innocence Files"* "is one of the best true crime series ever made", showing high acceptance scores by critics.^{5,6}

Although the series is presented in three sections of three episodes each ("misuse of forensic evidence", "false eyewitness testimony" and "prosecutorial misconduct"), the first section focuses almost exclusively on BMI. This singular perception is even highlighted by Neufeld in episode 2 of the show: "Levon (Brooks) and Kennedy (Brewer)'s cases were landmark cases for us. We didn't have any real experience with bite marks until then. We found that it wasn't just an outlier, it wasn't just a bad apple, it was the whole profession of forensic odontology" (minute 47:50 of the episode). The concept of "junk science", an expression invoked as spurious or fraudulent scientific data, is used continuously in the documentary almost as a synonym for FO. However, the 2009 NAS report highlights the controversial use of that term, and in the particular case of FO; although it reaffirms the need for standardization, deep investigation and validation, these weaknesses are recognized exclusively in one of its focus areas, the BMI.²

Given that the validity and foundation of all forensic identification techniques, with the exception of DNA analysis, have been called into question,^{1,2} and that FO, "the application of the science of dentistry to the field of law", includes other areas of focus beyond BMI,² we present a scoping review of cases reported in the US National Registry of Exonerations in which FO or dental evidence was false or misleading forensic evidence leading to wrongful convictions. The conceptual, legal and media scopes of this critical paradigm for forensic odontology are also discussed.

2. Methods

The National Registry of Exonerations is a project of the University of California Irvine Newkirk Center for Science & Society, University of Michigan Law School & Michigan State University College of Law.⁷ The mission of the National Registry of Exonerations is "to provide comprehensive information on exonerations of innocent criminal defendants in order to prevent future false convictions by learning from past errors".⁸ The Registry collects, analyzes, and shares detailed information on all known exonerations of convicted criminals cleared in the U.S. from 1989 to the present. The general public can freely access the database, which provides valuable information on each of the cases. The legal basis for the exemptions is classified into one or more categories defined by the Registry: I) Mistaken witness identification; II) False Confession; III) Perjury or False Accusation; IV) False or Misleading Forensic Evidence; V) Official Misconduct; and VI) Inadequate Legal Defense. It has been mentioned that, "Recognizing there is no standard definition of 'wrongful conviction' or a national database of cases identified as 'wrongful convictions', the Registry provides an invaluable source for reviewing and analyzing a select number of cases of criminal defendants who have been falsely convicted".⁹ The National Registry of Exonerations has an algorithm that allows, in a simple and intuitive way, to perform searches, order the results in ascending or descending order, and select values or "tags" in particular to search and order the cases that meet common characteristics.

The search objective was to identify exonerations where the "False or Misleading Forensic Evidence" (F/MFE) leading to the wrongful conviction must have been produced by dentists or dental evidence of some kind according to the standards defined by the NAS report for the FO²; therefore, a search was carried out on the platform of The National Registry of Exonerations for the terms "bite" "mark" "bitemark" "dental" "dentist" "mouth" "odontologist" "odontology" "teeth" "tooth" using the Boolean operator "OR" and the filter "F/MFE" provided by the system to select only those cases where the contributing factor was "False or Misleading Forensic Evidence". Two calibrated observers conducted the search and each of the cases was analyzed according to the categories offered by the system: "Most serious crime", "Contributing Factors",

"Sentence", "Time served in prison" (according to the dates of conviction and exoneration), "Questioned dental expertise" (according to the consensus of the authors, both odontologists with forensic training and skills) and if the "DNA evidence contributed to the exoneration". The information was contrasted with general information and resources provided by the system.

3. Results

The search was conducted on September 30, 2020 and the case selection process was carried out up to October 4, 2020. Fig. 1 shows the totals and percentages of exonerations by contributing factor reported by The National Registry of Exonerations as of October 4, 2020. Out of a total of 2674 exonerations, 654 (24.46%) F/MFE was the contributing factor. Using the search terms together with the Boolean logic operator "OR" and the filter "F/MFE", the search yielded a total of 26 cases in which forensic odontology or dental evidence was the cause of wrongful convictions (Table 1).

In 19 cases, murder was the most serious crime, and the longest sentences were life in 11 cases and death in 4 cases. Only 1 case (a conviction for an alleged sexual assault) had a sentence of less than 15 years. Regarding time served in prison, this ranged from 2 years to 35 years, with an average of 16.35 years. The years served in prison by Steven Chaney (Case #4; 32 years.), Keith Harward (Case #8; 33 years), Gary Cifizzari (Case #5; 35 years) and Robert DuBoise (Case #7; 35 years) should be highlighted, with DuBoise being the last exoneration to the date of this review. The first conviction was in 1983 (Keith Harward) and the last was in 2006 (Case #23; Crystal Weimer), with a distribution close to 1 case per year (1.13), and a maximum of 4 convictions in 1987, and of 3 convictions in 1992 and 2001 each. There were fifteen convictions (57.69%) between 1987 and 1995 alone.

BMI was exclusively the only questioned dental expertise in the 26 cases, considered as the F/MFE declared in the Registry (100%). However, in only 2 cases (7.69%) was F/MFE the sole contributing factor. Table 2 shows the distribution of F/MFE and other contributing factors in the other 24 cases. Official misconduct (OM) in 19 cases (73.08%) and Perjury or false accusation (P/FA) in 16 cases (61.54%) are worth noting. Although in 19 cases (73.08%) DNA evidence contributed to the exoneration, the Registry indicates that 6 of these cases were not included in the Innocence Project's list of DNA exonerations because post-conviction DNA evidence was not central to establishing innocence, and other non-DNA factors were essential to the exoneration. Expert discrepancy and the discredited expert (both linked to BMI) were factors that led to exoneration in 4 cases (15.38%) each.

4. Discussion

Avon et al. (2010) made it clear that, beyond the error rate in the BMI, the real meaning of attributing the wrong dentition to a bite mark is that it "would be analogous to inculcating an 'innocent' person", which constitutes "a critical error" in the procedure. The authors claim that even the best-trained experts can make these critical mistakes, both individually and collectively,¹⁰ which has already been demonstrated by the history of BMI. Although a sentence may have nothing to do with truth, the impact of these critical errors on the lives of the 26 people identified in this review cannot be denied, all of whom were unfairly convicted and the vast majority of whom lost the best years of their lives behind bars. This is the view that has served as the basis for the continuous improvement in forensic science practices strongly recommended by the NAS report: to protect "innocent persons from being convicted of crimes that they did not commit".² That same report recommends exposing many forensic tests to stringent scientific scrutiny, dedicating significant efforts to training, education, standards development, and certification programs. Of course, BMI is among the techniques called into question according to the NAS report, together with firearm and toolmark identification, shoeprint identification, ear print

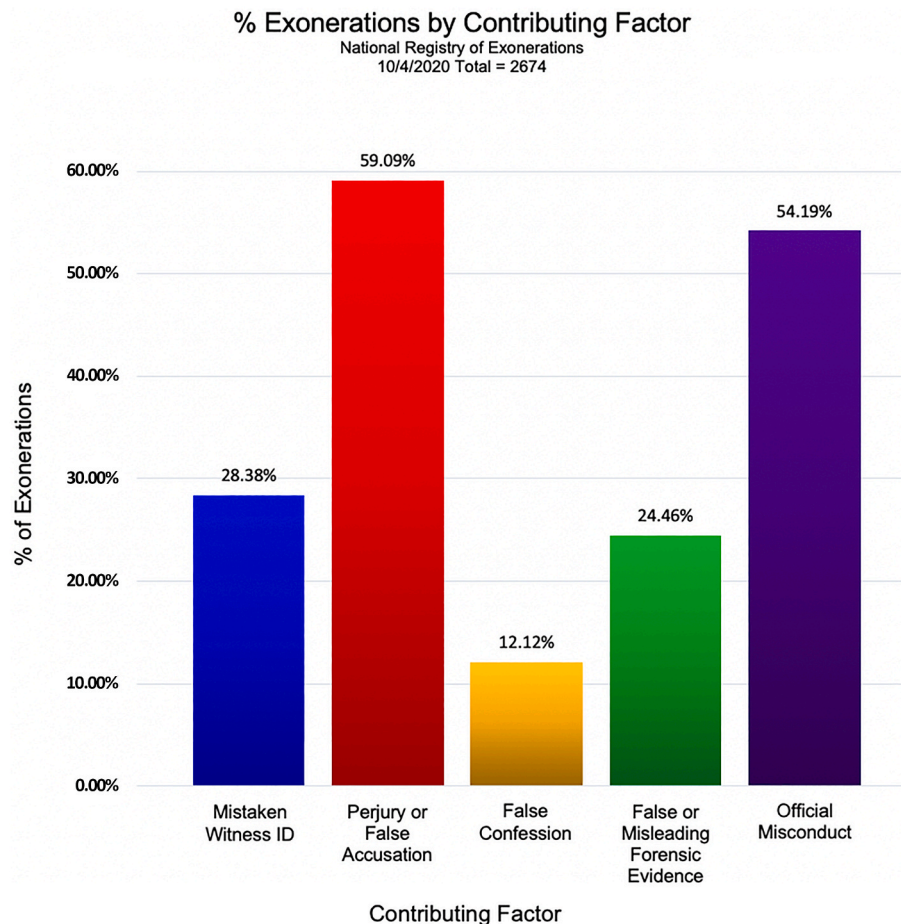


Fig. 1. Percentage of exonerations by contributing factor.

identification, analysis of hair evidence, analysis of fiber evidence, questioned document examination, explosives evidence, even fingerprint analysis, and many others.² We agree with Hamer and Edmond (2019) that, curiously, these traditional forensic sciences are rarely discussed in decisions.¹¹

The widely cited and discussed article by Saks and Koehler already highlighted in 2005 that “there has been remarkably little research on the accuracy of traditional forensic sciences”¹; one of the bite mark cases identified in this review [Case #12]¹² is cited by these authors in addition to the renowned misidentification of Brandon Mayfield made by FBI fingerprint examiners, the significant error rates of microscopic hair comparisons (12%), spectrographic voice identification (63%), or handwriting (40–100%). However, the disastrously high rates of association between erroneous forensic science expert testimony and wrongful convictions reported by Saks and Koehler (63% for forensic science testing errors and 27% for false/misleading testimony by forensic scientists)¹ appear to have improved as reported figures from the National Registry of Exonerations indicate (Fig. 1). This reading requires further analysis as it is obviously superficial: with 24.46% as a contributing factor of exoneration, the F/MFE category on the Registry currently includes those based “at least in part on forensic information that was (a) caused by errors in forensic testing, (b) based on unreliable or unproven methods, (c) expressed with exaggerated and misleading confidence, or (d) fraudulent”.¹³ It would be interesting to delve into these subcategories and contrast them with the results reported by Saks & Koehler.¹ Citing research by academics from the American University and the University of San Francisco and warning about inconsistencies in publicly available data, LaPorte (2017) states that “without a comparison or control group of cases, researchers risk labeling these factors

as ‘causes’ of erroneous convictions when they may be merely correlates”.¹⁴

It has been claimed that it is “dangerous” that only FO is exposed to public derision as the “culprit for misidentifications”.¹⁵ Writing for the Journal of the National Institute of Justice (NIJ), LaPorte states that the forensic methods most frequently currently associated with wrongful convictions are forensic biology (serology, 76 cases) and microscopic hair examination (61 cases), distant and more worrying rates than the 10 bite mark cases in that report,¹⁴ even more than the 26 cases as of the date of this review. Specifically in terms of bite mark cases, LaPorte draws attention to the smallness of the data set used to reach relevant conclusions, and the results of this review coincide with his report: “From 1985 to 1998, 10 cases involved bite mark examinations; seven of these cases involved official misconduct. Thirty percent (three) of the cases also included mistaken eyewitness identification, which is significantly less than the percentage of cases involving forensic serology and microscopic hair examination. In half of these cases, analyses performed by defense experts actually exculpated the exonerees; however, the data set is too small to reach any significant conclusions”.¹⁴ Table 2 shows 92.31% of cases in which BMI included other contributing factors: official misconduct (73.08%) and perjury or false accusation (61.54%). There are different ways of looking at these figures; we also agree with LaPorte that ambiguity in the narrative, generalization of causes, and even (accidental or intentional) discrepancies in the data reported contribute to an incorrect perception of forensic science.¹⁴

4.1. Junk science: the noun beyond the adjective

What is forensic science? According to the 2009 NAS report, the term

Table 1

Cases reported in The National Registry of Exonerations in which forensic odontology or dental evidence was false or misleading forensic evidence leading to wrongful convictions. Categories of Contributing Factors, according to The National Registry of Exonerations: **F/MFE**= False or Misleading Forensic Evidence; **OM**= Official Misconduct; **P/FA**= Perjury or False Accusation; **MWID**= Mistaken Witness Identification; **FC**= False Confession; **ILD**= Inadequate Legal Defense.

| Case # | Name | Most serious crime | Contributing Factors | Questioned dental expertise | Sentence | Convicted/Exonerated (Time served in prison) | Did DNA evidence contribute to the exoneration? |
|--------|-----------------------|--------------------|-----------------------|-----------------------------|---------------------|--|---|
| 1 | Brewer, Kennedy | Murder | F/MFE, OM, P/FA | Bite mark evidence | Death | 1995/2008 (13 yrs) | Yes |
| 2 | Brooks, Levon | Murder | F/MFE, OM, MWID | Bite mark evidence | Life without parole | 1992/2008 (16 yrs) | Yes ^c |
| 3 | Brown, Roy | Murder | F/MFE, OM, P/FA | Bite mark evidence | 25 to Life | 1992/2007 (15 yrs) | Yes |
| 4 | Chaney, Steven | Murder | F/MFE, OM, P/FA | Bite mark evidence | Life | 1987/2019 (32 yrs) | Yes ^c |
| 5 | Cifizzari, Gary | Murder | F/MFE, P/FA, FC, ILD | Bite mark evidence | Life without parole | 1984/2019 (35 yrs) | Yes |
| 6 | Cristini, Michael | Sexual Assault | F/MFE, OM, P/FA | Bite mark evidence | 44–60 years | 1991/2004 (13 yrs) | No ^a |
| 7 | DuBoise, Robert | Murder | F/MFE, OM, P/FA | Bite mark evidence | Death | 1985/2020 (35 yrs) | Yes |
| 8 | Harward, Keith | Murder | F/MFE, OM, P/FA, MWID | Bite mark evidence | Life | 1983/2016 (33 yrs) | Yes |
| 9 | Hill, Harold | Murder | F/MFE, OM, P/FA, FC | Bite mark evidence | Life without parole | 1994/2005 (11 yrs) | Yes ^c |
| 10 | Jackson, Willie | Sexual Assault | F/MFE, MWID | Bite mark evidence | 40 years | 1989/2006 (17 yrs) | Yes |
| 11 | Keko, Anthony | Murder | F/MFE, OM, P/FA | Bite mark evidence | Life | 1993/1998 (5 yrs) | No ^b |
| 12 | Krone, Ray | Murder | F/MFE, OM | Bite mark evidence | Death | 1992/2002 (10 yrs) | Yes |
| 13 | Moldowan, Jeffrey | Sexual Assault | F/MFE, OM, P/FA | Bite mark evidence | 60–90 years | 1991/2003 (12 yrs) | No ^a |
| 14 | O'Donnell, James | Sexual Assault | F/MFE, OM, MWID | Bite mark evidence | 3 1/2 to 7 years | 1998/2000 (2 yrs) | Yes |
| 15 | Richards, William | Murder | F/MFE | Bite mark evidence | 25 to life | 1997/2016 (19 yrs) | Yes |
| 16 | Richardson, Gerard | Murder | F/MFE | Bite mark evidence | 30 years | 1995/2013 (18 yrs) | Yes |
| 17 | Starks, Bennie | Sexual Assault | F/MFE, OM, P/FA | Bite mark evidence | 60 years | 1986/2013 (27 yrs) | Yes |
| 18 | Stinson, Robert Lee | Murder | F/MFE, ILD | Bite mark evidence | Life | 1985/2009 (24 yrs) | Yes |
| 19 | Stubbs, Leigh | Assault | F/MFE, OM | Bite mark evidence | 44 years | 2001/2013 (12 yrs) | No ^b |
| 20 | Swinton, Alfred | Murder | F/MFE, P/FA | Bite mark evidence | 60 years | 2001/2018 (17 yrs) | Yes ^c |
| 21 | Vance, Tammy | Assault | F/MFE, OM | Bite mark evidence | 44 years | 2001/2013 (12 yrs) | No ² |
| 22 | Washington, Calvin E. | Murder | F/MFE, OM, P/FA | Bite mark evidence | Life | 1987/2001 (14 yrs) | Yes |
| 23 | Weimer, Crystal | Murder | F/MFE, OM, P/FA | Bite mark evidence | 15–30 years | 2006/2016 (10 yrs) | No ^{a,b} |
| 24 | Wilhoit, Gregory | Murder | F/MFE, ILD | Bite mark evidence | Death | 1987/1993 (6 yrs) | No ^a |
| 25 | Williams, Joe Sidney | Murder | F/MFE, OM, P/FA | Bite mark evidence | Life | 1987/1993 (6 yrs) | Yes ^c |
| 26 | Young Jr., Dan | Murder | F/MFE, OM, P/FA, FC | Bite mark evidence | Life without parole | 1994/2005 (11 yrs) | Yes ^c |

^a Expert discrepancy.

^b Discredited expert.

^c The case is not included in the Innocence Project's list of DNA exonerations because post-conviction DNA evidence was not central to establishing innocence, and other non-DNA factors were essential to the exoneration.

Table 2

Contributing factors identified in the 26 cases reviewed.

| F/MFE: False or Misleading Forensic Evidence | 26/26 | (100%) |
|--|-------|----------|
| F/MFE (exclusively) | 2/26 | (7.69%) |
| F/MFE and other contributing factors | 24/26 | (92.31%) |
| OM: Official Misconduct | 19/26 | (73.08%) |
| P/FA: Perjury or False Accusation | 16/26 | (61.54%) |
| MWID: Mistaken Witness Identification | 4/26 | (15.38%) |
| FC: False Confession | 3/26 | (11.54%) |
| ILD= Inadequate Legal Defense | 3/26 | (11.54%) |

“forensic science” “encompasses a broad range of disciplines, each with its own distinct practices”.² That same report includes FO among the forensic science disciplines, defining it as the application of the *science of dentistry* [emphasis added] to the field of law. What appears to be a terminological subtlety has much greater significance from an epistemological point of view: a scientific discipline represents “the primary unit of internal differentiation in science”.¹⁶ According to Stichweh (2003), although the differentiation processes of science are occurring all the time, the scientific discipline remains a basic unit of structure formation, as a teaching-learning domain and even as an element for the

designation of occupational roles and professionals.¹⁶ In forensic science, this concept is envisioned by the NAS by implicitly stating the existence of hierarchies: forensic science disciplines *group* techniques, methodologies, processes and activities (in fact, forensic pathology is considered a *subspecialty* of medicine).² Along the same lines, after defining FO, the NAS mentions BMI as only one of the several distinct areas of focus of this science.² Hinging an *entire* forensic science discipline (the noun) as “junk” (the adjective) on the results of *only one* of its practices (BMI), results not only in an impromptu and confusing use of nouns and adjectives, but also in an absolutely distorted and dangerous representation of what FO is for the layman.¹⁵ As early as 1967, Roland stated that experts working in a certain field of knowledge can build incorrect grammatical constructions and their understanding is not really affected¹⁷; however, the outsider trying to learn and understand the topic can be confused by the paradoxical use of language.

The expression “junk science” has been and is used ubiquitously to explain problems in the law-science relationship. According to Edmond and Mercer (1998), “junk science is a convenient scapegoat for a deeper law-science conflicts” model, and is thus based on a possible lack of control in science and technology, oversimplifying the division between “junk” and “good” science.¹⁸ For the authors, the junk science model is

based on naive notions of the efficacy of science, the motivations of scientists, scientific norms and the scientific method itself. They claim that junk science is actually the result of a legal distortion of “normal” scientific practices, which makes discussion difficult in areas that are usually excluded (for example the efficacy of various sciences, their objectives, the ethics of their practitioners), discouraging constructive processes and possible learning from discussion, the catalyst for scientific growth. In short, the authors conclude that “the junk science model tends to convert what should be more visible political debates into narrow, inadequately framed, pseudo-epistemological debates”.¹⁸

For Roberts (2013), the simplistic image of Law and Science as opposites, each with its own institutions, experts and cultures, immediately vanishes when forensic science is recognized as an “inveterate hybrid” with mostly artificial and arbitrary divisions. Science must be carried out within the trammels of the law, and each professional participating in criminal proceedings must fully understand what their role, value and objectives are within the process.¹⁹ For the author, there are undoubtedly practical tensions between lawyers and forensic scientists; however, when science applies to the administration of criminal justice, by necessity the normative ideals of justice must be prioritized.¹⁹ This does not mean that the law must assume “unscientific” conceptions of truth or evidence, but that other epistemic concerns come to play a secondary role. Roberts asserts that the correct characterization of forensic science is crucial, and that the debate among scholars should not filter out of the appropriate spaces at the risk of reinforcing misconceptions or “myths” that only parody the system. According to Roberts, practitioners and academics should be prevented from transforming criminal justice ideals into their own practical achievements that undermine fruitful interdisciplinary collaboration.¹⁹ For Stichweh, the modern system of scientific disciplines is a highly dynamic system with an internal environment that offers ideas, methods and concepts seeking solutions within the reach of the disciplinary tradition itself in addition to a parallel environment of interdisciplinary science that arises from conflicts, provocations and stimuli generated by other disciplines, probably the most important factor in the dynamics of modern science.¹⁶

4.2. Standards and system defects

We agree with LaPorte that the chronology of convictions and exonerations should also be subjected to a linear and contextual analysis.¹⁴ In the case of BMI, the arrival of forensic genetics on the scene, the founding of The Innocence Project, and evidently the Daubert ruling²⁰ are all fundamental milestones that have radically changed the paradigm of forensic identification.^{21–23} Uniqueness, one of the assumptions for BMI, has not been scientifically established.² For Page et al., trying to demonstrate uniqueness is wasting resources and misunderstanding the real criticisms of the discipline: poor performances, lack of standards, bias and observer error.²³ Daubert represents the critical intersection point between science and law, by requiring that the admissibility of forensic evidence be based on contemporary scientific standards; however, for Bell et al. (2018) this poses a dilemma for prosecutors and even to some extent to law enforcement: there are situations in which past legal precedents are used to convince the courts to admit evidence that today would be seriously debatable. For these authors, the scientific community must make genuine efforts to counteract this pressure, while demanding scientific independence.²⁴

Much emphasis has been placed on the role played by expert competence or honesty in these wrongful convictions for BMI.^{25,26} This review identified discrepancies between experts and discredited experts in 4 cases (15.38%) each, none with DNA evidence contributing to the exoneration. Out of 10 failed cases of BMI, LaPorte highlights that 7 of them involved official misconduct, 3 included mistaken eyewitness identification and, in fact, in half of them the forensic analyses requested by the defense were those that “actually exculpated the exonerees”.¹⁴ For this author, presenting these cases only as F/MFE is insufficient.¹⁴ Even using guidelines and recommendations, different experts and

dental graduates provide very different results on the same bite mark, even in controlled comparative studies.^{2,10} It is important to note that none of the questioned cases (F/MFE) take into consideration the educational and practical experience of the expert, which would denote a necessary research variable (and even represent a significant difference in the progress and results of those cases). Dror and Cole state that bias is present in all forensic disciplines and in the most qualified examiners, and that “even the robust and newer forensic domain of DNA profiling is susceptible to biased interpretation”.²⁷ We agree with the author that forensic identification experts clearly have special skills and cognitive processes appropriate for pattern recognition, but that these processes are also vulnerable to error when issues within the domain of cognitive science such as visual cognition, experience and decision-making are included.²⁷ LaPorte offers clarity still further when he asserts that even though forensic misconduct is unacceptable and that forensic scientists must avoid being ambiguous in their reports by expressing their conclusions impartially and objectively, “errors are often unavoidable; when they do occur, it is critical to focus on the underlying problems that contributed to the event - and then to learn from the error. This is an especially challenging issue because the general tendency is to blame an individual”.¹⁴

“Human beings, in all lines of work, make errors. Errors can be prevented by designing systems that make it hard for people to do the wrong thing and easy for people to do the right thing”. This quote is from the opening paragraph of *To Err is Human: Building a Safer Health System*,²⁸ a report by the Institute of Medicine (IOM) (entity established by the NAS in 1970) as a call to action regarding the 44,000 to 98,000 annual deaths caused by medical errors in the United States. The document, published in 2000 and cited more than 20,000 times in the scientific literature, “changed the conversation to a focus on changing systems, stimulated a broad array of stakeholders to engage in patient safety, and motivated hospitals to adopt new safe practices”.²⁹ In Chapter 3, “Why do errors happen?”, the IOM report states, “the common initial reaction when an error occurs is to find and blame someone. However, even apparently single events or errors are due most often to the convergence of multiple contributing factors. Blaming one individual does not change these factors and the same error is likely to recur. Preventing errors and improving safety for patients require a systemic approach to modify the conditions that contribute to errors”.²⁸ Returning to the forensic arena, LaPorte adheres to that concept when he states, “Erroneous convictions, like most catastrophic mistakes in the criminal justice system, are rarely caused by a single identifiable act or weakness. Instead, multiple failures in the process can lead to a negative outcome”.¹⁴ Cooper asserts that wrongful convictions are the majority (and naturalized) result of official misconduct at the law enforcement and prosecution levels.⁹ This review adheres to the observations of these two authors: Official Misconduct was present in 19/26 cases (73.08%); in only 2 cases (7.69%) was F/MFE the only contributing factor of erroneous convictions, while in 7 (26.92%) cases there was F/MFE plus one additional factor, in 13 cases (50%) there were F/MFE plus two additional factors, and, in fact, in 4 cases (15.38%) there was F/MFE plus three additional factors (Table 1). Citing the IOM again, the report states that some systems are more prone to errors than others given how intricately they work, and in particular human error is induced by system failures ... just blaming an individual for this error seems to be a simple solution, but at the same time difficult to determine what really went wrong.²⁸ Earwaker et al. emphasize that the propensity to blame failed standards or “bad apple” forensic scientists for these errors is important but insufficient; the organizational approach must also be changed, considering that human error must be managed within the context of risk.³⁰ “Given the complex and varied nature of knowledge with the forensic science process, the breadth of error types, and the negative connotations of ‘error’ terminology within the forensic science community, alongside the inherent nature of human error and need to expose and manage it, a new dialog may be beneficial. Rather than using the terminology of ‘error’, it may be preferable instead to discuss the

risky nature of forensic science, enabling dialog around the management of this risk ('the impact of uncertainty on objectives') that is focused around the forensic science process rather than attributing blame to the individual', as Earwaker et al. express it. And they conclude: "a culture of risk management (rather than a language of error prevention) needs to be embraced".³⁰ Incidentally, those authors include "forensic odontology" (sic) instead of "bite mark identification" among the disciplines susceptible to cognitive biases and human interpretation issues.³⁰

4.3. Forensic odontology and "bad apples"

Episode 3 of *The Innocence Files* ("The Evidence: The duty to correct") is directed by American director, producer and writer, Roger Ross Williams.³¹ He was the first African American director to win an Oscar with his short film *Music by Prudence* (2010, iThimba Productions). The 58-min episode has an impeccable editing job and a 7.9/10 public acceptance ranking³ as of the date of this review. The episode features the case of Keith Harward (Case #8 in this review) and "a crusade to discredit bogus forensics and raise awareness" (episode information on the official Netflix site). The contrasts are exquisite and explicitly formulated ("there are real scientists, there are junk scientists, and there is everything in between", says Chris Fabricant, attorney for the Innocence Project at minute 24:33 of the episode). The CSI Effect, the NAS Report, even the Bundy case provide context, while the Kennedy Brewer and now-deceased Levon Brooks cases (Cases #1 and #2; respectively in this review) give emotional force to the exposure of the one responsible for both wrongful convictions, Dr. Michael West, a Mississippi forensic dentist. Not coincidentally, the forensic dentist Dr. Lowell Levine of New York is also exposed for his responsibility in the erroneous conviction of Keith Harward, and almost in parallel, Dr. Richard Souviron, forensic dentist in Miami, is interviewed about his expert opinion regarding Ted Bundy's conviction, *just minutes before* exposing him for his responsibility for Gary Cifizzari's wrongful conviction (Case #5 in this review). Again, exposing those responsible, the "bad apples" that must be removed from the barrel. "It just takes one bad scientist and the whole system gets it wrong", emphasizes Fabricant at minute 37:21 of the episode). Even the exonerated Keith Harward is caustic of the discipline: "I will stand out front with a placard and say, 'This stuff's junk'. Maybe I can catch one juror before these odontologists come in with all their smoke and mirrors". This is said at minute 46 of the episode, as he drives his bus across the U.S. to tell his story. What can the influence of this type of exposure on public belief (and on jurors, in addition) be? Kaplan et al. (2020), after surveying the U.S. public in a recent study, conclude that respondents have a skeptical view of the vast majority of forensic techniques (including BMI).³² The authors declare a particular limitation inherent in this review: "It is unclear whether participants interpreted this as bite mark analysis, as was intended, or if they believed this item to refer to the identification of human remains based on teeth examination".³² Oliva and Beety, associate professors at West Virginia University, in their essay entitled "*Discovering forensic fraud*", directly consider that BMI is synonymous with FO.³³

It has been claimed that the error-review approaches model called "bad apples" focuses on blaming a single person and rectifying the harm caused by the case, but diverts attention from broader institutional, structural and cultural factors, possibly contributing to wrongful convictions.³⁴ For Aguirre (2018), this does not prevent the appearance of new "bad apples" or new unjust convictions, so that the criminal justice system, by functioning as an "ecosystem" and not as a "structural system", should reflect a more cultural than structural approach to fix it.³⁵ Aguirre deliberately compares the "sentinel events" of the medical field for risk prevention ("those in which a patient dies or suffers permanent or severe temporary damage and intervention required to sustain life") with "sentinel events" in the context of criminal justice that include "wrongful arrest[s], (a) wrongful release from prison of a dangerous offender who later harms another victim, the conviction of an innocent person, [or] a wrongful police shooting".³⁵ For the author, "these errors

go largely undetected, if at all, and when they are detected, it is usually after the victim invests years in investigating the error", such that implementing a sentinel event review system would avoid erroneous sentences (among other serious system errors), thereby significantly improving the criminal justice system.³⁵

"There have been some egregious mistakes with forensic dentistry," says Dr. Richard Souviron at minute 31:53 of the episode, and we deeply agree with him. Neufeld counters Souviron by arguing: "People were sentenced to death as a result of these screw-ups, and what the forensic dentists need to do, they have a moral and ethical obligation to go back and look at all those cases to see if there aren't more innocent people" (minute 34:01 of the episode), and we also strongly agree with him. However, we also agree with Dror (2020) that "bad apples" is one of several fallacies that prevents a proper understanding of bias and error; blaming the experts involved is to "make firewood out of the fallen tree" rather than acknowledging any systemic issues, where the type of bias may not be due to incompetence but to implicit cognitive biases, which are much more difficult to detect and correct.³⁶ This does not absolve the experts who have made these mistakes of their responsibilities, but it should force the judicial system to reinvent its control mechanisms, to reformulate scientific standards (dental forensic scientific associations have taken up this challenge),¹⁴ to assimilate a *new culture of risk management in the forensic field*, and fundamentally to take the discussion to the most appropriate terrain.

5. Conclusions

This review shows that there are false beliefs and assumptions as to the usefulness of FO. FO not only includes BMI, but also identification based on dental characteristics, age estimation on living people, etc. Only one of these fields, BMI, in recent years has been questioned; however, there are few instances of wrongful conviction cases compared to other disciplines of forensic sciences. Furthermore, this evaluation often does not discriminate between the quality and the specific experience of the experts called to produce the scientific evidence. This review has cast light on the relationship between the media and forensics and shown that science has been much more profitable for the former and much more unfortunate for the latter, likely due to reasons related more with spectacularization than science.

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