



Resources for Forensic Sciences and Adherence to New Technologies as Fundamental Elements for Elucidating Crimes

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Mini Review

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Abstract

A country's security forces must properly preserve a crime scene and use all available resources to solve the incident. If the country is poor and lacks resources, there will be a direct impact on solving the case. Using the example of forensic genetics, this article will discuss how the increase in resources for forensic sciences and adherence to new technologies has influenced the elucidation of crimes. Two recent technologies in DNA analysis are considered: Forensic DNA Phenotyping (FDP) and Genetic Genealogy (GG). Some thoughts will be given on these two topics. Interestingly, the scientific community has a consensus to study only Externally Visible Characteristics in FDP technology. However, FDP has already been used with non-EVCs, at least in Italy and the USA, for the defendant's benefit. Some countries, such as the USA, UK, New Zealand, and others, are already exploring Genetic Genealogy technology or have already implemented it into their forensic routine. Which criminal circumstances are sufficiently serious to justify the use of new technologies? Should only heinous crimes benefit from the scientific development of forensic science or all crimes? Should new technologies only be used to benefit defendants, even against the advice of the scientific community? I hope that these thought-provoking questions can be useful to reflection and to forming our own opinions on these topics.

Keywords: Forensic DNA Phenotyping; Genetic Genealogy; Recent Technologies; Resources for Forensic Sciences

Abbreviations

FDP: Forensic DNA Phenotyping; GG: Genetic Genealogy; EVCs: Externally Visible Characteristics.

Introduction

How much effort must a country's authorities invest to solve a crime, whether heinous or of low offensive potential? When solving a crime, a country's security forces must properly preserve a crime scene and use all available resources to elucidate the incident. The seriousness of a

developed country's justice system depends on the perfect correspondence of the chain of custody of material evidence with the regulations for this purpose [1]. Failure in this chain of custody can "generate undue economic damage, exonerate the probably guilty or convict the innocent", which would be a catastrophic reality when it comes to legal security, both in criminal and civil law [2,3].

If the country is poor and does not have resources, there will be a direct impact on solving the case, either due to a deficiency in the training of the officers who attend the crime scene, or due to the absence of materials to process and/



or identify the material evidence of the crime. In this way, the advent of technology and investment in education and technology have never been so useful for solving criminal cases. In the case of forensic sciences, the first look should be taken at crime scene investigation, as very well indicated by Mateen RM, et al. [4] in their considerations on the criminal investigations in Pakistan, a developing country. These authors clearly stated that “local policemen are not properly trained and equipped with the necessary items required for systematic processing of crime scene”, as occurs in many countries with the same socioeconomic status. Undoubtedly, the greater the resources provided to forensic sciences, the higher the rate of resolution of criminal conflicts. It is necessary to say that such resources should not be diverted for political purposes and/or as a result of corruption that exists primarily in developing countries. In these countries, as in Brazil, some research has shown how much impunity still exists [5], despite the resources allocated to public safety.

Periodic audits of the use of public resources and appropriate punishments must be implemented to ensure greater efficiency in the use of funds earmarked for public health, education and safety. In developed countries such as the USA, UK, Netherlands, Germany, among others, new technologies have been routinely developed and used for each area of forensic sciences. It is no coincidence that such countries are always among the safest in the world.

This mini-review will cover some developments using the example of forensic genetics, which can be considered the gold standard of forensic sciences across the globe [6,7] to explain how their respective growth is closely related to the injection of material and human resources so that various criminal occurrences can be elucidated. At the same time, it will be argued whether the lack of investment and/or low compliance with new technologies can have an impact on the determination of the truth of a police incident.

Forensic Genetics and their Latest Developments

Forensic genetics has made significant advances in the last 40 years of history and is considered by many professionals as the gold standard of forensic sciences worldwide, despite the occasional errors that have been revealed throughout its development [6,7]. These mistakes have increasingly forged and strengthened forensic DNA technology in terms of its procedures, methodologies, statistics, innovations, and extremely high-quality criteria in analyzing the technical evidence. The first forensic DNA case on the planet happened in the United Kingdom [8] and, at the time, DNA dragnet from 4,852 volunteers was done [9]. Still, the crime was not solved at first. Initially, DNA technology was used to exonerate suspects. The perpetrator of the crime was genetically identified only later, and the

case found a solution. In any case, this case gives an idea of how much resources were spent to extract and process DNA from 4,852 samples, in the 1980s, when the costs of genetic analysis were still exorbitant. For more information on the development of forensic genetics technology, please consult the recent review published by Panneerchelvam S, et al. [9].

More current technologies, such as Forensic DNA Phenotyping (FDP) or Genetic Genealogy (GG) have also helped to solve forensic cases [10-14] and has aroused the interest of many countries, but caution is needed, and such technologies have methodological and/or ethical obstacles to further progress in the forensic routine.

Forensic DNA Phenotyping (FDP) is a technology used mainly to reduce the number of suspects and reduce the DNA dragnet needed to establish the facts, saving money in a criminal investigation [13,15].

This investigation will look for suspects with specific physical characteristics such as hair color, eye color, skin color, height, age, among other phenotypes indicated by DNA testing, to later solve the case with conventional genetic analysis (Short Tandem Repeats, for instance) (see the recent review on the topic published by Kayser M, et al. [13]). This technology had its name coined in 2008 [16] and the first country with a legal provision on the topic, since 2003, was the Netherlands, according to the authors. It is interesting to note that the scientific community has a consensus on applying only Externally Visible Characteristics (EVCs) in FDP technology [15,17] in compliance with ethical standards on the confidentiality of human genetic data associated with a person (The Universal Declaration on the Human Genome and Human Rights; International Declaration on Human Genetic Data) [18,19]. However, this technology has already been used, at least in Italy and the USA, for the benefit of defendants (for example, to reduce the sentence or change the sentence from an intentional crime to a culpable crime), to indicate that such individuals had “low activity variant of MAO-A, which made them genetically predisposed towards violence” (a non-EVC) [20]. Could we say that everything is allowed for the benefit of the defendants? This is a reflection for another time. Some countries have already used the FDP in forensic practice, such as the Netherlands, Germany, Austria, Poland, Spain, United Kingdom, Slovakia, Sweden, Hungary, among others for more detailed information, please consult Schneider PM, et al. [21].

In continuation, Genetic Genealogy (GG), in turn, is the technology that uses genetic data available in public or private databases of the civilian population (for example, from direct-to-consumer genetic testing such as 23andme, AncestryDNA, and other databases) to point out possible kinship relationships (shared alleles and/or identical

chromosome segments by descent) between two or more individuals [14]. Such technology can be used to investigate possible genetic relationships between a sample left at a crime scene and the sample in these databases, aiming to find criminals through their relatives whose DNA is already available online. Indeed, an emblematic example of Genetic Genealogy analysis was the closure of the Golden State Killer case (Joseph James DeAngelo), using GEDMatch, as shown by Erlich G, et al. [10] and discussed by Guerrini CJ, et al. [11]. Erlich G, et al. [10] indicated some cold cases solved with the help of Genetic Genealogy technology, with long-range familial DNA searches. Guerrini CJ, et al. [11], in turn, conducted a survey in which it was found that people generally agree with the use of Genetic Genealogy to catch criminals, especially when it comes to violent crimes, crimes against children, or finding lost people. This latest study also revealed that the majority of questionnaire respondents (n=1,587, from the USA) even agree with the creation of fake profiles by police forces to search for additional information about suspects. Machado H, et al. [22] reviewed the public opinion on forensic DNA testing and also discussed how DNA databases and these new technologies (FDP and GG, especially) tend to be well regarded by the population (including an optimistic view of prisoners) and, also, how they can be used for the benefit of public safety on the planet. In an independent study, carried out by Del Real A, et al. [23], the opinion on the national DNA database and familial searching showed the same tendency of optimism among the prisoners and prison officials interviewed in Spain. Some countries, such as the USA, UK, China, Sweden, Spain, Netherlands and New Zealand are already exploring Genetic Genealogy technology or have already implemented it in forensic routine, according to the review published by Wang M, et al. [14]. The latter authors have even provided a map of the distribution of forensic cases (solved or under investigation) of Genetic Genealogy worldwide.

Anyway, the solution to a criminal conflict depends on continuous scientific development and massive investments in devices and technologies for the proper performance of the bodies involved in public security as a whole. In Brazil, for example, as far as I know, a DNA dragnet has never been carried out to solve a crime. In this country, the DNA database was only implemented and integrated in all states in 2013, when the regulations for this purpose were published [24]. Contrarily and worthy of consideration, in India, there is still no DNA database available for the proper analysis of the genetic data produced by the country, even considering its population of over 1 billion people [25]. A broader overview of the DNA database situation in other countries can be found at Del Real A, et al. [23]. In Brazil, the low resolution of homicides and other crimes is recognized, compared to the crime resolution rate in more developed countries [5].

Final Considerations

Unquestionably, a better magnifying glass (e.g. more technologies and more resources) leads to better optical resolution in the visualization of an object (e.g. forensic cases). In other words, the real truth of a criminal fact is found more quickly if the public security's professionals have better equipment and more advanced technologies to elucidate a crime, whether to exonerate or convict individuals. In this mini-review, some solved cases using FDP and GG were mentioned and, also, how these cutting-edge technologies are advancing in some developed countries. Conversely, examples of traditional and routine analyzes [perhaps trivial] in genetics (e.g. DNA dragnet and DNA databank), already implemented in developed countries, and which have not yet been seen in developing countries, were discussed. Could it be due to a lack of resources and poor adherence to new technologies or simply a lack of interest in resolving penal conflicts?

Which criminal circumstances are sufficiently serious to justify the use of new technologies? Should only heinous crimes benefit from the scientific development of forensic science or all crimes? Should new technologies only be used to benefit defendants, even against the advice of the scientific community? I hope that these thought-provoking questions can be useful to reflection and to forming our own opinions on these topics.

Declaration of Competing Interest

The author declares no competing interest.

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