Chapter 2
Forensic Podiatry Principles and Human Identification

Keywords Physical evidence • Class characteristics • Individual characteristics • ACE-V

This chapter will introduce the reader to the scientific approach that is required to both comprehend and safely practice forensic podiatry. A thorough explanation of what is needed for evidential purposes, a discussion of class and individual characteristics, and a short explanation of the Bayesian approach to forming conclusions in the consideration of pedal evidence is provided. A discussion of evidence handling and the methodology that would be utilized which parallels that of other disciplines is given (including the ACE-V(R) – Analysis, Comparison, Evaluation, Verification, Reporting approach). Some basic information relative to the requirements necessary to be a credible expert witness in this field is also presented.

2.1 The Purpose of Human Identification

> In modern Society, ordinary citizens accept certain personal responsibilities. In return, society guarantees fundamental personal and civil rights. These facts constitute the major reason why every citizen must retain personal identity throughout life and beyond death (Keiser-Neilson 1980, p. 1).

The fact that identification is required within society is widely understood. The reasons why personal identity is required are, however, rarely considered in depth by the public. In the statement above, Keiser-Neilson succinctly defined the reasons why the maintenance of identity is so important throughout both life and death. In the case of death, every single body that has been discovered does at that point belong to someone missing, so in an orderly society, every human body must be identified as quickly as possible (Keiser-Neilsen 1980) to enable societal order to continue. Problems that can occur in the case of a missing person can involve the settlement of estates, the need to pay out insurance awards, ascertainment that no foul play is involved, and the need to avoid the possibility of bigamy (Reisner and Wooldridge 1977). Where the missing person supports a family and it is not known

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whether that person is alive or dead, financial burdens may be placed on the family until the individual is officially pronounced as dead. In such cases, "assumed death" can replace the death certificates, but a period up to several years can be stipulated before an application for this verdict can be made. Because of this, serious legal complications are created when a person becomes missing. By law, minimum non-physical data are recorded for everyone on birth certificates representing social identity, and death certificates are used to officially record death. These are important legal documents and until the death certificate is issued, missing persons must be considered alive and entitled to the full protection of their personal and civil rights.

Where a crime has taken place and human evidence has been left by the perpetrator, there is again a need within society to identify that person as quickly as possible. While that person is alive, they remain fully responsible for keeping their actions within the acceptable constraints defined by the society within which they live. Again, there are legal implications when the rules of society have been broken and the associated person cannot be identified. In the case of a crime scene, the requirement is to identify the perpetrator of the crime as soon as possible in order to prevent further occurrence and to allow justice to be administered.

Personal identity is formed from infinite combinations of physical and mental features, few of which in isolation can be seen as individual. In the deceased person, loss of identity may occur through the body becoming severely traumatized, being unknown, or through the process of decomposition. In the living person, loss of identity most commonly occurs in relation to crime, where the perpetrator can deliberately make attempts to hide their identity at varying levels. This can range from simply leaving the scene of crime and hoping to never be associated with the event, to being forensically aware and going to great lengths to avoid leaving any evidence of their presence at the scene and possibly destroying such evidence after the event.

To establish the identity of an unknown person, the process of person identification is used in which data of a known person is compared with that available from an unknown person – either the dead, the amnesiac, or the criminal – with a view to attempting to establish a match (identification) or mismatch (exclusion) of the unknown. When authorities are satisfied of a match, and identity is re-established, subsequent actions can, respectively, include the issuing of death certificates, rehabilitation, and the criminal conviction of the person concerned.

Personal identity is important in society and its loss through death, memory loss, or denial as in crime situations may require help from the forensic examiner to re-establish that identity.

2.2 Forensic Podiatry Practice: Principles and Definitions

2.2.1 Forensic Podiatry Is a Science

Thomas Samuel Kuhn was a science philosopher of great significance. It was Kuhn's belief that *normal science* "meant research firmly based upon one or more past scientific achievements, which within that community provides the foundation

for further practice" (Kuhn 1970, p. 10). Kuhn referred to these scientific achievements as *paradigms*, which he described as essentially a set of agreements shared by scientists about how problems are to be understood. He believed that paradigms are essential to scientific inquiry because "no natural history can be interpreted in the absence of an implicit body of theoretical and methodological belief that allows selection, evaluation, and criticism" (Kuhn 1970, pp. 16–17). A paradigm therefore guides the research efforts of scientific communities, and as such its presence most clearly identifies a field of knowledge as a science.

Following the establishment of paradigms, the formation of professional groups and their attendant activities (e.g., journals, educational programs, etc.) usually takes place, all of which are centered on those with assumed knowledge of the paradigm in question. Kuhn believed that a scientific community cannot practice its trade without such a set of received beliefs, which rigorously prepares and authorizes the student for professional practice within that science.

The knowledge utilized by podiatrists as part of their forensic practice must therefore be that component of their knowledge base, which can be described as scientific. Podiatry was formally founded under a national body in 1895 in the USA, with the first school of podiatry opening in 1911 (Weinstein 1968). In the UK, podiatry was established in 1912 (Dagnall 1987), where it then sought full professional recognition with a specialist knowledge base for many years, only in recent times managing to achieve this status. In 1983, Larkin (1983) noted that chiropodists[1] needed to prove their worth and, at the time of writing, had not developed their own science. In his doctoral study, Vernon (2000) noted that his work had revealed certain knowledge limitations among podiatrists. Professional groups have both a theoretical and a practical knowledge basis (Eraut 1994), with further tacit knowledge being developed through practical experience, where reflection on that experience is required (Fleming 1994). "Knowing how" has been previously described as the non-propositional knowledge developed by practitioners through practice and experience, some of which may be tacit (Polyani 1967). Vernon (2000) speculated that such knowledge may not have developed to the level expected among podiatrists because of the immediate effects that many podiatry interventions are known to have, which in turn may impair the level of reflection otherwise anticipated.

The knowledge available to podiatrists is therefore not only that with a scientific basis, but also that which can be described as "pre-scientific" or that concerned with everyday practice (Frolov 1984) and which in podiatry may not have developed to the level expected. Given this scenario, caution is needed in the practice of forensic podiatry in order to ensure that the knowledge used is that which is scientific and robust and not those aspects of a podiatrist's knowledge which are tacit and also may be underdeveloped.

[1]In the USA up to the mid-1950s and in the UK up to 1983, chiropody was the predominant title of the professional groups dealing with the health of the foot. The profession of podiatry developed from this basis, with both the term and practice of chiropody now fading into obsolescence.

2.2.2 Forensic Podiatry Is Science Used for Forensic Purposes

Forensic science is science used for the purposes of the law, particularly in the detection of crime and the administration of justice (House of Commons 2004–2005). In its broadest sense, the full spectrum of forensic science includes all related activities within that discipline from basic research to applied technology. The term "forensic science" therefore refers not only to the typical services offered by the main forensic science providers, such as those involving toxicology, drug and document analysis, DNA, hair, fiber, footwear, tool mark, and firearms comparisons; but also to the research that underpins the development, testing, and introduction of new forensic technology. Forensic pathology, the examination of human bodies to determine the cause and manner of death in criminal or suspicious circumstances, is also included within this definition, as is the use of fingerprints for identification purposes. In the UK, around the majority of forensic services are delivered by the scientific laboratories of the Forensic Science Services (FSS) and in the United States, through the many organizational levels of crime laboratories. Forensic podiatry is currently practiced outside this context; however, the approach must remain scientific and by definition must be used for forensic purposes.

Fundamentally, although the scientific aspects of the podiatry knowledge base are used in clinical practice, in forensic podiatry work, the context of practice and the way that science is used in forensic work are fundamentally different. For example, in clinical diagnosis, the propositional knowledge approach predominates, with scientific adjustments and excursions being required where that approach is not immediately successful. Conversely, in forensic practice, the approach must use the principles of applied science from the start, with there being no potential for "diagnostic" adjustments as the work progresses. Forensic podiatry work therefore needs to be approached cautiously due to the fact that the use of science for forensic purposes requires a different overall approach than that of clinical practice.

2.2.3 Pedal Evidence Is One Form of Physical Evidence

Physical evidence is diverse in nature and can include, for example, body fluids, fibers, fingerprints, footprints, explosive materials, and the like. This type of evidence has a number of functions as follows:

- To prove that a crime has been committed
- To provide investigative leads
- To link a crime to a suspect
- To corroborate or refute a suspects' position
- To identify a suspect
- To induce a confession from a suspect

- To exonerate the innocent
- To provide expert testimony in court (Eckert 1997, pp. 33–34)

Forensic podiatry is concerned with the identification of either the deceased, or more usually, the association of persons with scenes of crime using the podiatrist's knowledge base and expertise. There are many approaches within forensic science, which are available to identify people, using features as wide ranging as fingerprints, DNA, teeth, bone structure, and shoeprints. Many of the techniques used in the identification can be considered mainstream and are used as standard approaches because they are evidence-based, proven in practice, tested, and widely available. Occasionally, however, material available for identification relates to the expertise of the podiatrist as opposed to any other specialist and this is where the work of the forensic podiatrist is required. The forensic podiatrist may be required in the following circumstances:

1. Where there is no material available to enable any of the standard approaches to identification to be used
2. Where the standard approaches have only elicited conclusions of limited value and the investigators wish to strengthen the conclusions
3. Where more complex questions need to be addressed, which the standard approaches cannot assist with and which fall within the knowledge base of podiatrists
4. In criminal cases, where the defense position requires additional work to be undertaken in order to investigate the validity of the link between items already associated with the scene of crime and the suspect

It should therefore be understood that most forensic investigations do not require the input of podiatrists and indeed to do so may create an unnecessary tier of investigation where the evidence already presented by traditional mainstream approaches is strong and compelling. This appreciation should not, however, lessen the value of forensic podiatry input where required and indeed many examples exist in which the input of podiatrists has proven essential to the outcome of the case.

2.2.4 Criteria for Usable Physical Evidence

The physical evidence considered by podiatrists, as in other disciplines, needs to meet certain general criteria in order to be of value. These criteria are briefly considered below:

Physical evidence needs to be available: Without the availability of physical evidence, very little further can be done to identify a person. This is a factor that forensically aware criminals attempt to exploit when attempting to destroy all evidence that could link their presence to a scene of crime.

Physical evidence needs to be of reasonable quality: Even if physical evidence is present and available, this evidence will be of minimal to no value if it is not of reasonable quality. Examples of physical evidence of inadequate quality in forensic podiatry terms include footprints that have been heavily smeared through

slippage, the insoles of shoes in which the barefoot impression is unclear, and CCTV images in which the gait of the person of interest is blurred and indistinct. For this reason, one of the first tasks that should be undertaken by forensic podiatrists is that of a quality check to determine whether or not the evidence presented is usable.

Physical evidence needs to be able to express individuality: Even if physical evidence is available and of high quality, this evidence may still be of limited value if it does not express some degree of individuality. An example of this issue in podiatric terms would be the clear presence of five toes in a barefoot impression. Although the fact that the barefoot impression contains five toes may be incontrovertible, where comparison with the general population is required, this fact on its own will be of limited use as the majority of the general population exhibit this same feature.

Physical evidence ideally needs to be stable as a feature: Physical evidence can be present, of high quality, and presenting a high degree of individuality, yet still could be of limited value if that evidence is not stable. In podiatric terms, stability means that the evidence is unlikely to be altered in any way, for example, through the effects of function, external influences, and the passage of time, which may include the impact of the aging process. An example of a stable feature would be a bony deformity of the foot (e.g., a true hammer toe), which is only likely to be amended through surgery or trauma. An example of instability could include the presence of a corn, which is present because someone is wearing a poorly fitting shoe, which may later resolve when the poorly fitting footwear situation has been addressed by that person. Where instability is a factor, the evidence can still be of value, however, potentially for a shorter period of time.

The need for stability brings in complications in relation to some podiatric aspects of forensic identification. For example, it has been demonstrated that shoe outsole wear patterns are not as stable a feature as was first thought, being subject to the influence of multiple variable effects (Vernon 2000). Such features should therefore be handled cautiously in the identification process. Similarly, undertaking identification using podiatry records, where superficial skin lesions are being considered (corns, callus, pressure points, etc.), it may not be possible to state that these lesions are stable. The fact of antemortem records showing the presence or absence of such lesions does not necessarily mean that they are going to be present at a later date. This does not mean that such features cannot be used, but instead that the podiatric examiner must be aware of their limitations if stability is not guaranteed. In the forensic work of the footwear, or marks examiners, accidental characteristics of shoe outsoles are known to be virtually unique (Stone 1984) and as such, this is one of the most valuable sources of evidence in identification. Despite this, the causative shoe may need to be found quickly after the shoe impression has been left as it is possible for the accidental features that were then present to be obliterated and replaced in time by new areas of trauma and damage.

2.2.5 Class and Individual Characteristics

Physical evidence can express different levels of individuality ranging from features that a large proportion of the population can demonstrate, to features that can be considered as unique. An understanding of this fact is fundamental to the use of evidence in case work. In this sense, two different levels of physical evidence have been described – individual- and class-level characteristics.

Individual-level characteristics are features that are unique (Paulisick 1994). They have also been described as identifying, unique, random (Bodziak 2000), and accidental (Cassidy 1987) characteristics, depending on the context of use. Such characteristics are as unique as it is possible to be within the natural world. When dealing with this level of evidence, the probability of a chance match is so remote as to be considered impossible (Stone 1984). In footwear terms, examples of individual characteristics include the random cut and nick marks under the outsole, which have formed through damage as the shoe has been worn. These can then transfer to a surface through a shoe print and can be used for comparison purposes when a suspected shoe is available for examination.

Class-level characteristics have been given a number of different definitions (Bodziak 2000; Cooke 1984; Cassidy 1987; Osterberg 1967). Common to these definitions, however, is an implicit understanding that class characteristics are features that are not unique, but do instead demonstrate incontrovertible compatibility between similar items. In footwear terms, the marked size would be an example of a class-level feature. The marked size of a shoe is certainly not a unique feature, but where a shoe impression is being compared with the same make and type of shoe that has a different marked size, it can be stated with certainty that the shoe impression has not been formed by that shoe. Other examples of class characteristics in relation to footwear include the shoe style, color, make, model, fastening device, etc. Class characteristics show consistency and compatibility. They do not show uniqueness. In combination, however, class characteristics can create a picture of much stronger individuality than they would on their own as long as those characteristics are independently variable from one another. The use of class characteristics in this way involves considerations of known data (e.g., prevalence and survey data) for the class features under consideration.

It is fundamentally important to note that there is currently no evidence considered and utilized by forensic podiatrists that has been demonstrated at the individual (unique) identification level. Forensic podiatrists therefore exclusively operate at class level only. In the future, this situation may change as knowledge and understanding improve; however, such change is not anticipated in the foreseeable future.

2.2.6 Class Characteristics Differ in Evidential Value

Although forensic podiatry evidence exists exclusively at class level, the evidential weight of each item of evidence differs considerably. The presence of a condition

that is known to be present in 20% of the population, for example, would be weaker in evidential value than one present in just 0.1% of the population. In recent times, consideration has been given to a number of class characteristics that have not been proved to be unique but do nevertheless represent very high levels of individuality (Kennedy 1996), and it has been suggested that these could be considered as a type of intermediate characteristic between that of class and unique. These intermediate characteristics are, however, still formally recognized as class characteristics and should be considered as such until consensual opinion in the forensic science world is that these should be defined separately.

In the UK, Bayesian approaches to dealing with evidence have been developed. These involve the use of likelihood ratios to express the strength of an item of evidence. The statistical theories underlying this approach were developed by a team of forensic statisticians lead by Dr. Ian Evett (Cook et al. 1998; Evett et al. 1998' 2000), and these have been adopted and further developed across Europe by the European Network of Forensic Science Institutions (ENSFI) (Yetti 2006). The approach involves creating a framework of propositions, that are formed from likelihood ratio calculations. In these calculations, the proposition that a particular person has undertaken an action that has led to the transfer of evidence is compared with an alternative proposition that someone other than that individual could have undertaken that particular action resulting in the transfer of that evidence. While widely used in many areas of forensic practice, these approaches can be somewhat complicated to understand and incorrect working of the likelihood ratios can lead to erroneous results. Alternately, basic probability estimates can also be used to determine the evidential value of compared items in which the probability of independently recognized variable features occurring in the same item of evidence is considered.

The task in forensic podiatry is to identify features of podiatric relevance in the questioned and known items being compared for identification purposes. The individuality represented by these features is determined by considering population prevalence and the likelihood of all such independent variables being present within the same evidential item. At the same time, features that suggest that the evidential items do not match are also sought. This task can be addressed using Dr. Evett's approach or, alternately, by using a basic probability calculation. Whichever approach is utilized, it is essential to be comfortable with the methods adopted and the reader is directed to literature in this area, where the likelihood ratio approach is being considered (Cook et al. 1998; Evett et al. 1998, 2000).

2.2.7 Physical Evidence and the Chain of Custody

Even powerful evidence can have its value completely destroyed by not maintaining what is described as a chain of custody. At its most basic level, the chain of custody is the demonstrable care and isolation of the evidence under consideration. From seizure to court, all persons holding the item of evidence, including the podiatric examiner, must be able to demonstrate that the evidence has been free from external

influence and contamination at all times. Individual responsibility is limited to the period that the evidence is held in their possession. Maintaining the chain of custody will include the following:

- Using sealed bags to isolate the evidence under consideration
- Storing the sealed evidence bags in a safe, lockable area
- Recording with signature and personal details the names, date and time of opening, and possession of the evidence
- Working with the evidence in an appropriately clean area
- Ensuring appropriate care is given to the storage of such evidence (e.g., sealing a wet shoe in a polythene bag can lead to mold damage, and placing weights on top of a shoe to be used as the evidence in storage can interfere with podiatric considerations in relation to functional distortion of that shoe)

2.2.8 Expert Opinion Standards

In the USA, Daubert hearings are used to determine the general acceptance of reliability of expert scientific testimony in a given forensic discipline when evidence is presented (Daubert 1993). There is not yet an equivalent process in the UK, although this has recently been considered (The Law Commission 2009). The principles involved in Daubert hearings do, however, appear to be eminently sensible, especially in relation to relatively new disciplines such as forensic podiatry, where particular attention needs to be given on the reliability of the evidence presented. For this reason, forensic podiatrists undertaking case work are advised to consider their work in relation to the factors seen as pertinent to Daubert, i.e.,

- To briefly name the technique or techniques employed in the work
- To consider whether the scientific technique or theory used can be tested
- To ensure that the technique or theory has been subject to peer review and publication
- To consider the potential rate of error of the technique
- To note the standards used for controlling the operation of the technique
- To find information to support the scientific theory or method being accepted within a relevant scientific community

These considerations link to the earlier principle that forensic podiatry is a science. If the work undertaken by forensic podiatrists meets the criteria for scientific classification, it should then, by definition, also be capable of meeting the Daubert, or similar, criteria.

2.2.9 ACE-V(R) Methodology

ACE-V or ACE-V(R) simply refers to the outline process, which should be followed by forensic podiatrists in the investigation. The acronym ACE-V(R) is used to represent:

Analysis: This is the phase of work in which the evidence is assessed for both the known and unknown items that are to be compared. Here, it is important to observe, note, measure, and record what is seen using justified approaches. This assessment will also include consideration of the evidence to ensure that it is of "reasonable" quality[2] to determine if it is possible to proceed further.

Comparison: Here, comparison is made between what has been observed in both the known and unknown items. Any similarities and differences are noted between these items. These can relate to both descriptive and quantifiable aspects of the evidence under consideration.

Evaluation: Evaluation is the crux of the work and this is where the examiner must come to a conclusion as to the strength of evidence in terms of match or mismatch between the items examined. It is here that the likelihood ratio will be stated.

Verification: Verification is a quality check of the work undertaken, which is especially important as there is a subjective (opinion) element involved in reaching conclusions in forensic work. In this, a colleague with an understanding of the process involved checks through all aspects of the work and, on completion, countersigns that work to indicate that they are in agreement with the findings. As in all scientific approaches, the work should be replicable by any other competent examiner and, in effect, this is what the verification is confirming.

Reporting: The reporting (R) component of the ACE-V(R) approach refers to the need to have produced a report, which is the anticipated output on conclusion of the process. It is this report that will be tested in court, should this later be required and the examiner should be certain that all aspects of the report will bear scrutiny and challenge. The report is nearly always read out in the absence of the expert and therefore musty be clear and accurate throughout.

2.3 Expert Witness Background and Qualifications

Personal credibility is necessary for the forensic podiatrist acting as an expert witness. This fundamental principle cannot be overstated. There are two types of witness – the lay witness and the expert witness. The expert witness is someone who has knowledge and/or skills derived through education and/or experience, which qualify that individual to take a set of facts and reach conclusions not attainable by the average person (including the judge and the jury) (Siegel 2007). This expertise can be qualification-based, but can also relate to people with very specific experience in a particular area. In forensic podiatry work, the expertise is more likely to be established by both education and experience in this area of work. In court, attorneys

[2] See earlier comments under Sect. 2.2.4 noting that "physical evidence needs to be of reasonable quality."

usually take a considerable amount of time and effort to establish the credibility of an expert at the start of their questioning and it is essential that a forensic podiatrists' background justifies their presence as an expert in court. Typical factors that demonstrate the expertise required could include:

- Higher educational qualifications (PhD, master's degree) if relevant to the case work undertaken
- Postgraduate qualifications, for example, courses that provided specific training in the area of consideration
- Forensic case experience, not only the number of cases undertaken, but also the length of time that the expert has practiced in this area
- Relevant clinical podiatry experience, again in terms of patient numbers and the length of time in practice
- Experience of specialty footwear work (if relevant) including a specific interest in and focus on footwear work in practice
- Relevant research that the expert has personally been involved in
- Personal peer reviewed publications
- The number, type, and level of court presentations made
- Membership of relevant professional bodies (both podiatric and forensic)
- Distinction through award or position of esteem (if relevant)

It is important to note that credibility will only be enhanced by factors relevant to the work undertaken (e.g., possession of a PhD in the sociological history of podiatry will not demonstrate expertise in footwear examination).

These then are the most basic principles of forensic podiatry practice. Any podiatrist working in the forensic context should be familiar with these principles and adherence to these at all times should prevent any problems from being experienced during case work.

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