The Application of Forensic Podiatry to Clinical Practice

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The practice of the clinical podiatrist traditionally focuses on the diagnosis and treatment of conditions of the foot, ankle, and related structures of the leg. Clinical podiatrists are expected to be mindful of "the principles and applications of scientific enquiry." This includes the evaluation of treatment efficacy and the research process. In contrast, the forensic podiatrist specializes in the analysis of foot-, ankle-, and gait-related evidence in the context of the criminal justice system. Although forensic podiatry is a separate, specialized field, many aspects of this discipline can be useful in the clinical treatment and management of foot and ankle problems. The authors, who are forensic podiatrists, contend that the clinical podiatrist can gain significant insights from the field of forensic podiatry. This article aims to provide clinical podiatrists with an overview of the principles and methods that have been tested and applied by forensic podiatrists in their practice, and suggests that the clinical practice of the nonforensic foot practitioner may benefit from such knowledge. (J Am Podiatr Med Assoc 110(2): 1-11, 2020)

In 1989, the article "Forensic Methods and the Podiatric Physician," published in this journal, provided an introduction to the forensic examination of foot-related evidence by podiatrists and other experts in relation to criminal matters.[1] Since that time, the knowledge and methods used in the forensic analysis of pedal and gait evidence in the context of the criminal justice system have developed considerably. In 1999, forensic podiatry was defined as "... the application of sound and researched podiatry knowledge and experience in forensic investigations, to show the association of an individual with a scene of crime, or to answer any other legal question concerned with the foot or footwear that requires knowledge of the functioning foot."[2,3] (Suitable qualified persons who are not podiatrists may also perform this forensic work.)

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Commonly, forensic podiatrists are concerned with analyzing an individual's gait, a person's footwear, or a footprint associated with a crime, although their investigation may also include the postmortem identification of an individual, the analysis of medical treatment, and other practice-related issues.[4-8] Although forensic podiatry is a specialized field, the underpinning research, principles, and methods used by the forensic podiatrist are relevant to the clinical treatment and management of a number of foot or ankle problems.

The clinical podiatrist's expertise generally focuses on the diagnosis and treatment of ailments of the foot, ankle, and their related structures, and the evaluation and treatment of disorders of gait. Podiatrists, other physicians, and scientists engaged in the clinical treatment of these problems may not be aware of benefits that can be derived from understanding and applying forensic science principles and methods to the day-to-day treatment of patients. In this article, the authors are not intending to detract from clinical podiatry but suggesting how forensic science approaches may be applicable to clinical situations and could provide beneficial knowledge to the clinical, nonforensic foot practitioner.

Forensic Versus Clinical Practice

Pedal evidence in forensic matters has its beginnings in 1862, when footprints made in blood at the scene of a homicide in Scotland were linked to the suspect.[9] The modern analysis of pedal-related evidence began with the work of Canadian podiatrist Norman Gunn in the 1970s.[10] It is only relatively recently that this area of practice has become a specialty in its own right.[4]

Unlike the clinical environment, forensic podiatry does not involve the management and treatment of conditions of the foot and lower limb to maintain or improve a patient's health. Instead, forensic podiatrists generally focus on using their knowledge to address questions in assisting with criminal matters and other questions of scientific identification of individuals. These questions usually entail corroborating the identity of a specific person; however, forensic issues may relate to other matters, such as physical abuse or torture, malingering, insurance fraud, postmortem identification, criminally negligent care, and other matters.[4,10] Although there is a benefit to society in helping courts deliver justice based on the analysis, comparison, and evaluation of foot-, ankle-, or gait-related evidence, it is a distinctly different pursuit from that of treating patients who seek health benefits in day-to-day clinical practice.

In the same light, tasks involved in forensic pedal or gait analysis differ in some respects from those required in clinical practice. In the forensic application, the specialist is typically concerned with the analysis, comparison, and evaluation of physical evidential materials or recorded images that may assist in the investigation of crime. This includes the comparison of attributes and features found in questioned and referenced materials—and arriving at a conclusion as to whether and to what degree that comparison suggests that the compared evidence has commonality or differences.[11,12] The forensic podiatrist's work includes isolating and capturing evidential features, typically through forensic digital photography, three-dimensional casts or molds, and/or video recording techniques. It entails physically measuring and comparing the findings from these materials using established approaches in an attempt to recognize the presence or absence of shared features. These features will usually require a detailed comparison by the forensic specialist and a determination as to the strength of the evidence.

Podiatrists engaged in forensic investigations may be called on to assist various entities, such as local, state, or federal law enforcement agencies; attorneys; investigators; and private individuals. The forensic podiatrist may also be tasked with reviewing evidence previously reviewed by other forensic experts to render an additional opinion, to corroborate previous findings, or to evaluate previous analyses and conclusions.

Both clinical and forensic podiatrists may serve as expert witnesses—providing opinions based on their training, education, and/or experience. They have specialized knowledge that laypersons lack.[4] This specialized knowledge and training is used to assist the fact-finder, which may be a judge, jury, employer, administrative board, or other entity.[4,8] (The forensic podiatrist does not determine a verdict but usually assists the fact-finder in reaching a verdict.)

Legal

Although podiatrists involved in clinical work may participate as expert witnesses in civil legal matters, forensic podiatrists are frequently asked to consult and provide expert testimony. In those proceedings, determining what expert witness testimony is deemed to be admissible in court varies by jurisdiction. The forensic podiatrist's analysis must satisfy the legal requirements of each specific jurisdiction to ensure that his or her findings and conclusions will be admissible in court and permitted to be presented to the judge or jury deciding a given case.

In the United States, the federal court system adheres to the "*Daubert* standard." This rule derives from the 1993 US Supreme Court case of *Daubert v. Merrell Dow Pharmaceuticals, Inc*,[8] along with two subsequent decisions.[14,15] The Supreme Court in *Daubert* held that the trial judges must initially decide, pursuant to Federal Rule of Evidence 104(a), if the expert is "proposing to testify to (a) scientific knowledge that (b) will assist the trier of fact to understand or determine a fact in issue."[8] The *Daubert* Court determined that trial judges are the "gatekeepers" of what scientific or technical testimony is admissible in court, and admission of evidence must be based on meeting certain criteria that has been established by the Court.[8,14,15]

The Supreme Court also laid out a list of factors for trial court that have become known as the "*Daubert* factors." The trial judge or magistrate will apply these elements when determining whether evidence is derived from scientific knowledge. The

Daubert factors can be considered by asking the following questions:

- Can the technique, science, or theory the expert used be tested or has it been tested?
- Has the technique, science, or theory the expert used been subject to peer review?
- What is the known or potential rate of error?
- Do standards exist for the control of the science or technique's operation?
- Has the expert's science or technique been generally accepted within the relevant scientific community?[8]

Some state court systems have adopted the *Daubert* standard for their courts in whole or in part, whereas other states rely on the older *Frye* standard or a variation of that decision.[16,17]

In the United Kingdom, the admissibility of expert evidence has evolved from common law, with changes occurring as a result of key appellate rulings.[18] In general, expert evidence in common law must be of assistance to the court: 1) the expert must have the relevant expertise; 2) he or she should be impartial; and 3) the evidence should be reliable.[18] The methods used must be scientific, such that the forensic podiatrist should, when available, use "validated methods or procedures based on sound scientific principles and methodology" and be "up to date in specialized literature relating to the field of expertise" in the context of methodology and reasoning.[18] Although this is a similar situation to that expected in best clinical practice where decisions should be informed by the known evidence base, in forensic podiatry, such approaches are not simply best practice, but instead are basic practice and demand greater in-depth reflection on the part of the practitioner.

Bias

A significant concern for forensic scientists is the issue of bias, which may impact the reliability of an expert's findings and his or her subsequent testimony.[19-23] The 2009 National Research Council report on forensic science repeatedly discussed the importance of minimizing bias.[24] The report recommended that procedures and performance standards be adopted to minimize bias, and recommended additional research on the effects of bias in forensic practice.[24] In forensic science, bias can take several forms—from intentional partisanship to conscious or even unconscious influences and information—imparted directly or indirectly to the nonpartisan expert that may lead to incorrect conclusions.[25,26]

Efforts to reduce bias in the forensic context are being addressed through education, standardized procedures, and such measures as ensuring the expert has only the information absolutely necessary to perform the analysis. The process of addressing bias in forensic science is an ongoing pursuit.[20,26]

In the clinical environment, cognitive bias also exists, leading to errors in diagnosis.[27-31] Cognitive factors account for up to 75% of errors in internal medicine practice, 30% of errors in the emergency room, and 78.9% of errors at a veteran's affairs facility during the patient encounter.[30] Efforts to reduce such clinical decision-making bias in medical education have begun to be addressed in some institutions,[32-33] whereas in the field of forensic science and practice, awareness of the potential for bias and taking measures to address bias are key routine considerations.

Process

The process forensic experts will often follow is analysis, comparison, evaluation, and verification (ACE-V).[25] These four steps will vary depending on the task and field of forensic science. Analysis, comparison, evaluation, and verification is typically considered the standard process for criminal matters and in some jurisdictions also for civil matters. The process can be summarized as follows:

- Analysis: the expert analyzes and assesses the evidence.
- Comparison: the expert compares the evidence with a sample from a known person of interest (eg, a footprint from a crime scene is compared to a footprint from a suspect).
- Evaluation: the expert reaches a conclusion.[20]
- Verification: the expert's results are then verified by one or more other experts.

This final step is concerned with attempting to reduce the effects of cognitive bias in forensic case work.[34,35] In forensic case work, verification is often imperative, as it is generally demanded by codes of practice and/or professional standards.[4]

In the clinical setting, differential diagnosis is the process physicians generally use to determine a patient's disease or ailment. The process involves eliminating diseases and problems until the correct diagnosis emerges, and at that point, the appropriate treatment is determined. This process involves

the physician obtaining information from the patient, such as the history of the problem, the patient's medical history, and their symptoms. It also includes a review of the patient's medical records, combined with physical examination findings. Diagnostic tests may be ordered to further narrow the diagnosis alternatives.

The forensic podiatrist's process and background create a set of skills—some of which are transferable to clinical care. These skills allow for nonspecific, broad benefits, potentially impacting many patient encounters, whereas other skills are specifically directed to a narrow issue, affecting a small number of patient interactions. Although the critical thinking skills are different—convergent thinking in the clinical setting versus divergent thinking for forensic podiatrists—there are potential benefits of general and specific aspects of a forensic podiatrist's work to clinical practice. These contributions and the prospect for a professional partnership between clinical and forensic podiatrists are considered below.

The Verification Phase of the ACE-V Approach. The emphasis on the verification step in the ACE-V forensic process described above may be of benefit in the clinical environment when addressing a complex case or determining a difficult diagnosis. Verification has been described in the clinical context as the equivalent of seeking a second opinion.[4] Seeking a second opinion in medical decision-making in the clinical setting may not be routine (although the closely integrated multidisciplinary team approaches, such as those used in the management of active foot disease in patients with diabetes mellitus, may involve the use of second opinion and clinical consensus, these situations are less likely in an office-based clinical practice[36]), but there has been a benefit when used for surgical pathology diagnosis and for reducing unwarranted elective operations.[37] One study found that 10% to 62% of second opinions resulted in a significant change in the diagnosis, treatment, or prognosis,[38] whereas another study suggested that according to patient-initiated second opinions, 15% of diagnoses should be changed.[39]

Understanding Bias. Understanding bias in forensic matters creates heightened awareness of bias in the clinical setting. Forensic podiatrists use various methods to reduce bias that are transferable to the clinical setting. For example, one such method is the use of step-by-step procedures to reach conclusions, such as when performing a comparison of an unknown perpetrator's gait to that of a suspect or a person of interest. In these forensic gait analysis cases, the expert will perform a detailed examination of the individual's gait first. Only then will the expert consider the features of gait of the suspect. This reduces the bias of possibly "seeing" features of the subject individual's gait in the perpetrator and possibly overlooking features in the perpetrator's gait that differ from the suspect.[40] This procedure avoids "reverse reasoning," which, for example, led in part, to the flawed fingerprint identification in the Madrid commuter bombing case. In that investigation, the Federal Bureau of Investigation erroneously concluded that Brandon Mayfield was the bomber.[26,27]

In broad terms, these procedures can be thought of as checklists, and in the clinical setting, checklists have been shown to reduce bias in reaching difficult diagnoses,[41,42] and for diagnosis of high-risk problems.[43] Forensic podiatry requires the expert to consider alternate hypotheses and confront the evidence in the case. For example, when comparing a footprint found at a crime scene to that of a suspect, the podiatrist should consider whether differences in the footprints could preclude the possibility that the same person made both footprints, potentially exonerating the suspect.[4] In clinical practice, considering flaws with a diagnosis and/or reflecting on the diagnosis with the goal of allowing for alternate diagnoses reduces diagnostic errors and increases the clinician's diagnostic performance.[44]

It is not unusual for forensic podiatrists to be given less-than-ideal evidence. For example, a footprint associated with a crime may be only a partial footprint or be obscured, possibly by characteristics of the surface. These deficiencies open the door to various interpretations. The examination of evidence in these forms or conditions provides the podiatrist with awareness to consider multiple hypotheses. Similarly, the need to consider multiple hypotheses may be required in clinical decision-making when test results and/or pertinent information is not available.[4] (Such experience may translate either way, from forensic to clinical podiatrist or the reverse.)

Enhanced Governance. Forensic podiatry, as noted above, is pursued within a framework of highly demanding legal standards and/or governance depending on the jurisdiction; and though clinical podiatry also must be applied with these high standards, that practice tends to be less prescriptive than the detailed legal standards and codes of conduct applicable to forensic podiatrists and other forensic experts. For example, in the United Kingdom, the *Health and Care Professions*

Council's Standards of Conduct, Performance and Ethics is 11 pages long (excluding a two-page glossary) and describes 10 basic standards that all health-care professions are required to satisfy.[45] A comparison can be made to the *UK Forensic Science Regulator's Codes of Practice and Conduct for Forensic Science Providers and Practitioners in the Criminal Justice System*,[46] which is 60 pages long (excluding a seven-page glossary). This document advocates following other relevant internationally recognized standards (eg, International Organization for Standardization standard 17025),[45] of which clinical practitioners also need to be cognizant.[46]

Forensic podiatry's adherence to governmental standards can arguably also support clinical podiatry practice. Applying legal and/or governance standards in the practice of forensic podiatry inevitably means that research and/or investigation will typically need to be or will have been undertaken to test and validate the methods used. This proof should underpin the assumptions on which conclusions are based. This research may include the use of published literature in this discipline and/or related disciplines and, if not available, local, in-house service, or department-based research to validate the methods and conclusions presented. Understanding and working to achieve these standards provides the practitioner with knowledge to guide and assist in enhancing clinical problem-solving and/or challenging non–evidence-based or anecdotal assumptions. For example, historically, podiatrists and other experts evaluate and claim that outsole wear patterns on footwear can be accurately interpreted to relate directly to foot abnormalities and/or biomechanics of the foot.[47-50] However, research by a forensic podiatrist following standards outlined above investigated these assumptions and found that these interpretations and their subsequent analysis may be flawed, and caution is required in their analysis.[51] In this example, this research evaluated long-standing anecdotal clinical assumptions and contributed to the proposal of a new paradigm for the podiatrists to explain shoe wear pattern formation.[52] The authors state, in part:

"Shoe outsole patterns seem to result primarily from foot and lower-limb function, and this function is represented by combinations of focal points of wear: the areas from which the wear spreads. Although anatomical and morphologic factors (including foot pathologies) may influence wear, this is through their effect on the primary walking intention. External factors may also influence the wear pattern, but their effect is usually minor. Wear extending beyond focal points is superfluous to such interpretation."[52(p265)]

In addition to the legal and/or government standards imposed upon the forensic podiatrist, opposing counsel and their experts will often scrutinize the expert's methods and findings. This cross-examination can be thought of as a type of peer review, which occurs in the clinical setting. Indeed, verification by the previously described ACE-V process may be considered peer review, where the scrutiny is not intended to change the conclusion but instead to evaluate whether the forensic expert arrived at the conclusion by using accurate methods and sound methodology.[25,53] In fact, methodology is the focal point of the *Daubert* analysis. A subsequent Supreme Court decision, *Kumho Tire*, explained that in applying the Federal Rules of Evidence to the testimony of all expert witnesses, the evaluation of methodology must determine whether "the testimony is the product of reliable principles and methods" and whether the expert "has applied the principles and methods reliably to the facts of the case."[15,54]

To add to this, the analysis of the forensic podiatrist in some matters will, in effect, undergo a double-peer review by two individuals: 1) a known expert and 2) the opposing party's expert(s). However, research shows that peer review in the clinical setting (in the form of clinical audit) has the potential to improve patient care.[55,56] The retrospective review of a patient's case, possibly resulting in an untoward outcome, could lead to the discovery of a physician or other health-care worker using inappropriate methods or inattention to accepted methods. The result may be improvements in patient care through new procedures, training, and/or awareness.

Practice

The specialized areas of forensic podiatry, such as footprint, footwear, records, and gait analysis, provide the means for growth in the podiatric clinical setting. These areas and their potential clinical relevance are discussed below.

Footwear Examination and Analysis

In forensic podiatry, the analysis of footwear requires the expert to examine features of wear and fit to determine whether an item of footwear could have been worn by a specific individual. The features and wear characteristics include distor-

tions of the outsole, upper sole (internal and external), and on the insole or sock liner. The forensic practitioner will compare a shoe that has been associated with a crime scene with a reference shoe—one that is known to belong to a particular individual of interest—to determine the likelihood that both of the shoes could have been worn by the same person. The forensic podiatrist may also consider how well the shoe fit the wearer, such as whether the shoe was too large or too small for the wearer. Such analysis requires an in-depth understanding of the interface between the foot and the shoe, along with the resulting impressions and wear that occur over time.[4] These examinations and comparisons will include an interpretive element in which the forensic podiatrist will provide an expert opinion as to the relevance of the shoe's features of wear and fit.[4] Although it is essential that the forensic podiatrist understand the meaning and implication of these features, it is reasonable to assume that such in-depth examinations would also improve the practitioner's understanding of the shoe-foot interface in the clinical context. For example, knowledge of how footwear structure may impact adversely on the contained functioning foot or how problems of the foot may manifest themselves as shoe wear and distortion would aid the clinician in his or her diagnosis and treatment of the patient. In addition, this knowledge can help identify and prevent shoe- or boot-related foot problems, such as developing an ulceration.

In a practical scenario, forensic podiatrists often cut open an item of footwear for internal examination, an action that has been referred to as a "shoe autopsy."[57] This procedure is typically impermissible in the clinical situation, where the patient will want to keep their shoe intact to be worn in the future. However, this thorough scrutiny of footwear allows the practitioner to gain additional insight into the characteristics of the footwear and interaction between the foot and shoe, which can be applied in the clinical context. The learnings from shoe autopsies may be of benefit to clinicians when fitting and/or recommending diabetic shoes, inserts, or shoes for use in sports or other physical activities.

In another empirical example, two of the forensic podiatry authors of this article were involved in a medicolegal case where they were asked to consider which insoles a patient had been wearing in their footwear at the time of an ulceration. The podiatrists thoroughly examined the footwear and insoles of the individual using forensic methodologies and by using different forensic light sources to bring out occult detail otherwise not observable. From this examination of the footwear, they were able to provide a precise, unambiguous, and supported answer to the question presented. Given that this task required familiarity with the use of forensic light sources, it is understandable that a clinical podiatrist with little or no forensic experience would be less likely to have been able to reach such a determination.

Footprint Recording and Analysis

Forensic podiatrists may also be asked to provide an assessment of a single footprint or trail of footprints associated with a crime and compare this evidence with the footprints of an individual.[4,58] This comparison may begin with the podiatrist physically collecting the footprints from crime scenes and/or persons of interest or providing instruction to law enforcement on how to perform such collection.[4,58,59] Footprints may occur as individual prints or sequences of prints and may be found on a variety of surfaces. Although the floor of a crime scene may be the obvious place to search for footprints, a print may also be discovered on a chair or other furniture, in mud or dirt, or on the victims themselves—either on their clothing or appearing as a bruise on their body.[60] Because footprints may be found in two or three dimensions, the methods of collecting them include photography, casting, and the use of adhesive-lifting materials. In addition to understanding the proper collection of footprints, the expert often understands the various methods of enhancing the visibility of a footprint, which may involve alternate light sources, chemicals, and/or digital image manipulation.[4]

The examination and analysis of a footprint requires the forensic podiatrist to consider factors including the foot's structure and the functional interface between the plantar surface of the foot and the ground surface (such as the floor). The expert is usually required to describe and measure a footprint, and identify its features, which are then compared with reference footprints collected from a suspect,[4] with inferences or conclusions subsequently being drawn.

Although the forensic analysis of footprints is typically undertaken to assist in the process of linking (or unlinking) a footprint found at a crime scene with a suspect's foot, the enhanced knowledge developed in this field leads to improved understanding by clinicians of how the foot interacts with a given surface. Footprints also demonstrate features that may not be readily apparent in

the direct physical examination of the foot.[61] Footprints have been shown to predict foot structure, function, abnormalities, and potential for injury.[62-75] The forensic podiatrist's enhanced knowledge of footprints provides insight into the manner in which a patient's footprints are collected. This in turn leads to further appreciation by all podiatrists for the relationship between the foot and the surface on which the footprint has been left, the way in which the features of the foot manifest themselves in the footprint, and the manner in which they are altered through the interaction of the foot and the surface.[60] This examination and analysis may include serial footprints, the use of which has been applied to children to ascertain whether development is normal.[68]

Furthermore, the determination of a patient's foot type, often reduced to the broad terms of flat, normal, or high-arched, is a common podiatric task that, according to Cowan et al,[76] requires caution when using visual inspection alone. Footprint measurements, particularly the footprint index and truncated arch index, are well-correlated with foot type. However, currently, clinicians rarely take the opportunity to use them in their practices.[77]

Medical Record Review

Forensic podiatry may involve the examination and use of foot-, ankle-, or gait-related medical records to assist investigators and prosecutors in the justice system. This includes practical tasks such as the identification of postmortem remains, the comparison of a suspect's foot or footprint to medical records, or the determination of medical care issues. The use of podiatry records for identification of dead persons, particularly in a mass disaster or when other identifying areas of the body have deteriorated or are absent, was first suggested by Doney and Harris.[78] The use of podiatry records for identification of unknown persons has since been tested with positive results.[11,77,79,80]

This work may involve consideration of the features of the foot or footprint in question with regard to their permanence and individuality, and changes in nature and/or severity of a pathologic finding.[4] Such reviews of clinical records may involve working with incomplete records, mislabeled or mixed-up records, inaccuracies in documentation or diagnosis, and the possibility that the records reflect an examination that was below the expected standard of care. The forensic podiatrist will need to address these issues appropriately, based on the specifics of the case.

In clinical practice, knowledge of the type of issues that can occur with the patient's medical record has the potential to improve documentation. In a study of the use of podiatrists' records as an aid to human identification, it was found that one group had significantly better success in identifying patients than the other.[81] During later personal communication, the researcher indicated that the difference was likely because the more successful group had been encouraged to keep accurate and thorough records by means of memorandum and subsequent audit. This arose because a senior practitioner in the group had a heightened awareness of the threat of litigation and other problems that could arise through poor record-keeping because of the practitioner's involvement in forensic podiatry matters. It could therefore be suggested that the ability of podiatrists to use medical records in identification was significantly better in the group with enhanced standards of record-keeping because of one practitioner's involvement in forensic podiatry.

Forensic Gait Analysis

The clinical podiatrist analyzes gait with the aim of determining or evaluating a medical issue. In contrast, the task of the forensic gait analyst is typically to assist in the identification of a specific subject. This task typically entails the examination of surveillance video recordings and comparing it to gait evidence of a criminal, suspect, or a person of interest to determine whether the individuals' gait is similar or identical.[4] To a lesser extent, forensic gait analysis may be used in other legal matters, such as evaluating the legitimacy of a person's medical injury claim (MN Nirenberg, written communication, January 5, 2019).

The processes of forensic and clinical gait analysis are similar in many respects. However, some notable differences are present. In the clinical setting, measures can be taken to reduce sources of error and limitations, whereas forensic gait analysis generally requires the expert to work within the limitations and sources of error present in the available footage. In fact, an important aspect of forensic gait analysis is the recognition and evaluation of the limitations and a total awareness of the potential for erroneous conclusions.[4,80] Forensic gait analysis also requires an appreciation of the external factors that may affect gait, such as the incline of the surface the subject is traversing or nonlinear walking, where the subject navigates a curve or turns a corner.[4] Although the clinician may

need to consider external factors during a gait examination, these elements are generally limited to situations where the individual must wear a brace or must use an assistive device, such as a cane.

Forensic gait analysis also requires an understanding of additional descriptive terminology[82] and the adherence to an established scientific methodology.[4,41,83] One example of an appropriate methodology is the Sheffield Features of Gait Tool, which was spawned from the need to create a process/checklist to reduce the risk of bias. This tool offers a systematic approach to evaluating specific aspects of a person's gait. Referencing a body part's motion during gait, the Sheffield tool requires the expert to analyze the entire subject—from head to foot—working through 14 sections, with a total of 113 options.[83] (The forensic expert may note additional findings during the use of this tool.)

The use of categories in gait analysis is helpful in the thematic analysis, a method that is leveraged to evaluate qualitative data. Categories are descriptors of themes.[84] In this regard, Browne et al[85] found that the evaluation of gait with the use of categories provided a "rich amount of information" and that more experienced experts provided more in-depth information. The research of Browne et al also correlated with other research that found when the expert considers the subject's entire body (not merely the lower extremities), a more complete understanding of the subject's gait emerges.[83,85,86]

The use of the Sheffield tool by the expert mandates a detailed evaluation of the subject's gait.[81] Practically speaking, this necessitates repeated viewings of video of the subject walking or running. This video may be limited to one section of footage or multiple sections, with each portion varying in length from a few seconds to over 1 hour. As a result, the process of working through the Sheffield tool during the forensic gait analysis is frequently a time-consuming task.[4,81]

The intensive, systematic method of performing forensic gait analysis can benefit the clinical podiatrist by enhancing the performance of patients' gait examinations. The use of forensic gait analysis protocols and/or a similar dissecting of the gait examination into categories could improve the accuracy of the podiatrist's findings and ultimately lead to better medical management.

Forensic gait analysis also requires knowledge of video, as the expert will need to assess the quality of the video footage that shows the subject's gait. As such, the expert must understand the limitations of a given section of footage with a subject walking or running when conducting gait analysis. Often, the expert will evaluate the video for such factors as frame rate, lightning, sharpness, and contrast.[87] The forensic gait analyst may also be called on to advise others, such as law enforcement, as to the way in which reference recordings of a suspect's gait should be arranged and produced.[4] In the clinical setting, this enhanced video knowledge may lead to improvements in the capturing of video data and better analysis of the gait of patients.

Footprint Sequencing

Another form of forensic gait analysis is footprint sequencing. In this process, a series of footprints or shoe prints, typically found at a crime scene, are examined and interpreted by the forensic podiatrist to determine specific aspects of the unknown person's gait.[80] The interpretation may also include a hypothesis as to the type of activity occurring when the footprints were made.[10] Involvement in such analysis could again be beneficial to clinical podiatry because it could reasonably be assumed that the experience gained through such focused work can lead the clinician to develop an improved understanding and practical knowledge of the various methods of footprint sequencing interpretation. These refined measures may be particularly useful where gait analysis equipment is unavailable.

Conclusions

Understanding the methods and principles of the field of forensic podiatry offers the clinical podiatrist significant benefits and improvements in patient care. These benefits can lead to an enhanced ability to analyze and diagnose foot-, ankle-, and gait-related issues, particularly in relation to appreciation of fine detail and questioning established paradigms. The clinical podiatrist's ability to use forensic podiatry principles may be furthered through education in this field, perhaps provided by academic institutions at the undergraduate and postgraduate levels, self-study, mentoring, and/or continuing education. In addition, the podiatrist seeking to learn forensic podiatry may join an appropriate organization to advance their development in this field, such as the American Society of Forensic Podiatry in the United States or The Chartered Society of Forensic Sciences in the United Kingdom.

Although clinical podiatrists focus their practice on the diagnosis and treatment of conditions of the foot, ankle, and related structures of the leg, there is

the expectation that these professionals "be aware of the principles and applications of scientific enquiry, including the evaluation of treatment efficacy and the research process."[88] In addition, they must recognize "the role of other professions in health and social care."[88]

Although clinical podiatry involves convergent thinking to come to a diagnosis, forensic podiatry requires divergent thinking. This may pose a significant obstacle for some clinical podiatrists who seek to train as forensic podiatrists. The specialized field of forensic podiatry supports this objective by providing clinicians with applicable principles and methods, tested and applied by forensic podiatrists.

Unfortunately, there is currently a lack of direct research to evaluate how forensic podiatry knowledge and skills can assist the clinical podiatrist. Current appreciations of these benefits are anecdotal or through indirect associations. As such, more evidence through research or audit is recommended to determine the role of forensic podiatry education and training in clinical practice.

Financial Disclosure: None reported.
Conflict of Interest: None reported.

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