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1aSCa2. A Canadian perspective on forensic science versus pseudoscience

Brent Ostrum*

*Corresponding author’s address: Science & Engineering Directorate, Canada Border Services Agency, Suite 280, Ottawa, K2E 7M6, Ontario, Canada, brent.ostrum@cbsa-asfc.gc.ca

This presentation will provide my personal observations regarding Forensic Science versus Pseudoscience in the Canadian legal system. I am neither a lawyer nor a judge; rather, I am a forensic scientist with over 25 years of experience in the Canadian system. My presentation focuses on relevant criteria for expert evidence considered in Canadian courts. The key ruling in R. v. Mohan (1994) provides the start of the discussion with subsequent court rulings adding various elements. In Canada, we have had several judicial inquiries, such as the Kaufmann Commission, that can serve to guide experts. Select aspects of the 2009 NAS report "Strengthening Forensic Science in the United States: A Path Forward" will also be referenced. There are some common 'criteria' often used by courts in different jurisdictions to assess expert evidence, including Forensic Acoustics. In other words, some basic expectations for all forms of expert evidence can be identified. I will attempt to show how select 'sciences' have tried to fulfill those expectations. This will involve some commentary on issues of individual examiner competency, oversight at a system level (eg. accreditation), and the need for proper and adequate method validation.

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INTRODUCTION

This paper, and the related presentation, provides some personal observations regarding Forensic Science versus Pseudoscience in the context of the Canadian legal system.

I am neither a lawyer nor a judge; rather, I am a forensic scientist with more than 25 years of experience. More specifically, I am a senior scientific advisor in the Canada Border Services Agency (CBSA) Laboratory and I work as Forensic Document Examiner. The CBSA Laboratory provides federally-mandated scientific support to the CBSA and the Canada Revenue Agency (CRA) as well as various other clients, on request. I also serve as the chairman of the Document Section within the Canadian Society of Forensic Science (CSFS) and I have presented workshops on this and related topic at CSFS meetings in the past.

My comments are based upon my personal experience and reflect solely my own beliefs about forensic science and expertise. It is important to note that the information in this paper does not reflect the official policy of the Government of Canada, the CBSA, the Science and Engineering Directorate of the CBSA, the CSFS or any other party or agency. These are my personal and professional observations.

Although my specific area of expertise is forensic document examination the topic of this paper spans across all disciplines and applies equally to every type of forensic expertise. The key Canadian Supreme Court ruling of interest is R. v. Mohan, [1994] 2 SCR 9. There have been several Canadian judicial inquiries, such as the Commission on Proceedings Involving Guy Paul Morin and the Inquiry into Pediatric Forensic Pathology in Ontario, which help experts and laymen alike to understand the role and function of experts in the Canadian system.

I believe there are some common ‘criteria’ that all experts should try to address when doing their work. This applies equally to all expert evidence, including Forensic Acoustics. These are based upon the principles of sound and proper science as well as criteria for the admissibility or assessment of expert evidence as outlined by the courts in different jurisdictions.

FORENSIC SCIENCE VS. PSEUDOSCIENCE

Most people have some idea, often derived from depictions in modern media, of what constitutes ‘forensic science’ but, like science in general, forensic science is not very well understood. Any discussion of forensic science requires a reasonable understanding of what it is and what it is not. This is particularly important when addressing the issue of pseudoscience and why it must be avoided in the forensic context.

A simple definition of forensic science might be good science applied to fulfill the needs of the justice system. At its most basic ‘science’ can be described as any activity aimed at advancing knowledge about the world through rigorous and careful study. Science often involves the use of hypotheses formation, testing, and experimentation. Good science occurs when proven methods and techniques are used to test and check different theories about a topic of interest. Ideally testing should be ‘repeated’ to challenge the theory in different ways. Another critical aspect of good science is communication, peer review and discussion or debate.

The ‘forensic’ side of things relates to the justice system. Our justice system deals with problems of tremendous importance and great variety. Judges or juries must decide about a specific issue in dispute; for example, determine if a crime has occurred, who the perpetrator was or what was actually done. To assist them, witnesses are called to provide relevant information. As the Court in R. v. Abbey observed, “Witnesses testify as to facts. The judge or jury draws inferences from the facts.” Most witnesses are permitted to give testimony based on personal observation regarding matters commonly known or understood by lay persons. In general, they cannot express an opinion. An ‘expert witness’, on the other hand, is a special type of witness. An expert is permitted and expected to provide ‘opinion evidence’. Once accepted by the Court they are permitted to express an opinion about something that cannot be fully understood without their input or assistance. This is permitted because they have some special knowledge that the judge or jury does not. This is the concept of ‘necessity’ which, in the Canadian context, comes from Kelliker (Village of) v. Smith, [1931] S.C.R. 672 where the Court quoted Beven on Negligence (4th ed. 1928) and stated for expert evidence to be admissible, “[t]he subject-matter of the inquiry must be such that ordinary people are unlikely to form a correct judgment about it, if unassisted by persons with special knowledge”.

There are many traditional disciplines within the general field of forensic science – for example, fingerprint examination, document examination, firearms examination and so on. Historically, most forensic science has been done in laboratories dedicated to this purpose and primarily in support of the police or a similar agency. In a forensic lab personnel work with the understanding that their results may end up in a court of law. Most work is done for an investigator or client with the lab results first assessed and used by that person. Eventually, the report
Forensic science tends to be very ‘practical’ in nature. The primary role of a forensic scientist is to assess evidence and evaluate it in terms of differing hypotheses (or propositions) that might explain how the evidence came to be. In order to fully evaluate evidence they need to understand as much as they can about how such evidence might be produced. They also need to understand sources of variation that might occur in the evidence both naturally and due to intrinsic or extrinsic influences. Their knowledge about such things comes from their education and training as well as any specific experimentation they may have done for the case at hand.

In a given case, there are always at least two possible scenarios or propositions that might explain the presence of observed evidence. Those propositions reflect competing positions in the matter. Of course, the actual cause is unknown and unknowable, other than in some probabilistic sense, and it is the role of the Court to determine which of the various propositions is ‘true’ to whatever standard applies in a given instance. The forensic scientist simply assists the Court in that determination by providing information otherwise unavailable. The forensic scientist has the knowledge and expertise required to assess the probability of the observed evidence under each of the possible scenarios. The actual assessment will vary by the type of evidence being considered but it will determine which of the scenarios, if any, is differentially supported by the evidence. This approach may be familiar to readers as being the assessment of a likelihood-ratio, or Bayes Factor, for the evidence under competing propositions. Taking into account relevant and necessary information about the matter, the expert can then provide the Court or the jury with their opinion. There are many ways such an opinion might be expressed and the general topic of evidence evaluation and reporting is very complex.

The topic has received a great deal of attention in the forensic science community as it is applicable to all disciplines. For anyone not familiar with the topic, some excellent introductory textbooks are *Statistics and the Evaluation of Evidence for Forensic Scientists* by Aitken and Taroni, *Fundamentals of probability and statistical evidence in criminal proceedings* by Aitken, Roberts and Jackson, and *Interpreting Evidence: Evaluating Forensic Science in the Courtroom* by Robertson and Vignaux.

Forensic science has changed over the years to the point today where experts routinely testify in court on topics far removed from the traditional ones. There are experts in many areas, some scientific and some not, that provide useful service to both civil and criminal courts. In many instances the expert/scientist is someone who has advanced and specialized knowledge in a particular area but whose primary work is something other than testifying in court. Hence, as a rule, their role as an expert witness is secondary or coincidental to their primary work. That is neither surprising nor is it a problem. Such persons are often highly qualified in their area of expertise. However, while they may understand the science or technical side of the equation very well, they sometimes do not fully appreciate the forensic side.

When forensic science is done properly the courts should receive important and useful information to make better decisions about the matter at hand. Ideally, the opinion of an expert will be more objective (even when the expertise is based on subjective knowledge), more accurate and more reliable than what the Court would have access to otherwise. Of course, all knowledge is limited and part of the concern for expert opinion is that it be given the correct weight by the trier. The critical qualifier in all the above is what is meant by the term ‘done properly’. That topic is discussed later in the paper.

It is important to remember that the role of any expert witness is simply to assist the Court in making the final decision. An expert provides knowledge and information that the Court would otherwise not have but, quite literally, the expert is not the one making any decision in a court of law. Decision-making is the responsibility and the purvey of the Court as was explained in *R. v. J.-L.J.*, “The purpose of expert evidence is thus to assist the trier of fact by providing special knowledge that the ordinary person would not know. Its purpose is not to substitute the expert for the trier of fact. What is asked of the trier of fact is an act of informed judgment, not an act of faith.”

In contrast to forensic science, or science in general, the Oxford English Dictionary defines pseudoscience as “a pretended or spurious science; a collection of related beliefs about the world mistakenly regarded as being based on scientific method or as having the status that scientific truths now have.” A similar term often seen in legal literature is ‘junk science’, a term taken from Peter Huber’s 1991 textbook, *Galileo’s Revenge: Junk Science in the Courtroom*. In the present discussion pseudoscience and ‘junk science’ are considered synonymous notwithstanding distinctions that might be made between them. Also, while one might argue that pseudoscience is detrimental in all contexts, the discussion is restricted to pseudoscience in the forensic context.

It can be challenging for anyone to discern between a legitimate science and pseudoscience. It is especially serious for a judge being asked to grant someone the status of ‘expert’ in their court. While judges and lawyers are indisputably knowledgeable about legal matters, they are unlikely to have much understanding of the area of expertise being presented. Furthermore, many trials involve juries comprised of persons who are very unlikely to
have knowledge of the area. As was observed by the Court in *R. v. Mohan*, “There is a danger that expert evidence will be misused and will distort the fact-finding process. Dressed up in scientific language which the jury does not easily understand and submitted through a witness of impressive antecedents, this evidence is apt to be accepted by the jury as being virtually infallible and as having more weight than it deserves.”

Quite simply, laypersons often do not see a difference between science and pseudoscience. The ‘trappings’ of science can be very convincing and information presented in that manner is often quite compelling, even though there may be little or no actual science behind it.

The Court in *R. v. J.-L.-J.* commented, “Expert witnesses have an essential role to play in the criminal courts. However, the dramatic growth in the frequency with which they have been called upon in recent years has led to ongoing debate about suitable controls on their participation, precautions to exclude ‘junk science’, and the need to preserve and protect the role of the trier of fact – the judge or the jury.”

The danger of pseudoscience as evidence in a trial should be obvious. The end-result can be expected to vary considerably depending upon the specifics of a case and the nature of the actual testimony. However, at best the information provided to the Court might be ‘correct’ despite its being derived through invalid methods or inappropriate evaluation of evidence. In that situation the negative aspect comes from the information being given more weight than it deserves. At worst the Court could receive incorrect information that misleads the trier completely. In either event, the potential outcome is a miscarriage of justice depending upon how the Court incorporates the evidence into their decision making process.

**COMPETENCY, ADMISSIBILITY AND COURT GUIDELINES**

Courts in every jurisdiction have had to address concerns about ‘expert evidence’. Expert witnesses can have a tremendous impact on the outcome of a trial. It is therefore very important to permit such witnesses to testify only when it is appropriate and correct to do so. There are several key rulings that outline the expectations the courts have for expert evidence. It should be noted that ‘expert evidence’ need not be scientific, nor does the expert have to be a scientist or have anything to do with science. An ‘expert’ need only have specialized knowledge beyond that of the court or the jury and that knowledge may be in almost any field or endeavor.

While jurisdictions differ in case law and specific policies or precedents, there are some common ‘criteria’ generally used in courts to assess expert evidence, including Forensic Acoustics. These constitute the basic expectations for expert evidence about which anyone working as an expert witness should be fully aware.

The courts in Canada dealt with forensic expertise many times but a couple of rulings are particularly important. *R. v. Mohan* [1994] is the key Canadian court ruling. In *Mohan* the issue of admissibility of expert evidence was reviewed and basic guidelines were laid down to help ensure pseudoscientific evidence does not influence the Court. *Mohan* occurred a few years after the *Daubert* ruling in the US but did not cite that case. A second ruling is *R. v. J.-L.-J.* [2000] which incorporated the evaluation process from *Daubert* in the analysis.

Before discussing Canadian rulings, there are three important US cases that should be reviewed due to their influence on courts around the world. These three comprise the ‘Daubert Trilogy’ – *Daubert v Merrell Dow Pharmaceuticals, Inc.*, 590 U.S. 579 (1993), *General Electric Co. v Joiner*, 522 U.S. 136 (1997), and *Kumho Tire Co., Ltd. v Carmichael*, 526 U.S. 137 (1999). In *Daubert* the Court considered the admissibility of scientific expert testimony in terms of the existing standard outlined in *Frye vs. United States*, 293 F. 1013 (D.C. Cir. 1923), where the D.C. Circuit Court held that novel scientific evidence must be have gained “general acceptance” in the relevant scientific community as a prerequisite to admissibility, against the more modern Federal Rules of Evidence (FRE), specifically Rule 702. As of 2000, FRE Rule 702 was amended to read “If scientific, technical, or other specialized knowledge will assist the trier of fact to understand the evidence or to determine a fact in issue, a witness qualified as an expert by knowledge, skill, experience, training, or education, may testify thereto in the form of an opinion or otherwise, if (1) the testimony is based upon sufficient facts or data, (2) the testimony is the product of reliable principles and methods, and (3) the witness has applied the principles and methods reliably to the facts of the case.”

The Court in *Daubert* determined that FRE superseded *Frye* although it should be noted that the latter standard is still applied today in some select US jurisdictions. The Court attempted to clarify admissibility standards saying that the trial judge must act as a “gatekeeper” to determine whether proffered testimony was relevant and reliable. To help in doing this, the Court provided a list of factors (which they called “general observations”) a trial judge could consider in a flexible manner when assessing the scientific validity (and, hence, evidentiary relevance and reliability). The factors are as follows:

- Whether the theory or technique can be (and has been) empirically tested?
- Whether the theory or technique been subjected to peer review and publication?
The known or potential rate of error for a particular scientific technique
The existence and maintenance of standards controlling the technique’s operation, and
The degree of acceptance of a technique within the scientific community.

In *Joiner* the Supreme Court clarified *Daubert* which had stated the focus for admissibility must be on the methodology and techniques, and not on conclusions derived from it. The Court in *Joiner* affirmed this point but noted it was not a simple task saying “But conclusions and methodology are not entirely distinct from one another. Trained experts commonly extrapolate from existing data. But nothing in either *Daubert* or the Federal Rules of Evidence requires a district court to admit opinion evidence which is connected to existing data only by the *ipse dixit* of the expert. A court may conclude that there is simply too great an analytical gap between the data and the opinion proffered.”

In the third case, *Kuhmo Tire*, the Supreme Court expanded the scope of the ruling considerably saying the *Daubert* factors should apply not only to scientific testimony but to all forms of expert testimony. No distinction should be made between scientific knowledge and technical knowledge meaning the *Daubert* factors could apply to anyone giving expert testimony, e.g., the testimony of engineers, doctors, accountants, harbour pilots or others whose expertise is not necessarily ‘scientific’ in nature. The Court also clarified that the *Daubert* factors were not a “checklist” or strict requirements. Instead, the *Daubert* factors were just things the trial judge could consider when determining if the proffered testimony is reliable and admissible. Every case is unique and the evaluation of proffered expert evidence had to be flexible and customized to the case at hand.

The Court in the *R. v. Mohan* discussed admissibility of expert evidence in the Canadian context and outlined the following four criteria that should be applied by the trial judge when assessing admissibility:

(a) relevance;
(b) necessity in assisting the trier of fact;
(c) the absence of any exclusionary rule; and
(d) a properly qualified expert.

In its discussion the Court touched upon many of the same points raised in *Daubert*. *Mohan* involved a form of novel scientific evidence and the Court noted “In summary, therefore, it appears from the foregoing that expert evidence which advances a novel scientific theory or technique is subjected to special scrutiny to determine whether it meets a basic threshold of reliability and whether it is essential in the sense that the trier of fact will be unable to come to a satisfactory conclusion without the assistance of the expert. The closer the evidence approaches an opinion on an ultimate issue, the stricter the application of this principle.”

The Court in *R. v. J.-L.J.* also dealt with novel science. Perhaps the most interesting aspect of this ruling was the Court’s express inclusion of principles from *Daubert*. As Glancy and Bradford noted “Although the principles in Daubert were enunciated [...] in the case, they were not specifically referred to in the conclusions. It does appear, however, that Canadian law now recognizes those principles for acceptance of novel science.” In taking that approach, the Court acknowledged the basic applicability of those concepts in the Canadian context. There was extensive discussion in *R. v. J.-L.J.* regarding error rate and the testimony of the expert. For example, the expert provided information about the “the known or potential rate of error” of their method however the data used was based on a therapeutic use of the technique. In the case the technique was used for diagnostic purposes, and not as therapy. No evidence was provided that other experts in the same field would agree with the use of the method in that way, or with the applicability of the suggested error rate. The Court felt the concept of an ‘error rate’ had to be considered carefully. An ‘error rate’ can be derived for any technique or procedure but care must be taken when trying to apply the results to some different use of the technique. This was a key element in the court ruling and part of the reason for rejecting the evidence in that case.

Aside from court rulings there are various commissions, inquiries and other reports of interest. In 2009, the National Academy of Sciences (NAS) in the US released a report called “Strengthening Forensic Science in the United States: A Path Forward”, commonly referred to as the NAS Report. While not without critics, the report detailed many concerns about forensic science, ostensibly in the United States justice system. Overall, many of the points raised are legitimate but space does not permit a full and complete review.

One area of concern was validation, or lack thereof, for procedures and methods used by forensic scientists. The report commented “Much forensic evidence — including, for example, bite marks and firearm and toolmark identifications — is introduced in criminal trials without any meaningful scientific validation, determination of error rates, or reliability testing to explain the limits of the discipline”. The report outlined extensive guidelines for validation for new methods and techniques aimed at assessing reliability and limitations under varying conditions. In general, the recommended procedures are in line with ISO/IEC Standard 17025, *General requirements for the competence of testing and calibration laboratories* (2005), so none should surprise any scientist familiar with validation in a research context.
The NAS report also commented upon error rates and the potential for bias effects in expert opinions. For example, with respect to the former the report stated,

“The existence of several types of potential error rates makes it absolutely critical for all involved in the analysis to be explicit and precise in the particular rate or rates referenced in a specific setting. The estimation of such error rates requires rigorously developed and conducted scientific studies. Additional factors may play a role in analyses involving human interpretation, such as the experience, training, and inherent ability of the interpreter, the protocol for conducting the interpretation, and biases from a variety of sources, as discussed in the next section. The assessment of the accuracy of the conclusions from forensic analyses and the estimation of relevant error rates are key components of the mission of forensic science.”

Traditional forensic disciplines have responded to the report in various ways including validation studies, error rate determination, changes in methodology (to include, for example, independent peer/technical review) and the adoption of terminology that better communicates the uncertainty present in expert opinions.

In Canada, Justice Fred Kaufman led the 1998 Commission on Proceedings Involving Guy Paul Morin (commonly known as the Kaufman Commission). Many recommendations were made but three are particularly of note. The techniques considered in the matter were hair comparison and fibre comparison (see Recommendations 2 and 3) which had not been validated sufficiently to support claims made by the forensic practitioner. Communication of results did not include information about limitations in the results (see Recommendation 7). Regarding communication the report listed specific language to be avoided deeming it to be “demonstrably misleading” (see Recommendation 9), and provided examples of specific language to be adopted so as to enhance understanding (see Recommendation 10). The report also addressed the approach of the forensic scientist endorsing a more rigorous adherence to the ‘scientific method’ “where scientists are to work to vigorously challenge or disprove a hypothesis, rather than to prove one” (see Recommendation 11). There were, of course, many other recommendations but these are the most salient in terms of the present discussion.

In 2008, Justice Stephen T. Goudge concluded his Inquiry into Pediatric Forensic Pathology in Ontario which examined, among other things, the work of disgraced pediatric forensic pathologist, Dr. Charles Smith. The inquiry was detailed and reviewed decades of work. Although it dealt with forensic pathology, many of the points apply to any forensic discipline.

At the risk of over-simplifying a very complex report a few of the key elements relating to forensic science and pseudoscience can be extracted. In hindsight it was abundantly clear that Dr. Smith was not qualified to do the work he did. He lacked basic and fundamental training, had never demonstrated any competency in the field and was never certified by any professional body. Closely related to the issue of competency was the issue of scope. Forensic pathology is a broad field in its own right but Dr. Smith frequently testified in areas far removed from his purported expertise. Every method or technique used in forensic science has a specific purpose. And each method must be tested and validated for that purpose. Indeed, when a forensic scientist is offered as an expert witness, the court must assess their qualifications in terms of a specified scope. It is the Court’s responsibility in their role as ‘gatekeeper’ to ensure the expert does not stray outside that specified scope during testimony. Forensic scientists should constantly be aware of the limits of their expertise and the methods they use. They must make every effort to stay within the bounds of their knowledge and skills. As Justice Goudge explained, “If experts do not have an accurate understanding of the limits of their own specialty, others are likely to be misled, whether intentionally or not, into believing that the opinions expressed fall within the pathologist’s area of expertise.”

Poor communication was another area criticized and an entire section (16) of the report was devoted to the topic. On this Justice Goudge wrote “One of the principal lessons learned at the Inquiry is that, although it is vital that forensic pathologists be highly skilled scientists, it is equally vital that they be able to communicate their opinions effectively to the criminal justice system.”

The report addressed the role of the Court and outlined several factors intended to assist a trial judge in determining “whether the expert scientific evidence has sufficient threshold reliability to be considered by the trier of fact.” In brief, these were:

1. Reliability of the witness, including whether the witness is testifying outside their scope of expertise,
2. Reliability of the scientific theory or technique on which the opinion draws (e.g., general acceptance, peer review, professional standards, quality assurance),
3. Whether the opinion can be related to a theory or technique that has been or can be tested,
4. Whether there is any serious dispute or uncertainty about the science and, if so, whether the trier of fact will be reliably informed about that dispute or uncertainty,
5. Whether the expert adequately considered alternative explanations or interpretation of the data and whether the underlying evidence is available to others to challenge the interpretation,
6. Whether the language that the expert proposes to use to express his or her conclusions is appropriate, given the degree of controversy or certainty in the underlying science, and

7. Whether the expert can express the opinion in a manner such that the trier of fact will be able to reach an independent opinion as to the reliability of the expert’s opinion.

The report also included some excellent commentary on testing and potential error rates by Professor Gary Edmond drawn upon his research study prepared for the Commission entitled Pathological Science? Demonstrable Reliability and Expert Forensic Pathology Evidence. Professor Edmond produced his own list of indicia for reliability “used to supplement and flesh out the Daubert criteria.” But the Professor’s preference was still for empirical testing as shown in the comment “Where rigorous empirical studies have been undertaken, the results of these studies will tend – though not invariably – to out-weigh the other indicia of reliability.” Justice Goudge agreed but added the following, “Testing and error rates are optimal, but it is important to reiterate that many kinds of expert opinion are not readily susceptible to empirical testing or reproducibility. The inability to provide testing results does not necessarily render these kinds of expert evidence unreliable. However, it does call for vigilant use of other indicators or reliability which are more germane to the task.” All in all, there is a tremendous amount of information in this report and it is worthy of very careful reading.

Aside from inquiries and reviews, many jurisdictions have published guidelines for expert witnesses intended to clarify their role in the justice system. These often include a Code of Conduct as well as specifics about what information must be provided both in terms of form and of general content. For example, at the Federal level in Canada amendments to the Federal Courts Rules for Expert Witnesses were published in 2010 in the Canada Gazette. In line with international jurisdictions, the amendments provide for pre-hearing conferences between experts (rule 52.6), the issuance of joint statements (rule 52.6, 4) and even testimony by a panel of expert witnesses (rule 282.1). Similar rules or guidelines have been adopted at the provincial level. For example, in Ontario see the Rules of Civil Procedure.

One important element common to such rules is that the duty of the expert is completely and solely to the Court, and not to any other party. The Code of Conduct for Expert Witnesses in Schedule 52.2 explains under “General Duty to the Court” that, “An expert witness named to provide a report for use as evidence, or to testify in a proceeding, has an overriding duty to assist the Court impartially on matters relevant to his or her area of expertise.” It states further that, “This duty overrides any duty to a party to the proceeding, including the person retaining the expert witness. An expert is to be independent and objective. An expert is not an advocate for a party.”

Anyone who intends to testify as an expert in a given jurisdiction should ensure that they have reviewed the guidelines that exist in the specific jurisdiction.

Another very valuable and recommended reference is the 2011 Report of the Federal/Provincial/Territorial Heads of Prosecutions Subcommittee on the Prevention of Wrongful Convictions entitled The Path to Justice: Preventing Wrongful Convictions. This document reviews all aspects of the issue of wrongful convictions in Canada, with a review of related international law, and Chapter 9 of the report specifically addresses ‘Forensic Evidence and Expert Testimony’. It is well worth reading.

DISTINGUISHING FORENSIC SCIENCE FROM PSEUDOSCIENCE

A critical part of a trial judge’s job is to distinguish between forensic science and pseudoscience. The rulings discussed above, and others, provide extensive guidance as to how this should be done. In a given trial, however, the evaluation process will be flexible and, especially in Canada, somewhat unique to the matter at hand. Precedence will always matter but the trial judge has great discretion in any given trial.

In order to demonstrate to the Court that good forensic science has been done and will be presented, the proposed expert must be prepared to provide information to the trial judge, such as the following:

- Their personal credentials and qualifications
- Information about competency such as details of testing, certification and/or specialized training
- Information about relevant accreditation (if any)
- Details about method(s) used in the case including validation studies and how they were done, error rate estimations and what they mean, limitations that apply to the method and the evaluation process itself including some explanation of the potential outcomes (e.g., conclusions/opinions that might result)
- Details about application of the method specific to the case including quality controls applied (e.g., technical review, confirmatory analyses), data sources, limitations unique to the case
- Details about the evaluation process specific to the case at hand including any relevant case information used, propositions considered in the evaluation and other related information
One of the most important elements is the evaluation process used by the expert. That is, the question of interpretation of test or analytical results. Interpretation is the ‘key’ to this. It is not merely a matter of running some tests or procedures to generate data or observe certain results. That data or those observations must be interpreted in the context of the matter at hand. In a given case, there will always be at least two scenarios or propositions that may explain the presence of observed evidence. The propositions should reflect competing and mutually-exclusive positions. The function of the expert is to evaluate the observed evidence in terms of the propositions to assist the Court when it determines which of the various propositions is ‘true’ to whatever standard applies in a given instance.

The expert simply assists the Court in their determination. The actual assessment must be aimed at determining which of the scenarios is differentially supported by the evidence. Taking into account relevant and necessary information about the matter, the expert can then provide the Court or the jury with their opinion. There are many ways such an opinion might be expressed. But, as noted earlier in this article, an ideal approach would be based upon sound and coherent logic with the evaluation focused on the probability of the evidence given each proposition, rather than the probability of the propositions themselves.

Of course, the results must also be communicated in a clear and understandable manner, first to the immediate client and later to the court. The Court in Mohan noted “The closer the evidence approaches an opinion on an ultimate issue, the stricter the application of this principle.” This relates to the issue of ‘how’ an opinion is expressed to the court. Experts should be careful not to address the ‘ultimate issue’ in their testimony. At the same time, this is not an absolute constraint since judges in Canada do have the discretion to permit experts to express such opinions as Glancy and Bradford observed, “In Canada, contrary to the U.S. Federal Rules of Evidence, experts are permitted to opine on the ultimate issue at the discretion of the trial judge.” Nonetheless, it is not necessary to do so, in general.

The use of a likelihood-ratio approach provides many benefits. One is that it avoids the ‘ultimate issue’ concern completely as the expert does not provide an opinion about the propositions directly. The likelihood-ratio concept provides meaningful and relevant information to the Court in a form that is very accessible and understandable since the logic and reasoning is clear, unambiguous and open to review and discussion. It does require careful explanation but no moreso than any other approach that might be used.

Numerical analyses are very well-suited to this approach. They can generate meaningful data for likelihood-ratio assessment. However, any numeric data, whether the result of some analysis or from an existing data source, requires careful explanation to the court about its applicability and limitations. At the same time, validating such an approach is arguably easier and simpler than for methods of a more subjective nature. Information about error rates, specificity, sensitivity and related metrics are readily obtained from numeric data.

Expert evidence of any type must be assessed by the Court to ensure it is valid and admissible. Of course, there is no way to know how a trial judge may rule in a given case but, if an expert is able to provide all the above information, they should fulfill the expectations of most judges and be admitted.

Pseudoscience can be recognized by significant limitation in one or more of the above factors. The onus is on the expert to show why their evidence should be admitted. Failing to provide the necessary information may result, by default, in their exclusion. In particular, a lack of proper validation is very important. Even if something is not truly pseudoscience it will be viewed, at a minimum, as poor or bad science if validation is lacking.

**CONCLUDING REMARKS**

In my opinion, the onus is on the practitioner first and foremost to ensure that good forensic science is being done. While it is ultimately the Court’s responsibility to vet anyone who comes before them as an ‘expert’ in a given trial, it is up to the forensic scientist to make sure what they are doing is ‘good forensic science’.

Newer areas of expertise and the methods used in those areas tend to fall into the category of ‘novel science’ from a legal perspective. Anyone advancing a new method or theory must ensure that proper and complete validation has been done. If the validation results are limited or the method itself is disputed, the onus is on the expert to disclose that to the court. Remember that validation is an ongoing process which never really ends – that is, arguably, the essence of science. It also means there will always be some uncertainty in any result or opinion deriving from any method. The degree of uncertainty in results or the expert’s opinion must be conveyed to the court to permit proper weight to be given to the testimony.

Finally, it is very important that the evaluation of evidence intended for use in a court of law must be done in a logically sound and coherent manner, and communicated in a clear and understandable way.
REFERENCES