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THE CURRENT STATE OF DNA EVIDENCE

BY: CHRISTOPHER J. LONSUBY

I. INTRODUCTION

A new form of forensic testing harkens the day when science can say with near certainty whether a suspect was present at a crime scene. Promising as this new technology is, a scientific method of itself cannot guarantee justice. Indeed, as presently received, the current identification method carries with it the potential to impart a significant prejudicial impact, if not a grave injustice.

The introduction of DNA identification into the criminal justice system has been heralded as the “greatest boon to forensic medicine and law since fingerprinting.”1 Praise for this new technique includes the claim that “disputing the technology is like disputing the law of gravity.”2 Accolades such as this overlook serious criticisms regarding the hurried acceptance of DNA evidence. These issues can be significant, if not critical, in a death penalty case.3

The current state of DNA forensics should be examined in light of several limitations. First, the techniques presently used in forensic testing do not identify the chemical structure of DNA. A detailed chemical analysis is possible, but at present is prohibitively expensive. Second, forensic DNA testing is subject to human error. Third, statistical interpretation of the results are based upon very limited testing of the populace. Last, procedural guidelines for testing have not been firmly established among testing facilities or widely recognized by the courts. Left unexplored, these factors can lead to prejudicial, or even erroneous, conclusions.

The apparent willingness of the American public to endure encroachment upon liberty and fairness in order to facilitate the fight against crime, particularly when drug related, has reached the proportion of a national obsession.4 Thus a cutting edge technology which promises to identify criminals with near certainty has found a very receptive market. DNA evidence has been accepted in many jurisdictions.5 Prosecutors and commercial laboratories have been able to push acceptance of DNA testing to the point that some courts take judicial notice of the process.6

This article will not challenge the technology; its foundation and potential are clear. This article will (1) summarize the prevailing DNA testing technique with the purpose of identifying possible sources of human error, (2) examine the validity of the “probability calculations” that are often given along with the test, (3) survey the law, particularly as it stands in Virginia, and (4) provide tactical advice for defense counsel. Further, this article will attempt to make clear that because the potential for the technology has not been reached in forensic application it may be harmful, if not lethal, for defense counsel’s client to let the judge and/or jury believe that such perfection currently exists.7

All forensic identification methods attempt to make use of physical qualities or traits that vary among individuals. The value of any particular method lies in its ability to accurately individualize people. Fingerprints are the model example of a forensic identification technique because they are unique to each person and they can be easily taken and read. DNA identification has been touted as equally accurate, but numerous observers now question whether the courts have been hasty in accepting these claims.

A simple first step toward avoiding the prejudice favoring this technology is to exercise care in naming it. This article takes the position that the procedure should be referred to as testing, profiling or identification. It is commonly referred to as DNA or genetic “fingerprinting.” Equating the procedure with fingerprinting, a forensic technique so well established that courts take judicial notice of its reliability, has contributed to the premature acceptance of DNA testing.8

II. THE MECHANICS OF THE TEST

Lifecodes Corporation,9 Cellmark Diagnostics,10 and the FBI11 each employ a process known as “restriction fragment length polymorphism analysis” (RFLP analysis). Other tests are occasionally used.12 This article will discuss RFLP analysis as it is the most common, and the most controversial, test in forensic use.13

The RFLP process breaks the DNA chain at specific points into smaller fragments. The results of an RFLP test represent a measurement of the length of these fragments. Thus, if tests performed on samples from the suspect and the crime scene identify segments of the same length, then a common source is suggested. The RFLP procedure is not a simple test. There are many steps where error or inaccuracy can occur.14 The procedure can be divided into seven steps. Each of these steps and associated potential sources of error are discussed below.

A General Description of DNA

Deoxyribonucleic acid (DNA) holds the chemically encoded genetic information present in all living organisms. It exists in the nucleus of every major type of cell except mature red blood cells. Each DNA molecule is structured as a “double-helix,” a long threadlike molecule consisting of two threads that intertwine and coil.

The DNA molecule is often described as a “closed zipper,” the teeth of which are formed by the chemical bases adenine, guanine, thymine, and cytosine. These four nucleotides pair together such that adenine molecules always pair with thymine molecules and cytosine with guanine. A molecule of human DNA contains three billion of these base pairs.

The order in which the nucleotides pair is the key to the information carried by the DNA. A gene is a particular sequence of base pairs that provide the information for a specific structure, function or feature, such as the gene for blue eyes. Thus, at certain sites, or loci, the arrangement of base pairs may differ from person to person. An individual’s genetic constitution at one or more gene loci is often referred to as “genotype.” Alternate forms of a gene among the relevant population (species, race, ethnic group, etc.) are referred to as “alleles.”

Approximately three million base pairs vary in human DNA. These variations, known as “polymorphisms,” are the basis for DNA profiling. Polymorphisms may be compared with those from other samples as a means of identification. Although each person’s DNA is unique as a whole, no person has a unique DNA pattern at a given polymorphic site. Since it is presently impractical to compare all three million differing base pairs, the DNA profiling technique seeks to distinguish among individuals by focusing on several highly polymorphic or “hypervariable” sections of human DNA. The kind of polymorphism most often sought in forensics15 is known as a Variable Number of Tandem Repeat or VNTR. VNTRs are stretches of DNA in which a short nucleotide sequence is repeated randomly 20 to 100 times.

Extraction of DNA

Sources of DNA at a crime scene are most often samples of tissue or bodily fluids dried on solid material. This biological sample is treated with various chemicals in order to accomplish removal from the material it is on. The sample is then treated with enzymes and organic solvents in order to release and clean DNA from the cells of the source substance.
The quantity and quality of the sample present two possible sources of error. Success of the RFLP test requires a sample containing several hundred nanograms of intact DNA.\textsuperscript{16} This amount of DNA requires a blood stain the size of a quarter or a semen stain the size of a dime.\textsuperscript{17} In rape cases, where a semen stain is the only biological evidence, approximately half of all samples given to Lifecodes did not yield sufficient DNA to test.\textsuperscript{18} Generally, a reliability problem is not created with insufficient molecular weight because the bands produced on the DNA print will be too faint to read, thereby causing an inconclusive “blank” result.\textsuperscript{19}

A second possible problem at this stage of the procedure is the presence of environmental contaminants. Molecular biologists have utilized RFLP testing methods for over a decade, however the application of the technology to forensics is relatively new. While some cases have accepted the notion that the scientific community has generally accepted the technique,\textsuperscript{20} it is worth noting that most non-forensic experts have experience with the procedure in a laboratory setting using “clean” samples. Samples from a crime scene may contain any number of contaminants including bacterial, viral or other nonhuman DNA. Some experts believe that false or misleading bands can be produced by the presence of foreign DNA in the sample.\textsuperscript{21} Others do not.\textsuperscript{22}

\textbf{Restriction Digestion}

After extraction and cleaning, the DNA specimen is mixed with “restriction enzymes.” These enzymes act as biological scissors and separate the DNA at specific places leaving segments known as “restriction fragments.” Although some of the fragments contain polymorphic genes, most do not.

Restriction digestion is widely accepted and used,\textsuperscript{23} but it is still subject to error.\textsuperscript{24} The ability of a restriction enzyme to cut at a particular restriction site is referred to as its “specificity.” Changes in the specificity of a restriction enzyme will cause the enzyme to cut the DNA at the wrong sites and will change the position and number of bands in the DNA print.\textsuperscript{25} An alteration of specificity resulting in incomplete cleavage of the DNA, is known as partial digestion; an alteration producing cuts at too many sites, is known as star activity.\textsuperscript{26} Alterations in specificity may arise from a variety of sources.\textsuperscript{27}

Other sources of contamination include organic solvents, detergents, and salt. These substances can also cause the restriction enzymes to cut the DNA at the wrong places resulting in an erroneous DNA print.\textsuperscript{28} Error at this stage is far more likely to result in diverse prints rather than a false match.

\textbf{Gel Electrophoresis}

After the DNA is broken down, the restriction fragments are placed on a slab of agarose gel. An electric current is passed through the gel in order to cause the fragments to move from the negative pole to the positive.\textsuperscript{29} The size of the fragments determine the speed with which they move, so that longer fragments will not move as far as shorter ones. The result is that the DNA fragments will align themselves in an orderly pattern of parallel lines.\textsuperscript{30}

An error can occur in this procedure if something causes the entire pattern to “shift” in the gel.\textsuperscript{31} A shift is usually caused by an imperfection in the gel. The result is that the DNA fragments will move further or less than their true length would normally dictate.

Lifecodes utilizes a calibration procedure where a DNA marker of known length is included with the sample.\textsuperscript{32} If, for example, the calibration marker does not move far enough, then it is assumed that all the fragments did not travel as far and the results are adjusted accordingly.\textsuperscript{33}

Uniformity between tests is also a problem because fragments derived from the crime scene are often run on different gels than the suspect’s DNA. The possibility of this difficulty arose in \textit{State of Georgia v. Caldwell}. Experts testified that the fragment pattern derived from the suspect’s DNA had shifted, but that a match could still be determined because the shift was uniform.\textsuperscript{35} Ultimately, the \textit{Caldwell} court accepted the DNA evidence, despite the “shift,” finding that a visual match of the DNA prints from the crime scene and the suspect was confirmed by a scientifically acceptable method.\textsuperscript{36}

\textbf{Southern Transfer}

The purpose of this step is to make a permanent copy of the pattern of the DNA fragments on the gel. First, a nylon membrane is placed on top of the gel. A reservoir of buffer is then placed beneath the gel, and absorbent paper is placed on top of the nylon membrane to pull the buffer through the gel, picking up the DNA fragments along the way. This absorption process causes the fragments to bind to the membrane in the same positions they occupied in the gel.\textsuperscript{37} The resulting copy is known as a “blot.”

The sample is also treated with a chemical which causes the DNA chain to “unzip,” a process which is analogous to cutting the rungs of a ladder. The purpose of this treatment is to prepare the DNA for the next step, hybridization with a genetic probe.

Assuming that this process is carefully done, there should be no reliability problems.

\textbf{Hybridization}

The next step locates portions of the DNA chain that are highly polymorphic or hypervariable. Specially selected pieces of DNA, known as probes, are “tagged” with a radioactive substance and applied to the nylon membrane. The probes attach to specific bases sequences on the DNA chain and act as a radioactive marker. Lifecodes and Cellmark use a single-locus probe that locks onto a polymorphic segment that occurs only once in the DNA chain.\textsuperscript{38} Because all chromosomes are present in duplicate, the resulting DNA print generally has two bands, one inherited from the mother and one from the father.\textsuperscript{39} This polymorphic segment may comprise only a portion of a fragment derived through restriction digestion. This step in the testing process poses no significant reliability problem.

\textbf{Autoradiography}

This step is essentially a “picture” of the positions of the probes. The nylon membrane, containing the radioactively-tagged probe, is placed on a piece of X-ray film. The radioactive energy from the probes expose the film and produces a pattern of bands known as a DNA print.\textsuperscript{40} The position of each band on the DNA print indicates the position of the polymorphic segment on the blot. The location of each tagged segment on the blot, which mirrors the location achieved by corresponding restriction fragments to which the probe attached, indicates the length of the DNA fragment identified.\textsuperscript{41}

The position of the bands on a DNA print varies from one individual to the next because the length of their DNA fragments vary. This procedure is relatively simple and has been reliably used by molecular biologists for over fifteen years.\textsuperscript{42} Assuming it is done correctly, it does not cause a reliability problem.

\textbf{Interpretation of the DNA Print}

The final step in the RFLP process is a comparison of the DNA prints produced from the crime scene and the suspect. If these match, there is a high probability that the samples came from the same source. There are two steps to the procedure. First, the two DNA prints are juxtaposed and examined visually to determine if they exhibit the same total pattern.\textsuperscript{43} Second, the size of each band is measured with the assistance of a computer digitizing system.\textsuperscript{44} The results are measured in terms of kilobase pairs. A kilobase pair is 1,000 base pairs.
For two DNA prints to be considered a match, the two bands compared should not differ by more than three standard variations. The standard deviation for these DNA segment measurements is 0.6 percent. Thus, two bands match if their measurements do not differ by more than plus or minus 1.8 percent. For example, a band length of 1,000 kilobase pairs matches bands with lengths of 982 kilobase pairs or 1,018 kilobase pairs because 1.8 percent of 1,000 is 18.

The Lifecodes matching procedure involves several steps that may result in error. First, the visual comparison for pattern similarity is based solely on subjective impressions with no objective check. This portion of the interpretation can be made difficult by degraded or contaminated DNA samples. Some critics have suggested that commercial labs hired by the prosecution may be more inclined to declare a close call a match where other evidence suggests that the accused committed the crime.

The matching rule of three standard deviations adopted by Lifecodes provides an element of consistency, but in two recent cases, Lifecodes declared a match when the actual deviation was greater. Their explanation for declaring a match was that after a correction required by shifting the samples fell within the matching rule.

An additional source of error is the lack of resolution on the DNA print. This is largely a limitation of the gel electrophoresis process. As previously mentioned, contaminated samples further reduce the sharpness of the DNA print. This lack of clarity is particularly crucial where a rare gene is close in length to a common gene. For example, one gene that is present in 60 percent of the Caucasian population differs in length from another gene found in 0.5 percent of the population by only 100 kilobase pairs. Using the Lifecodes test, these two genes would produce bands only two millimeters apart. Given the subjective element of the interpretation of a DNA print, the possibility of error at any given band length may be substantial, however this is increasingly tempered as the number of other matching bands increase.

III. THE PROBABILITY CALCULATION

After determining a match, the probability of such a match occurring at random is computed. Discounting other factors, the chance of a coincidental match decreases as the number of matching bands and the rarity of those bands increases.

As described above, the first part of the technique involves a measurement of the length of key DNA fragments. Estimates of the frequency with which these particular bands appear in the general population are then utilized to determine the probability of a coincidental match. These frequencies are taken from a database of test results performed upon other individuals.

The probability of a chance match of band lengths is determined through the product rule. The product rule states that the probability of the joint occurrence of two mutually independent events equals the product of the individual probability of each single event. Thus, the frequency of band one is multiplied by the frequency of band two. The result is the probability of having both band one and band two on a DNA molecule. Typically, forensic labs attempt to isolate and measure four different fragments thereby requiring the multiplication of four frequency figures.

The Reliability of Band Measurements

It is uncommon for band length measurements derived from RFLP testing to match exactly. As previously mentioned, Lifecodes considers two bands differing by less than 1.8 percent to be a match. The frequency figure is determined by averaging the length of the known sample with the length of the crime scene specimen and then consulting the database.

For example, assume that a band from the suspect’s DNA print measured 2,000 kilobase pairs while the band from the crime scene DNA print measured 1,960 kilobase pairs; in this case, Lifecodes would use the frequency of a band measuring 1,980 kilobase pairs. One human geneticist has written that this calculation may cause an error on the order of 8,000 fold. In Caldwell, a defense expert recalculated the probability of a random match, without averaging, to be only one in 360.

A fundamental criticism queries whether the lengths of the DNA fragments can accurately determine that the samples came from a common source. While the RFLP test is designed to determine the number of kilobase pairs contained in a restriction fragment, it cannot determine if the restriction fragments contain the same base pairs. Thus, fragments of similar lengths that register as a match under the RFLP test may in fact have a different chemical structure, and hence, may come from a different source. Be aware, however, that the prospect of a false match decline as more restriction fragments are isolated, measured and matched.

The Reliability of Band Frequencies

After computing the average of the two band lengths, Lifecodes looks at the frequency with which this band length will occur in the DNA strain as compared to the general population. Based upon DNA tests of 900 unrelated persons in the New York and Los Angeles areas, Lifecodes compiled a database of gene frequencies. This study provides Lifecodes with relative frequencies of various gene lengths at five loci on the human DNA chain.

The frequency figures used by Lifecodes have come under question. The most significant challenge is that the study is based upon only 900 people in only two cities. Some critics argue that deducing the frequency of fragment lengths from such a small and regional sample of the population is faulty.

The greatest flaw in the gene pool extrapolation may be variation among ethnic groups. The Lifecodes study was broken into three ethnic groups: U.S. Blacks, Caucasians and Hispanics. Significant differences were found in the pattern of distribution and relative frequencies of gene lengths among these three ethnic groups. For example, at D14S13 loci, U.S Blacks had frequencies four times more common than Caucasians and Hispanics for bands 3-4.5 kilobase pairs long. At the D2S44 loci, bands 6.7-9.3 kilobase pairs were found 2.7 times more frequently in U.S. Blacks than in Caucasians. The greatest difference occurred among the most common genes. One conclusion from these results is that there are subgroups even within ethnic groups and that each subgroup could have a different gene frequency distribution.

Another shortcoming of the Lifecodes study is that it does not encompass some ethnic groups, such as Asians, Jews and Native Americans. The lack of data from these groups will pose a reliability problem should a suspect belong to one of these classes. Equally problematic is the question of what to do when a suspect of mixed race is tested. Which gene frequency distribution should be used? What if a portion of the suspect’s ethnic makeup has not been studied? The differing results between the three ethnic groups tested thus far suggest that the untested ethnic groups would also have a different gene distribution. This potential for error should be recognized and warrants further study before these calculations are touted as reliable.

The Reliability of DNA Calculations

Law-enforcement agencies hold great hopes for DNA testing because of its potential for identification. The probability of a random match through blood typing may be as high as 1 in 2.36. Assuming that the test is done correctly and that the frequency calculations accurately
reflect the gene distribution in the population, the probability of a coincidental match between a suspect’s DNA and the sample taken from a crime scene can be as low as one in several hundred million. If the probability calculation is not of this order of magnitude, then counsel should seriously question the results. For example, a probability of 1 in 2,000 might suggest either that a different type of test was performed, or that one or more bands could not be used in the calculation.

As described above, the frequencies generated at each locus on the DNA chain are multiplied together to obtain a total frequency of occurrence for the entire DNA-print pattern. This number when stated as a reciprocal represents the probability of a random match.

However, the use of the product rule will accurately predict the chance of multiple events only if each event is independent from the others. Independence means that the occurrence of one event does not affect the probability of a second event. Thus, the band length at each locus must be independent of both other potential bands at that location and the band lengths at other locations on the DNA chain.

Statistical independence within a locus is referred to as Hardy-Weinberg equilibrium (HW), while statistical independence across loci is called linkage equilibrium (LB). Linkage disequilibrium is considered unlikely when the restriction fragments are on different chromosomes. Lifecodes has reduced the possibility of linkage disequilibrium by using probes that sever the DNA chain at locations significantly distant from one another.

The Hardy-Weinberg Law holds that gene frequencies will remain constant (“equilibrium” will be achieved) from generation to generation within a population unless outside forces act to change them, provided that mating remains random. Processes such as natural selection, inbreeding and population substructuring may cause deviations from the Hardy-Weinberg equilibrium. Population substructuring will result in a statistical phenomenon called the Wahlund effect. The Wahlund effect arises when genetic data from several genetically differentiated populations are collected and treated as if they have come from a single randomly mating population. It is arguable that the existence of ethnic or other subgroups may challenge the appropriateness of using the Hardy-Weinberg Law and the product rule.

A further difficulty is that a sufficiently broad and diverse sampling size is required to determine if a population is in Hardy-Weinberg equilibrium. An assumption of equilibrium based upon a limited sampling may be erroneous. Some experts argue that statistical tests for Hardy-Weinberg equilibrium are not the proper method for determining whether genetic differentiation exists among subgroups in a population, and that the only way to discern genetic variation is through sampling of the subgroups. If assumption of a Hardy-Weinberg equilibrium is erroneous, for whatever reason, then the application of the product rule will not result in a correct assessment of the probability of a random match.

Presenting DNA Test Results to the Jury

Several aspects of the RFLP test and analysis are of questionable accuracy. Some experts argue that the probability calculation is the greatest source of imprecision. Further, the likelihood of a random match, couched in terms of one in several hundred million, can have an overpowering effect upon the jury. The prejudicial impact includes a mistaken belief by the jury that the odds represent the probability that the defendant is not guilty. The sheer magnitude of the ratio distracts the jury from other issues in the case, including the question of whether the DNA test itself was properly done.

In addition, few jurors have the background to evaluate the validity of the probability calculation in an independent fashion. They must rely on the testimony of the party offering the test. The results of a DNA printing test lend a false sense of scientific certainty when they are bolstered with a probability of error that sounds like the odds in a state lottery.

One response to this situation has become known as the "Kidd Rule." Dr. Kidd, testifying on behalf of Lifecodes, stated that any disequilibrium in the Lifecodes database would not reduce the identity power of the test by any more than a power of 10. The court in Wesley took his remark quite literally and reduced the Lifecodes identity power by exactly a power of 10. Dr. Kidd did not mean that this adjustment would make the probability calculation any more accurate, indeed this "rule" is not based upon any scientific or statistical theory.

It is viable to argue that the probability calculation is not presently reliable enough to be admitted into court. In legal jargon, the probability calculation is not sufficiently probative to overcome the potential prejudicial impact against the defendant.

The best solution is to exclude all testimony regarding the probability of a coincidental match between DNA prints. The RFLP test is clearly a valuable and damning forensic tool. Its scientific basis cannot be seriously challenged. The only testimony that should be admitted is a statement that no two people have ever had identical DNA prints, with the exception of identical twins.

IV. ADMISSIBILITY OF DNA TESTING

As prosecutors began introducing DNA test evidence in criminal cases, the courts responded by looking to the evidentiary rules governing the admissibility of novel scientific techniques. Two rules have developed throughout the various jurisdictions: (1) the standard first introduced in Frye v. United States; and (2) the more permissive "relevancy" standard. The majority of jurisdictions apply the Frye rule. Virginia and the Fourth Circuit use the relevancy approach.

Andrews and Wesley: The Fast Track to Judicial Acceptance Begins

One of the first judicial considerations of DNA profiling evidence came under a jurisdiction governed by the relevancy approach. In State v. Andrews, the defendant became the first American convicted on the basis of DNA testing evidence while still maintaining his innocence throughout his trials. His case also resulted in the first appellate decision on the admissibility of DNA testing.

Another early indication of judicial reaction to DNA identification came from a jurisdiction subscribing to the Frye standard. The court in People v. Wesley enthusiastically upheld the use of DNA testing and elaborated on the Frye standard by observing that it does not require a particular procedure be unanimously endorsed in the scientific community, rather that it only be "generally accepted as reliable." In both Andrews and Wesley the prosecution was able to draw upon the expertise of the commercial laboratories marketing the test, and thus, put together testimony superior to that which the defense was able to present. While the courts had considered evidence concerning the implementation of the test, they had neither excluded evidence on this basis nor decided whether such evidence went to weight or admissibility.

Woodall and Spencer: High Courts Examine the Theory

During 1989 two decisions brought the issue of DNA evidence to a higher level of review. The first was State v. Woodall, which involved an inconclusive result from a DNA test. The issue before the court was whether evidence of inconclusiveness in the DNA test should be admissible. The West Virginia Supreme Court of Appeals declared that "the reliability of these tests is now generally accepted by geneticists, biochemists, and the like" and ruled that in the future West Virginia courts may dispense with Frye hearings and simply take judicial notice of the reliability of DNA profiling. The court provided that expert testimony was still admissible for the purpose of impeaching the specific procedures used, or for the results that were obtained; but such expert testimony generally goes to the weight of the evidence, and only in extreme cases will it go to admissibility itself.
The second decision involved the twin cases of *Spencer v. Commonwealth*. These cases were the first instance of a state high court affirming a conviction based upon DNA evidence. In fact, the DNA identification evidence was the only basis for convicting the defendant and for inflicting the death penalty. On the question of admissibility, the *Spencer* court did not state specifically which test should govern, however it did clearly reject the Frye test.

*Spencer* and *Woodall* resembled *Andrews and Wesley* in that the treatment of the DNA identification issue revolved around the theory of the test, rather than the accuracy of the specific procedures employed in the case. The *Woodall* court seemed to agree with the suggestion in *Wesley* that questions regarding adequacy of procedure go primarily to weight rather than admissibility.

**Castro and Schwartz: A Case Specific Threshold Inquiry**

Until the second half of 1989 the courts seemed to be on the fast track to judicial acceptance of DNA testing. This trend was challenged by *People v. Castro*. The *Castro* court quite accurately referred to its efforts as "the most comprehensive and extensive legal examination of DNA forensic identification tests held to date in the United States." The defendant in *Castro* was accused of the murder of a pregnant woman and her young daughter. The defendant was arrested wearing a wrist watch with detectable blood stains on it. While he claimed that the blood was his own, the prosecution sought to introduce DNA evidence demonstrating that the blood was that of the adult victim. The *Castro* court stated that it would follow the *Frye* rule in its consideration of the DNA evidence. The court then applied a three-prong analysis, which was described as follows:

- **Prong I:** Is there a theory, which is generally accepted in the scientific community, which supports the conclusion that DNA forensic testing can produce reliable results?
- **Prong II:** Are there techniques or experiments that currently exist that are capable of producing reliable results in DNA identification and which are generally accepted in the scientific community?
- **Prong III:** Did the laboratory perform the accepted scientific techniques in analyzing the forensic samples in this particular case?

As a theory, DNA analysis passed the first prong of the *Castro* test. Indeed, the court found this to be the "sole area of unanimous agreement" among the scientists and lawyers in the case. The second prong was also met after an in-depth review of the components of the DNA testing process. The court found enough evidence to establish that the techniques utilized in the test were currently recognized in the relevant scientific community and hence capable of producing reliable results in forensic identification.

The third prong was by far the most controversial aspect of the court's analysis and the basis for the most significant part of the case. The court conceded that prior decisions were in disagreement over whether testing procedures, performed in their respective cases, should be part of the *Frye* inquiry. It opined that the *Frye* test too often focused only upon the general acceptance issue and thus overlooked problems involving performance of the test.

The *Castro* court argued that "[t]he focus of this controversy must be shifted" and "centered around the resolution of the third prong." The court then explained that the complexity of the DNA testing procedure and the potential impact it could have upon the jury necessitated such a shift. The court then concluded that this concern would be better addressed in a pre-trial hearing to determine whether the procedure and calculations performed in the particular case were reliable enough for presentation to the jury.

As to the DNA evidence in question, the *Castro* court decided that it was admissible for purposes of excluding the defendant, but inadmissible for purposes of implicating the defendant. This decision was based upon a finding that the testing laboratory had "failed in several major respects to use the generally accepted scientific techniques and experiments for obtaining reliable results." Another recent case suggests that courts may be receptive to the *Castro* analysis. In *State v. Schwartz*, the Minnesota Supreme Court wrote that the question of admissibility under *Frye* "hinges" on "the laboratory's compliance with appropriate standards and controls, and the availability of their testing data and results." The *Schwartz* court, after considering both expert testimony on the laboratory's testing procedures and on guidelines for DNA RFLP analysis established by the Technical Working Group on DNA Analysis Methods, found that the lab performing the test had failed minimum guidelines and ruled that "the test results lack foundational adequacy and, without more, are thus inadmissible."  

**Proposals for Improvement**

In addition to a more detailed analytical framework, the *Castro* court offered three procedural suggestions based upon its extensive study of the issue of DNA evidence. First, a party intending to use DNA identification should give prompt notice to the opposing side. Second, expanded discovery should be permitted. Third, the proponent of the DNA evidence should have the burden of establishing that the tests and calculations in the case were conducted properly.

Another area in need of attention is quality control. Many of the most impressive claims regarding the accuracy and identification capabilities of DNA profiling are based upon laboratory research with "clean" samples. Biochemist Richard Roberts of Cold Spring Harbor Laboratory remarked that if a lab sample fell on the floor, he would throw it away and start over, "but [that] in forensics, all of the samples have been on the floor, so you don't really know what you've got." Another thorough and impressive law review note points out that "[t]he main criticism [of DNA testing] is not that it will never be reliable, but that the lack of uniform standards and quality controls allows the ambiguities and problems in the technique to go unnoticed." The note urges the following controls and standards:

1) controls to ensure the accurate interpretation of results; 2) standards for declaring matches; 3) standards for the choice and number of polymorphic sites studied; 4) standards for determining the probability of a coincidental match and for determining the relevant population studies; 5) standards for record keeping; and 6) standards for proficiency testing and licensing. However, some observers caution against a premature attempt to standardize a rapidly evolving technology and advise full consideration of the potential ethical issues.

**Recent Events**

The adequacy of the genetic databases is a matter of intense debate as of this printing. An article published in *Science* magazine taking issue with the assumptions underlying the probability calculation sparked so much controversy that it prompted an article supporting the current practice, and an editorial "lead-in" article and disclaimer of impartiality by the editors. All within the same issue! The following issue of *Science* included a study devoted to random matches in the Lifecodes and FBI databases concluding that the probability of a matching DNA profile between unrelated individuals to be vanishingly small. Several days after the controversial article in *Science* magazine, the FBI sent out a press release in support of DNA technology and the FBI's methods. In the release it was stated that Drs. Hartl and
Lewontin, the authors of the *Science* magazine article criticizing current probability calculations, made their argument to a federal court in *U.S. v. Yee*. and that even after a seven week admissibility hearing the court admitted both the evidence and the probability calculation.

The FBI press release also made reference to two other events which may have significant bearing on the future of DNA evidence. First, the National Academy of Sciences is scheduled to release their review of DNA testing in criminal trials. This report is expected to address the issue of standards and regulations. Second, Congress is scheduled to hold hearings on scientists' allegations that government officials are harassing them for opposing the introduction of DNA evidence.

The hearings will be devoted to substantive issues raised by defense lawyers' scientific experts, which primarily concern the adequacy of the population base from which the testing labs calculate probabilities. Also, to be discussed is a bill to create a national DNA data bank. Representative Don Edwards, D-Calif., Chairman of the House Subcommittee on Civil and Constitutional Rights, expects the DNA data bank proposal to become law before the end of 1992 either as part of the crime package or as a bill on its own.

On January 9, 1992, the United States Court of Appeals for the Second Circuit became the first federal appellate court to allow DNA testing evidence. The question is pending before the Sixth Circuit.

V. ADVICE FOR DEFENSE COUNSEL

The issues of admissibility, statistical validity and procedural propriety have already been discussed. These issues may form the basis for an evidentiary challenge, but the prospects in a Virginia court do not appear to favor the defense. Several other tactics and preliminary matters deserve attention.

At present, the use of DNA identification technology is primarily a tool for prosecutors. However, there may be times when the state will not have the evidence tested. For example, there may be other evidence suggesting guilt or the defendant may not have an alibi. In such a situation, obtaining the biological evidence through discovery so that an expert retained by the defense can compare samples may be advisable. If there is not a match, then the defense will want to bring up the exclusion of the defendant at trial. If there is a match, the defense will seek to keep the evidence out of trial and will attempt to prevent the prosecution from acquiring discovery of the results. The defense should, through a motion in limine seek an order of the court prohibiting the prosecution from even mentioning at trial that the defense has done any DNA testing.

Under certain circumstances retesting may be warranted. If it appears that an adverse test result will be introduced at trial, then the defense may wish to obtain the sample through discovery in order to have it retested by an independent expert. This option may not be available if there is insufficient sample remaining from the initial test. While the RFLP test requires a significant quantity of biological material, there may be enough remaining for a PCR test. The preservation and reanalysis of biological evidence is likely to become a major concern for the defense bar if DNA testing is routinely accepted by the courts.

Defense attorneys must be prepared to deal with the possibility of DNA evidence at the early stages of a case if the evidence is to be preserved for exclusionary or retesting purposes. A recent United States Supreme Court case holds that the failure of police to preserve potentially useful evidence is not a denial of due process of law unless the defendant can show "bad faith" on the part of law enforcement personnel. Thus, if biological evidence exists and there is a substantial issue over the identity of the perpetrator, then the defense should submit a motion to require preservation of the evidence. A subsequent failure to preserve such evidence may meet the standard set for "bad faith." Again, counsel will need to draft motions to accomplish this objective.

An agency relationship exists between the defense and an expert hired to perform DNA testing. Thus, all of the work in preparation for a test, as well as the actual result, is covered by the work product privilege unless and until, the witness is called to the stand. The jury should not be told that the defense has conducted a test, because to do so would require the jury to speculate about the result of the test. As a practical matter, the defense must usually make a tactical decision early in the case whether it will seek to have a DNA test performed, assuming the prosecution has not already initiated such testing. A defense request for evidence samples will force the prosecution to decide whether to conduct a test before the evidence leaves its custody. Therefore, there is always a calculated risk for the defense in moving for recovering of the evidence first, but it does have the advantage of forcing the prosecution to bear the cost.

The extent to which the defense will be granted discovery of any DNA test results obtained by the state may become an issue. The court may limit discovery to the reports alone, or it may allow discovery of all laboratory notes made during testing as well as permit access to physical evidence such as photographs, autoradiographs, and electrophoretic gels. Because DNA testing is often performed by private laboratories that compete with one another, the company conducting the test may assert a proprietary interest regarding some of the information. The defense may get around this by requesting a protective order to avoid disclosure of trade secrets to a competing firm. If the company continues to resist, the defense may have to argue that the due process rights of the defendant outweigh the economic concerns of a private company.

VI. CONCLUSION

DNA testing is here to stay. In time we may have an affordable test that identifies the actual chemical structure of a forensic sample. While the present technique falls short of this ideal, it is based upon sound theory. Nevertheless, a sophisticated procedure does not guarantee a flawless test. A forensic sample may be contaminated or of insufficient quantity. Human error or equipment flaws are possible in any scientific procedure. Even if these errors are rare, the potentially damning nature of the evidence requires close scrutiny.

The public outcry against seemingly rampant crime has fueled an accelerated acceptance of DNA testing. The multi-faceted technical aspects of DNA testing have caused a reliance upon experts. Until recently, the overwhelming majority of these experts were developing the forensic application of the test either commercially or in law enforcement.

Some courts have gone so far as to take judicial notice of DNA profiling. Without expanded discovery or uniform standards for testing, counsel opposing DNA evidence has little recourse. Most jurisdictions, and Virginia is one of them, consider any potential flaws in the test as factors going to the weight of the evidence rather than admissibility.

A controversial and potentially prejudicial aspect of DNA testing is the probability calculation that accompanies the declaration of a match between the defendant and the sample taken from the crime scene. Admissibility has been challenged on the ground that the probability calculation is not generally accepted scientific technique. The battle-ground for this issue includes not only the courts, but also scientific and legal journals, government studies and, most recently, the United States Congress.

Counsel facing the introduction of DNA evidence should seek as much information as possible about the evidentiary sample, testing procedures and results of the test. Further, counsel should urge that trial participants not refer to the procedure as "DNA fingerprinting." If the test appears to have been conducted properly and admission of the evidence is likely, counsel should at least argue that the recitation of astronomical odds against a random match distracts the jury from their duty to consider all of the evidence.
possible from degraded DNA. In addition, the test is relatively easy to be insufficient for RFLP testing. A second benefit is that testing is relatively easy to perform and can be obtained in a relatively short period of time. The test attempts to identify the “DQ-alpha genotype.” See Sensabaugh & von Beroldingen, The Polymerase Chain Reaction: Application to the Analysis of Biological Evidence, in Forensic DNA Technology 63 (Farley & Harrington ed. 1991).

See also Spencer IV, 240 Va. 78, 393 S.E.2d 609 (1990); note 89 infra.


15Thompson & Ford, The Meaning of a Match: Sources of Ambiguity in the Interpretation of DNA Prints, in Forensic DNA Technology 93 (Farley & Harrington ed. 1991)(hereinafter Thompson & Ford, Ambiguity in DNA Prints). This article is a very detailed account of errors that can and have been made, as well as a listing of cases where ambiguous DNA evidence was an issue. The article can be extremely helpful if an error or shortcoming in the DNA test is suspected.


18Interview with Michael Baird (May 4, 1988), as reported in Boeler & Wiebe, DNA Identification Tests and the Courts, 63 Wash. L. Rev. 903, 919 (1988).


20Id. at 649, 140 Misc.2d at 315.

21Interview with Michael Baird, note 18 supra, wherein it is reported that Lifecodes has observed erroneous bands produced by bacterial DNA.

22Budowle, Baechtel & Adams, Validation with Regard to Environmental Insults of the RFLP Procedure for Forensic Purposes, in Forensic DNA Technology 83 (Farley & Harrington ed. 1991).

23Wesley, 533 N.Y.S.2d at 648, 140 Misc.2d at 315 (The court accepted the claim that all of the steps in DNA testing utilize scientific principles and technology that have gained general acceptance in the scientific field in which they belong).

24Fuchs & Blakesly, Guide to the Use of Type II Restriction Endonucleases, 100 Methods in Enzymology 3, 33-38 (1983). The “troubleshooting guide” lists thirty-seven different possible causes of problems that may be encountered during restriction digestion.

"[Restriction digestion is] regarded as a rather tricky procedure which can yield spurious results if performed in a manner which departs even slightly from an exacting protocol.” Thompson & Ford, DNA Typing: Acceptance and Weight, note 14 supra, at 68.


27Fuchs & Blakesley, note 24 supra, at 5. According to Fuchs and Blakesley, the most important factors affecting the performance of restriction enzymes are: (a) the purity and physical characteristics of the substrate DNA; (b) the reagents used in the reaction; (c) the assay volume and associated errors; and (d) the time and temperature of incubation.

There are hundreds of different restriction enzymes available that recognize and cut at different sites. Brooks, Properties and Uses of Restriction Endonucleases, in Methods in Enzymology 152:113 (1987).


29Wesley, 553 N.Y.S.2d at 649, 140 Misc. 2d at 315-16.

30Id.

31Thompson & Ford, note 14 supra, at 70.


33Baird et al., note 46 supra, at 494.

34260 Ga. 278, 393 S.E.2d 436 (1990); Harvey & Berry, DNA Typing: Keeping the State Out of Your Client’s Genes, 8 Champion 19, 24 (1989).

35Id. at 288, 393 S.E.2d at 443.

36Id.


38Thompson & Ford, note 14 supra, at 72. Multi-locus probes are also used, usually in paternity cases, which lock onto “families” of polymorphic DNA segments that occur at many locations on the human DNA chain. These multi-locus probes produce approximately fifteen interpretable bands.

39Only one band will appear in cases where the maternal and paternal alleles are identical, for example when parents have the same blood type. Thompson & Ford, DNA Typing: Acceptance and Weight, note 14 supra, at 72.

40Id. at 74.

41Id.


43Baird, note 32 supra, at 44.

44Id. at 44-46.

45The standard deviation is the average amount all band lengths differ in magnitude from the mean band length computed for that locus.


47Baird, note 32 supra, at 46-47.

48Moss, note 2 supra, at 67. A degraded or contaminated DNA sample can result in a print that is less clear or one that has too many bands.


51Baird et al., note 46 supra, at 494.

52Thompson & Ford, note 14 supra, at 81.


55Baird, note 47 supra.

56Quoted from Dr. Eric Lander, a human geneticist and mathematician at Whitehead Institute for Biomedical Research Cambridge, Mass., as reported in Harvey & Berry, note 27 supra.

57Harvey & Berry, note 34 supra.

58Balazs et al., note 53 supra, at 182.

59Id.

60Balazs et al., note 45 supra, at 187-88.

61Id.

62Id.


64For example, Lifecodes will save a small portion of the crime scene sample for Polymerase Chain Reaction (PCR) testing which amplifies informative gene sequences.

65The use of a reciprocal here results in the translation of a decimal figure to a fraction. For example, 0.03 can be stated as 3/100 or as a probability of 3 in 100.

66Tribe, note 54 supra, at 1335-36.


68Id.

69Balazs et al., note 53 supra, at 185.

70Vogel & Motulsky, Human Genetics 152 (2d ed. 1986).

71Mueller, note 67 supra.
The court had not definitively handled the issue. The court explicitly adopted the relevancy standard, and noted that the lower applicable law on admission of scientific evidence).

A physician was prosecuted for the murder of his wife. The trial accepted a forensic test indicating the presence of a particular poison in the victim's body, even though the test was developed for use with Dr. Kenneth Kidd (Nov. 21, 1989)).

Just when a scientific principle or discovery crosses the line between the experimental and demonstrable stages is difficult to define. Somewhere in this twilight zone the evidential force of the principle must be recognized, and while courts will go a long way in admitting expert testimony deduced from a well-recognized scientific principle or discovery, the thing from which the deduction is made must be sufficiently established to have gained general acceptance in the particular field in which it belongs.

Under the relevancy standard, the question of admissibility is evaluated by the logical relevancy of the evidence, such that exclusion is required when its probative value is outweighed by potential prejudice. McCormick on Evidence § 203, at 607 (E. Cleary 3d ed. 1984). One statement of the test urges scrutiny of:

(1) the soundness and reliability of the process or technique used in generating the evidence, (2) the possibility that admitting the evidence would overwhelm, confuse, or mislead the jury, and (3) the proffered connection between the scientific research or test result to be presented, and particular disputed factual issues in the case.


Florida has a history of receiving novel scientific evidence readily. See e.g., Coppolino v. State, 223 So.2d 68 (Fla. Dist. Ct. App. 1968), cert. denied, 399 U.S. 427 (1970). In this highly publicized matter, a physician was prosecuted for the murder of his wife. The trial court accepted a forensic test indicating the presence of a particular poison in the victim's body, even though the test was developed for use in the investigation. Dr. Coppolino's appeal was denied, despite the able representation of F. Lee Bailey, and represented the first significant statement of the test urges scrutiny of:

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See Giannelli & Imwinkelreid, Scientific Evidence § 1-5, at 10-11 (1986)(describing Frye as the majority test); Thompson & Ford, note 14 supra, at 53.


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This prolific work by Janet Hoeffel borders on a treatise. Counsel

Evidence Meets the Criminal Defendant, 42 Stan. Law Rev. 465 (1990). This prolific work by Janet Hoeffel borders on a treatise. Counsel opposing the introduction of DNA evidence should strongly consider reading it.

105Id.

106Id. at 974-77, 980, 545 N.Y.S.2d at 996-97, 999.

107Id. at 428.

108 The Technical Working Group on DNA Analysis Methods is an FBI-coordinated group of scientists from the United States and Canada.


110Id. at 428.

111 The Castro court would require that the proponent of the DNA evidence to allow discovery of the following:

1) Copies of the autorads, with the opportunity to examine the originals. 2) Copies of laboratory books. 3) Copies of quality control tests run on material utilized. 4) Copies of reports by the testing laboratory issued to proponent. 5) A written report by the testing laboratory setting forth the method used to declare a match or non-match, with actual size measurements, and mean or average size measurement, if applicable, together with standard deviation used. 6) A statement by the testing lab, setting forth the method used to calculate the allele frequency in the relevant population. 7) A copy of the data pool for each loci examined. 8) A certification by the testing lab that the same rule used to declare a match was used to determine the allele frequency in the population. 9) A statement setting forth observed contaminants, the reasons therefore, and tests performed to determine the origin and the results thereof. 10) If the sample is degraded, a statement setting forth the tests performed and the results thereof. 11) A statement setting forth any other observed defects or laboratory errors, the reasons therefore and the results thereof. 12) Chain of custody documents.

Castro, 144 Misc.2d at 978-79, 545 N.Y.S.2d at 999.

112Id. at 979, 545 N.Y.S.2d at 999. After such a burden has been met, however, the ultimate burden of proof would shift to the adversary to show (by a preponderance of evidence) that the tests or calculations should not be admitted or should be modified. If issues of fact were to arise at the pre-trial hearing relating to the reliability of a particular test used in the case, or the size or ratio of the population frequency calculated, they would normally go to the weight of the evidence. Where, however, the procedures reach the level of unreliability found in Castro, the results would be inadmissible as a matter of law.

For an interesting argument that the opponent of the evidence should bear the burden of proof, see Imwinkelreid, A Debate in the DNA Cases Over the Foundation for the Admission of Scientific Evidence: The Importance of Human Error as a Cause of Forensic Misanalysis, 69 Wash. Univ. Law Q. 19 (1991).


115Id. at 479.

116Id.

117Wikowski, Milestones in the Development of DNA Technology, in Forensic DNA Technology 1, 14-17 (Farley & Harrington ed. 1991) (These suggestions were made in support of continued use of DNA testing).


121Was Science Fair to its Authors?, 254 Science 1722 (1991).

Disagreement over the issue of DNA evidence extends into the editorial board of Science magazine. The same day that the controversial issue was published, a major newspaper reported that [a]mong those strongly criticizing the paper... was Dr. C. Thomas Caskey of Baylor College of Medicine. Dr. Caskey, a member of Science's board of reviewing editors, is a strong defender of DNA fingerprinting, and has a $200,000 grant from the Justice Department to study the method. According to Nature, Dr. Caskey licenses his method to Cellmark Diagnostics, a company that does DNA fingerprinting.


For the Lifecodes database, the probability of a three-locus match ranges from 1 in 6,233 in Caucasians to 1 in 119,889 in Blacks. When considering all trios of five loci in the FBI database, there was only a single match observed out of more than 7.6 million comparisons. If independence is assumed [the probability calculations imply] that the minimum number of possible patterns for each ethnic group is several orders of magnitude greater than their corresponding population sizes in the United States.

The authors concluded that the chance of five-out-of-five site match occurring between two individuals of various ethnic groups to be no less than 1 in a trillion.


12491-3608 (6th Cir.)

125This study was partially funded by the FBI.


The FBI press release, note 23 supra, included a rebuttal to charges of harassment which stated that the FBI permits its attorneys to assist prosecutors in aggressively rebutting those who argue to keep DNA results out of court. In providing such assistance, the FBI has not in any way attempted to limit scientific debate or intimidate scientists into withholding publications critical of DNA testing in criminal cases.

127Kolata, note 121 supra. Among other complaints was that of a foreign expert, Dr. Ford, who claims that an FBI lawyer questioned him about the status of his visa during cross-examination in an Arizona trial.

128Sherman, note 126 supra. The FBI supports this idea wholeheartedly. See Baechtel, Monson, Forsen, Budowle and Kearney, Track-
**DRUG FELONY CAPITAL MURDER IN VIRGINIA**

**BY: SHARRON LAMOREAUX**

In 1990, Virginia amended its capital murder statute, Virginia Code § 18.2-31, by adding subdivision 9. The amendment provides that a killing during and for the purpose of furthering a drug transaction constitutes capital murder, punishable by the death penalty or life imprisonment. It is important for attorneys defending clients faced with murder and/or drug charges to be aware of the new provision and its meaning. This article explores the structure and scope of § 18.2-31(9) and compares it to a somewhat similar federal statute.

**Statutory Structure**

The Virginia drug felony capital murder provision involves three separate code sections. Virginia Code § 18.2-31(9) establishes that capital murder includes a “willful, deliberate, and premeditated killing of any person in the commission of or attempted commission of a violation of § 18.2-248, involving a Schedule I or II controlled substance, when such killing is for the purpose of furthering the commission or attempted commission of such violation.” Without § 18.2-31(9), a killing during a violation of § 18.2-248 could not be classified as capital murder solely because of that violation.

Section 18.2-248, violation of which is the felony predicate for § 18.2-31(9), addresses the distribution of drugs. Under this section, it is illegal to “manufacture, sell, give, distribute, or possess with intent to manufacture, sell, give or distribute a controlled substance or an imitation controlled substance” without authorization. Maximum punishments for violations vary with the nature of the substances involved. Trafficking in less serious drugs is a misdemeanor, punishable by jail time of not more than one year and/or a fine of not more than $2,500.¹ A violation of § 18.2-248 involving more serious drugs is punishable by five to forty years for the first offense and as much as a life sentence for subsequent convictions.

Controlled substances are classified as to their degree of seriousness by five schedules in The Drug Control Act, codified at Virginia Code § 54.1-3400 et sequitur. Only substances in Schedules I and II are pertinent to the drug felony murder provision — murders involving substances from Schedules III, IV, and V are not provided for in § 18.2-31. Schedules I and II include substances that have a high potential for abuse, such as heroin, mescaline, methaqualone, morphine, and cocaine.²

**Statutory Breadth: Picking the Correct Defendant**

Determining the scope of § 18.2-31(9) requires examining several aspects of § 18.2-31(9) itself and of § 18.2-248. The role of The Drug Control Act in this determination, although important for purposes of knowing which substances are in Schedules I and II and which are not, is fairly straightforward and consequently will not be further considered in this article.

It should first be noted that first degree murder is necessary for § 18.2-31(9) to apply. As with the other subsections of the capital murder statute, subsection 9 requires a “willful, deliberate, and premeditated” killing. Although the usual rule that premeditation need not exist for any specified period of time prior to the killing applies,² still the intent to kill must be formed before or at the time of the murder.³ An unintentional or grossly negligent or malicious killing that occurs during a drug transaction, therefore, would not be covered by the statute.

A second factor limiting the scope of the drug felony murder provision arises from § 18.2-248. Section 18.2-248 is a specific intent law — it requires manufacture, distribution, or possession of drugs or imitation drugs with intent to manufacture or distribute the same. Committing a prohibited act without having the prohibited intent is not a violation of this section and thus not a basis for a capital murder charge. For example, processing or transferring an illegal substance, thereby committing a prohibited act, without being aware of its illegality and thus not having the prohibited intent is not a violation. A murder to facilitate such an act would therefore not qualify as capital murder.

Furthermore, simple possession of a drug is also not encompassed by § 18.2-248.⁴ Although possession may violate another Virginia law,⁵ it is no violation of § 18.2-248 and thus again cannot be a basis for a capital murder charge. Apparently, then, a killing to further mere possession of a controlled substance, without intent to subsequently transfer the substance, is not chargeable as capital murder.

Finally, the last clause of § 18.2-31(9) is significant. The clause specifies that a murder during the commission or attempted commission of a § 18.2-248 violation must be “for the purpose of furthering the commission or attempted commission of such violation.” This phrase on its face seems to narrow the applicability of § 18.2-31(9) to premeditated murders committed in the course of an illegal drug transaction expressly to advance that transaction. Premeditated murders committed during drug transactions but not to aid or advance the transactions would appear to be outside the capital murder provision. Because the requirement is “for the purpose of furthering,” however, murders undertaken to aid the drug