

Supreme Judicial Court of Massachusetts

COMMONWEALTH v. ROSIER

Argued May 5, 1997

Decided August 25, 1997

685 N.E.2d 739 (Mass. 1997)

GREANEY, Justice.

A jury in the Superior Court convicted the defendant, Adam Rosier, of murder in the first degree (by reason of deliberate premeditation and extreme atrocity or cruelty) of sixteen year old Kristal Hopkins. Represented by new counsel on appeal, the defendant contends that a new trial is required because of error in the admission of deoxyribonucleic acid (DNA) test results that tended to identify samples recovered from the defendant's automobile as coming from the victim, and in the jury instructions concerning evaluation of the DNA evidence and the issue of intoxication. We reject the defendant's arguments. We also find no basis to exercise our authority pursuant to G.L. c. 278, § 33E, to grant the defendant any relief. Consequently, we affirm his conviction.

We first provide an overview of the Commonwealth's case against the defendant. After attending a party where people were watching football, drinking beer, and smoking marihuana, the defendant drove away in an automobile with the victim. A witness testified that he saw the victim and the defendant at the party talking and drinking beer, and that they both appeared to be drunk. The next day, hunters found the victim alive in the Pittsfield State Forest. She was barely breathing, clothed only from the waist up, and covered with blood. Her face was badly beaten, and she had deep abrasions, open wounds, and "road burns" on both sides of her legs. Her torso was scraped and bruised, and she had bruises and red marks around her neck. The victim died two hours after being rushed to a hospital. A State trooper involved in the investigation observed, approximately one-half mile away from the main gate of the State forest, skid marks going off the road and a tree that appeared to have been hit by an automobile (as evidenced by the transference of paint). The trooper recovered pieces of shattered safety glass and a piece of black plastic imprinted with a series of numbers and the Ford Motor Company logo.

The medical examiner testified that his autopsy of the victim revealed injuries that were consistent with large blunt trauma, which could have been caused either by impact or by compression. He stated that, if the victim had been struck by an automobile, the injuries were consistent with the body's being struck while in a crawling or semi-prone position. He expressed the opinion that all of the injuries were consistent with the victim's having been struck, run over, and dragged by an automobile, in two different directions.

On the night of the murder, the defendant was driving a Mercury Capri automobile (a Ford Motor Company product), owned by his girl friend's father. The defendant told the father, when questioned about damage to the vehicle's passenger side door and a

broken window, that someone had backed into it.¹ The next day, the defendant asked a friend if he had heard about the girl killed in the State forest; his friend responded, "What the hell did you do now?" The defendant replied that he had "fucked up" and killed her. The defendant went on to explain that he had had sexual intercourse with the victim, after which they engaged in a violent argument. The defendant stated to his friend that he had thrown the victim and her clothing out of the automobile, had hit and "stomped" on her "to shut her up," and then had backed the automobile over the victim and drove forward again, running her over once more. The defendant also told a cellmate at the Berkshire County house of correction that, "[I]ike that girl, I know I did it, I know I killed that girl." The defendant warned this witness not to tell anyone about his admission.

We next describe the background of the DNA evidence. During its investigation, the State police recovered bloodstains from the undercarriage of the Mercury Capri, from a tire, and from the inside passenger side of the vehicle. The State police also recovered "a white threadlike substance" that appeared to be human tissue from the undercarriage. The Commonwealth engaged Cellmark Diagnostics (Cellmark), a recognized forensic laboratory located in Germantown, Maryland, to perform DNA testing on two blood stains taken from the undercarriage of the automobile, one blood stain from the front tire on the passenger side, one blood stain taken from the passenger side quarter panel, the threadlike substance that appeared to be human tissue found on the undercarriage, a blood sample taken from the victim, and one taken from the defendant.² [FN2] Cellmark completed the testing using the polymerase chain reaction (PCR) method, and submitted a written report to the State police. The report concluded that PCR-based testing disclosed that the victim could not be excluded as the source of the DNA obtained from three of the blood stain samples and the human tissue sample,³ and that the approximate frequencies in the Caucasian and African-American populations between the genotypes analyzed in the sample, when compared with the same genotypes obtained from the victim's blood sample, were 1 in 770,000 for the Caucasian population and 1 in 7.5 million for the African-American population.

The defendant filed a motion in limine to exclude the Cellmark DNA test results from evidence. A judge in the Superior Court held an evidentiary hearing on the motion,⁴ where he heard testimony from two prospective Commonwealth witnesses, Dr. Charlotte J. Word, a microbiologist specializing in DNA identification testing and Senior Scientist at Cellmark, and Dr. Christopher J. Basten, a population geneticist from North Carolina State University. After the hearing, the judge entered a memorandum of decision in which he concluded "that the proffered expert opinion

¹ Later the next day, the defendant admitted to his girl friend that he had hit a tree.

² Despite the powerful nature of the Commonwealth's proof against the defendant adumbrated above, the prosecution appears to have decided that DNA testing was needed as a precaution to forestall any claim by the defendant that the bloodstains and human tissue taken from the Mercury Capri belonged to someone other than the victim. See *Commonwealth v. Daggett*, 416 Mass. 347, 353, 622 N.E.2d 272 (1993).

³ The defendant was excluded as the source of the blood stains.

⁴ This judge also presided at the trial.

evidence concerning the results of Cellmark's PCR-based DNA testing in this case, as well as expert opinion evidence as to the validity and reliability of Cellmark's statistical analysis, will assist the trier of fact to understand the evidence or otherwise to determine a fact in issue [and] that the results are scientifically valid and reliable, and that the testimony which [the court] heard complies with the standard enunciated in both [*Daubert v. Merrell Dow Pharmaceuticals, Inc.*, 509 U.S. 579, 592-595, 113 S.Ct. 2786, 2796-2798, 125 L.Ed.2d 469 (1993), and *Commonwealth v. Lanigan*, 419 Mass. 15, 24-27, 641 N.E.2d 1342 (1994)]." The DNA test results were admitted in evidence before the jury through the testimony of Dr. Word and Dr. Basten (and two other witnesses), and no issue is raised that the defendant has not preserved the right to challenge the judge's rulings on appeal.

1. We turn now to the issues involving the DNA evidence. As has been indicated, the samples submitted by the State police for DNA analysis were examined by the PCR method,⁵ and Cellmark performed DQA1, PM, and STR testing, using three commercial kits.⁶ We have explained the PCR method and the process of testing at the DQA1 and PM loci in *Commonwealth v. Vao Sok*, 425 Mass. 787, 683 N.E.2d 671 (1997). We need to explain STR testing.⁷ STR is an acronym for short tandem repeat. A tandem repeat involves multiple copies of identical DNA sequence arranged in direct succession in a particular region of a chromosome. A short tandem repeat is a tandem repeat in which the repeat units are three, four, or five base pairs (a base pair has two complementary nucleotides). Loci containing STRs are scattered throughout the chromosomes in enormous numbers. Such loci have a fairly large number of alleles and are usually capable of unique identification. Cellmark tested at three STR loci,⁸ which, in combination with the testing at the DQA1 and PM loci, gave results from nine different loci. The STR testing became important in the case because Cellmark had done prior DNA testing on the samples submitted examining only the DQA1 and PM loci and had concluded, based on results from those loci, that the population frequencies between the victim and the Caucasian and African- American population were 1 in 5,500 and 1 in 11,000 respectively. The additional testing of the STR loci, when considered with the results of the DQA1 and PM testing, increased the probabilities to 1 in 770,000 (Caucasian) and 1 in 7.5 million (African-American). As Dr. Basten agreed, STR analysis made a "significant difference" in terms of the frequency in which the genetic markers would be expected to be seen within a population. As the judge found: "At the CSF1PO locus, scientists have observed nine different alleles, giving rise to 45 possible genotypes. At the TPOX locus, seven

⁵ The PCR method was utilized because the samples were too small to be tested by the Restriction Fragment Length Polymorphism (RFLP) method, which requires larger samples of investigatory materials before profiling can be satisfactorily done. See *Commonwealth v. Vao Sok*, 425 Mass. 787, 683 N.E.2d 671 (1997).

⁶ The AmpliType HLA DQa Forensic DNA Amplification and Typing Kit, the AmpliType PM PCR Amplification and Typing Kit, and GenePrint STR Systems. The DQA1 and PM kits appear to be the same kits that were used by the Center for Blood Research, the laboratory that did the DNA testing in *Commonwealth v. Vao Sok*, *supra* at 790-94, 683 N.E.2d at 674-75.

⁷ All the information that follows as to STR testing is taken from the 1996 report of the National Research Council entitled, *The Evaluation of Forensic DNA Evidence* (1996 NRC Report).

⁸ The STR loci tested were at chromosomes identified as CSF1PO, TPOX, and TH01 using GenePrint STR systems.

different alleles have been observed, giving rise to 28 possible genotypes. At the TH01 locus, eight different alleles have been observed, giving rise to 36 possible genotypes."

At the hearing on the motion in limine, the defendant did not specifically challenge the collection and preservation of the samples submitted to Cellmark for DNA testing, the quality control and assurance standards at the laboratory,⁹ the use of the PCR method, the reliability of the three test procedures or the accuracy of the test results obtained from the use of the typing kits. The judge had an ample basis for finding Dr. Word and Dr. Basten to be well-qualified experts in their respective fields, and he left no doubt about the effect of their testimony when he stated in his memorandum that "I find Dr. Word and Dr. Basten to be extremely impressive, superbly qualified, and completely credible witnesses."

The PCR method is scientifically valid, and testing at the DQA1 and PM loci is scientifically reliable, if properly done. *Commonwealth v. Vao Sok, supra* at 799, 683 N.E.2d at 679. The defendant's appellate counsel appears to suggest that STR testing is unreliable because it is too new. No specific scientific or forensic evidence or literature is offered to support that suggestion. The judge heard testimony that, in 1991, several years before the STR kit became commercially available, Cellmark, working under contract to the United States government, used STR testing to identify the remains of soldiers killed in Operation Desert Storm, and that, by the time of the hearing, Cellmark had performed STR analysis in approximately fifty cases and had been permitted to testify as to its test results in at least five cases.¹⁰ While we have not been directed to any decisional law approving STR testing, an authoritative scientific study, the 1996 report of the National Research Council entitled, *The Evaluation of Forensic DNA Evidence (1996 NRC Report)*, has concluded (*id.* at 71) that STR testing is "coming into wide use," that "STR loci appear to be particularly appropriate for forensic use" (*id.* at 117), and that "STRs can take their place along with VNTRs as forensic tools" (*id.* at 35). The latter comment appears to recognize that STR testing is similar in principle to the RFLP (or VNTR) method, which has been found to be reliable. See *Commonwealth v. Daggett*, 416 Mass. 347, 350 n. 1, 622 N.E.2d 272 (1993). Based on the evidence before him and his careful analysis of the subject, the judge properly concluded that the methodology underlying the PCR-based tests in this case, including the STR testing, was scientifically valid and relevant to a fact at trial. See *Commonwealth v. Lanigan, supra* at 26, 641 N.E.2d 1342.¹¹

⁹ Cellmark is accredited for forensic work by the American Society of Crime Laboratory Directors and for paternity testing by the American Association of Blood Banks. The accreditations are the result of audits of Cellmark's work by these accrediting groups and regular proficiency and quality assurance testing. The testing and other safeguards adhered to by Cellmark comply with the guidelines set out by the Technical Working Group on DNA Analysis Methods (TWGDAM), a group of forensic DNA analysts from government and private laboratories who are considered authoritative in the field.

¹⁰ Dr. Word testified that, prior to using STR testing in forensic cases, Cellmark had conducted extensive validation tests to evaluate the reliability and sensitivity of STR testing, as well as how much DNA was needed to get results and the development of other "testing parameters."

¹¹ See also Micka, *Validation of Multiplex Polymorphic STR Amplification Sets Developed for Personal Identification Applications*, 41 J. Forensic Sci. 582, 589 (1996) (validating combined STR testing at

The defendant's principal attack on the DNA results is focused on the evidence pertaining to the statistical significance of the match found by the three tests between the DNA in the blood stains and tissue taken from the automobile and the victim's DNA. Evidence of a match based on correctly used testing systems is of little or no value without reliable evidence indicating the "significance of the match, that is, evidence of the probability of a random match of [the victim's or] the defendant's DNA in the general population." *Commonwealth v. Lanigan, supra* at 20, 641 N.E.2d 1342. To obtain the relevant statistical results in this case, Cellmark used a database it had developed using samples taken from paternity studies done at Cellmark.¹² At the time of the hearing, Cellmark's database was the only one that used samples from the same persons for all of the nine loci analyzed under the DQA1, PM, and STR tests used by Cellmark. The statistical results were calculated by means of the product rule. "Under the product rule, the frequency in the population base of each allele disclosed in the DNA test is multiplied to produce the frequency of the combination of all the alleles found." *Commonwealth v. Lanigan, supra* at 21, 641 N.E.2d 1342, citing *Commonwealth v. Curnin*, 409 Mass. 218, 224 n. 10, 225 n. 11, 565 N.E.2d 440 (1991). The defendant argues that Cellmark's database is too small and, for various other reasons, unreliable.

The judge acted properly in rejecting the defendant's arguments. He accepted the expert testimony that the Cellmark database was adequate and common within the field and that a database larger than Cellmark's would produce "no significant difference in the result." There was expert and scientific evidence that the Cellmark database met two factors critical to the reliability of a database. The first factor, "linkage equilibrium" (LE), establishes that the various chromosomal loci identified in a database occur randomly in proportion to one another, thus assuring that results related to one locus are not affected by, nor predictive of, the results related to another.¹³ The second factor is "Hardy-Weinberg equilibrium" (HW). A database is considered to be "in HW" when the predicted values for the various loci within the database actually correspond to those found in the population, assuming mates are randomly chosen. Thus, it was properly found that the Cellmark database was both in LE and in HW. The database and statistical results reached by Cellmark were also independently verified by Dr. Basten through calculations of "confidence intervals"¹⁴ and a comparison of

CSF1PO, TPOX, and TH01, through GenePrint STR Systems; testing found "sensitive and robust," and "highly reliable").

¹² The database consisted of one hundred blood samples from Caucasian persons and one hundred blood samples from African-American persons.

¹³ There was evidence that the Cellmark database, better than any combination of available databases, allowed for proper testing for LE to determine whether the identified alleles are genetically independent, because it used the same persons for testing results in each of its systems.

¹⁴ Dr. Basten's process of "confidence intervals" involved the selection of individuals at random from Cellmark's database to create a new database and then utilizing a computer to repeat the procedure 1,000 times so that 1,000 new databases of one hundred individuals each were produced. A complicated statistical analysis then followed (which is set forth in the judge's memorandum and need not be described here) to arrive at a statistical result that, according to Dr. Basten, verified Cellmark's results and frequency conclusions. The fact that the proportions derived by Dr. Basten from the confidence intervals differed

Cellmark's results with other databases that achieved statistically comparable results.¹⁵ Dr. Basten also concluded that the methods used by Cellmark to generate statistical results are "generally accepted" within the field of population genetics, and that the statistical results they produce are reliable and accurate.

At the motion hearing, the defendant did not make any argument that Cellmark's use of the product rule to reach its conclusions about population frequencies was wrong. We think it is appropriate, however, to discuss the product rule to assure completeness in the examination of this phase of the case. In *Commonwealth v. Lanigan, supra* at 21, 641 N.E.2d 1342, we stated that "[t]he product or multiplication rule is based on the assumption that the population does not contain subpopulations with distinct allele frequencies, and, therefore, each person's alleles constitute statistically independent random selections from a common gene pool." We went on to state that "[t]he validity of the use of the multiplication rule thus depends on the absence of population substructure. If there is population substructure, the assumption of complete statistical independence of alleles is not valid." *Id.* To ameliorate this problem, we accepted the recommendation that population frequencies be calculated by use of "the ceiling principle," which was "adopted to make irrelevant the dispute among population geneticists over the question whether the product rule may properly be used to express numerically the probability of finding a DNA match in a random selection of the appropriate population." *Id.* at 26, 641 N.E.2d 1342. The ceiling principle was recommended by the National Research Council in its 1992 Report on The Evaluation of Forensic DNA Evidence to help quiet the significant debate over potential problems arising out of population substructuring.¹⁶

It is fair to say that the controversy has been resolved in large part. The 1996 NRC Report notes (*id.* at 53) that "information is now available from a number of relevant populations, so that experts can usually base estimates on an appropriate database." In considering the same question, the admissibility of statistical evidence calculated under

from Cellmark's proportions did not throw the latter into doubt, because, as the judge noted, Dr. Basten was conducting a verification test and not a test designed to express an opinion as to the actual frequency of genotypes derived from the crime scene samples in the population at large.

¹⁵ Three other databases were consulted by Dr. Basten: one developed by the Federal Bureau of Investigation (FBI) and published in the *Journal of Forensic Science*; and two others as reported at the Fifth International Symposium on Human Identification.

¹⁶ The 1996 NRC Report describes the "ceiling principle" and the "interim ceiling principle" as follows: "The 1992 report ... recommended the use of an ad hoc approach for the calculation of an upper bound on the frequencies that would be found in any real population; this approach used what was termed the 'ceiling principle.' The report recommended that population frequency data be collected on homogeneous populations from 15-20 racial and ethnic groups. The highest frequency of a marker in any population, or 5%--whichever was higher, was to be used for calculation. Until the highest frequencies were available an 'interim ceiling principle' was to be used. That would assign to each marker the highest frequency value found in any population database (adjusted upward to allow for statistical uncertainty) or 10%-- whichever was higher. The result would be a composite profile frequency that did not depend on a specific racial or ethnic database and would practically always exceed the frequency calculated from the database of the reference populations." *Id.* at 52.

the product rule, the Supreme Court of Washington cited a major Federal Bureau of Investigation (FBI) study of VNTR frequency data from around the world entitled, VNTR Population Data: A Worldwide Study (Feb.1993) (Worldwide Study), which concluded that the product rule is reliable and valid.¹⁷ *State v. Copeland*, 130 Wash.2d 244, 267-268, 922 P.2d 1304 (1996), quoting Worldwide Study, *supra* at 2. That report has been supported by other studies that have similarly concluded that differences of allelic distribution are not forensically significant,¹⁸ and courts that have examined the question have agreed that challenges to the use of the product rule have been sufficiently resolved. See, e.g., *Lindsey v. People*, 892 P.2d 281, 292 (Colo.1995); *Armstead v. State*, 342 Md. 38, 83, 673 A.2d 221 (1996); *People v. Chandler*, 211 Mich.App. 604, 610, 536 N.W.2d 799 (1995), overruled on other grounds, *People v. Edgett*, 220 Mich.App. 686, 560 N.W.2d 360 (1996); *State v. Copeland*, *supra* at 269, 922 P.2d 1304. It is important to note as well: "The ceiling principles were intended for VNTRs with many alleles, no one of which has a very high frequency [and t]hey are not applicable to PCR-based systems." 1996 NRC Report at 158.¹⁹ We agree with the conclusions of the 1996 NRC Report that "both the ceiling principle and the interim ceiling principle are unnecessary," (*id.* at 162) and that "[i]n general, the calculation of a profile frequency should be made with the product rule," (*id.* at 5) both for VNTR and PCR-based systems.²⁰ Thus, the use of the product rule by Cellmark in connection with its PCR-based testing in this case was scientifically acceptable.

¹⁷ The Worldwide Study study, *supra* at 2, concluded as follows:

"(1) that there are sufficient population data available to determine whether or not forensically significant differences might occur when using different population databases; (2) that subdivision, either by ethnic group or by U.S. geographic region, within a major population group does not substantially affect forensic estimates of the likelihood of occurrence of a DNA profile; (3) that estimates of the likelihood of occurrence of a DNA profile using major population group databases (e.g., Caucasian, Black, and Hispanic) provide a greater range of frequencies than would estimates from subgroups of a major population category; therefore, the estimate of the likelihood of occurrence of a DNA profile derived by the current practice of employing the multiplication rule and using general population databases for allele frequencies is reliable, valid, and meaningful, without forensically significant consequences; and (4) that the data do not support the need for alternate procedures, such as the ceiling principle approach."

¹⁸ See, e.g., Budowle, The Assessment of Frequency Estimates of Hae III-Generated VNTR Profiles in Various Reference Databases, 39 J. Forensic Sci. 319 (1994); Budowle, Evaluation of Hinf I-Generated VNTR Profile Frequencies Determined Using Various Ethnic Databases, 39 J. Forensic Sci. 988 (1994); Shui The Development of DNA Profiling Database in an HAE III Based RFLP System for Chinese, Malays, and Indians in Singapore, 38 J. Forensic Sci. 874 (1993).

¹⁹ The judge noted that the ceiling principle arose in the context of RFLP testing, the technological limitations of which made it impossible to recognize specific allele types. Because PCR-based testing identifies specific alleles and genotypes at specific loci, the arguments voiced by critics of the product rule as applied to RFLP testing do not apply to PCR- based testing.

²⁰ The 1996 NRC Report also recommends that "[i]f the race of the person who left the evidence sample DNA is known, the database for the person's race should be used; if the race is not known, calculations for all the racial groups to which possible suspects belong should be made." 1996 NRC Report at 5 (Recommendation 4.1 of the Recommendations for Estimating Random-

2. We reject the defendant's arguments that, in two areas, the jury instructions were flawed.

(a) The judge refused to give the jury instruction that was requested by the defendant with respect to DNA evidence. There is no requirement that a judge give a special instruction on the role of DNA evidence. The judge had discretion in determining how he would instruct the jury on the issue. He gave a comprehensive and correct instruction on the evaluation of expert testimony, listing the witnesses who testified on the DNA evidence among the experts to whom the instruction applied, and he told the jury that they could, among other factors, "consider the soundness of the scientific or technical principles, the methods employed, and the results reached, as well as the soundness of the reasons underlying the expert's opinion." The judge's instructions were satisfactory.

(b) The judge adequately instructed the jury as to the evidence of the defendant's intoxication with respect to their consideration of the issues of premeditation, malice, and extreme atrocity or cruelty. Contrary to the defendant's claim, the judge also made the jury aware that the defendant's intoxication could reduce his culpability from murder in the first degree to murder in the second degree. We have not required that an intoxication instruction use the exact language in *Commonwealth v. Delle Chiaie*, 323 Mass. 615, 617-618, 84 N.E.2d 7 (1949). See *Commonwealth v. Freiberg*, 405 Mass. 282, 303, 540 N.E.2d 1289, cert. denied, 493 U.S. 940, 110 S.Ct. 338, 107 L.Ed.2d 327 (1989).

3. There is no merit to the defendant's argument that he should obtain relief under G.L. c. 278, § 33E, because the jury did not hear evidence of specific intent sufficient to warrant findings that he committed the killing with deliberate premeditation or in a manner manifesting extreme atrocity or cruelty. The evidence warranted the jury's finding that the defendant's actions were deliberate. "In particular, the fact that the defendant backed the car over the victim after he had run over her once could have been found by the jury to evidence intent." *Commonwealth v. Amazeen*, 375 Mass. 73, 81, 375 N.E.2d 693 (1978). The evidence also warranted a finding that the murder was intentionally committed with extreme atrocity or cruelty.

Judgment affirmed.

Match Probabilities). Recommendations 4.2, 4.3, and 4.4 suggest calculation methodologies for cases where a subpopulation is involved (4.2), where the source of the DNA sample is from a subpopulation for which no database exists (4.3), and where all possible contributors of the sample include relatives of the subject (4.4), situations that complicate the application of the product rule. 1996 NRC Report at 5-6.