Correspondence

Commentary on Amar A, Brautbar C, Motro U, et al. Genetic variation of three tetrameric tandem repeats in four distinct Israeli ethnic groups. J Forensic Sci 1999;44(5):983–6.

Sir:

By applying Bayes' rule Refs 1,2 to the allele frequency data in Ref 3, I have been able to estimate, for loci CSF1PO, TPOX and TH01, the range of probability of identity between a known and an unknown individual from four ethnic groups in Israel. In a criminal case, for example, the known individual would be either a suspect or a defendant, and the unknown individual would be the presumed perpetrator. My results may apply to certain novel issues in the field of criminal justice and civil rights.

In this work, I focused on the probability that, given a match between their DNA short tandem repeat (STR) profiles, the unknown is identical with the known. I symbolize this probability by P[U≡K| match].

The method I used hinges on the concept of alternative hypotheses about membership in two or more groups. Under this concept, one group is unique: it has only one member. That member is the known individual. The remaining groups, in this work, are Ashkenazi, Moroccan, Yemeni and Ethiopian Jews in Israel, making five groups in all. (Needless to say, the one-member group is actually a sub-group of one of these; however, for the purpose of analysis it can be considered "other" without causing serious error.)

If my reading of Ref 4 is correct, in 1997 there were 2.33 million Ashkenazis, 0.501 million Moroccans, 0.183 million Yemenis, and 0.063 million Ethiopians among Israel's Jews, totaling 3.08 million. Using these values, I took, as my *a priori* probability that the unknown was a member of each of my five groups: Ashkenazi, 0.757; Moroccan, 0.163; Yemeni, 0.059; Ethiopian, 0.020; and known, $3.25*10^{-7}$.

Given the unknown individual's STR profile, I set that profile's likelihoods for the four ethnic groups equal to the corresponding three-locus genotypic frequencies based on Ref 3, Tables 1–3.

Because I assumed a match between known and unknown, the likelihood for the known "group" was 1.000 . . . .

Labeling the STR profile D; the various group-membership hypotheses

$$H_{A(\text{skenazi})},\ H_{M(\text{oroccan})},\ H_{Y(\text{emeni})},\ H_{E(\text{thiopian})} \text{ and } H_{K(\text{nown})}$$

the prior membership probabilities

$$P_0[H_A],\ P_0[H_M],\ P_0[H_Y]\ P_0[H_E] \text{ and } P_0[H_K]$$

and the likelihoods

$$P[D|H_A],\ P[D|\ H_M],\ P[D|\ H_Y],\ P[D|\ H_E] \text{ and } P[D|\ H_K]$$

I can write Bayes' rule for $P[U{\equiv}K \mid \text{match}]$ as

$$P[U{\equiv}K \mid \text{match}]$$

$$= \frac{P_0[H_K]*\ P[D \mid H_K]}{P_0[H_K]*\ P[D \mid H_K] + P_0[H_A]*\ P[D \mid H_A] + P_0[H_M]*\ P[D \mid H_M] + P_0[H_Y]*\ P[D \mid H_Y] + P_0[H_E]*\ P[D \mid H_E]}$$

$$= \frac{P_0[H_K]}{P_0[H_K] + P_0[H_A]*\ P[D \mid H_A] + P_0[H_M]*\ P[D \mid H_M] + P_0[H_Y]*\ P[D \mid H_Y] + P_0[H_E]*\ P[D \mid H_E]}$$

I performed all calculations for this letter on an IBM PC running a Microsoft Excel spreadsheet I call ASTRID (*A*n *STR Id*entifier). Tables 1 and 2 show examples of ASTRID's inputs and outputs.

By calculating $P[U{\equiv}K|$ match] for a series of homozygous STR profiles in which I varied alleles at one locus at a time, I could rank the alleles at each locus by their relative identifying potential. Table 3 displays the rankings, with potential decreasing downward. Inputting highest-potential and lowest-potential STRs into ASTRID, I calculated the maximum and minimum of $P[U{\equiv}K|$ match], with the following results.

The range of $P[U{\equiv}K|$ match] runs from 1.000000, for {CSF1PO[14,14]; TPOX[13,13]; TH01[10,10]}, to 0.000200, for {CSF1PO[11,11]; TPOX[8,8]; TH01[6,6]}. (As an example of an intermediate value, $P[U{\equiv}K|$ match] = 0.461 derives from {CSF1PO[9,13]; TPOX[9,12]; TH01{7,8]}.)

In the present instance, at least, the practically full-scale variability of $P[U{\equiv}K|$ match] raises the issue of decision threshold. A juryman may want a $P[U{\equiv}K|$ match] greater than 0.999 (odds of ~1000 to 1), in order to vote "guilty." A prosecutor may want a probability greater than 0.85 in order to bring a case to trial. A police officer may feel that $P[U{\equiv}K|$ match] = 0.75 is probable cause for arrest, and that 0.60 or more indicates "prime suspect."

Perhaps, the more important combined issues of whether and when to perform an STR profile comparison arise because $P[U{\equiv}K|$ match] (not to mention $P[U{\equiv}K|$ mismatch], which is always 0.000. . .) can fall below the thresholds of the juryman, the prosecutor and the policeman. We are then faced with questions such as:

At what point in a criminal investigation should STR profiling of suspects take place?

Do non-offender suspects have a right to be cleared as quickly as possible?

Should investigators be required, not merely permitted, to profile suspects upon arrest?

If so, should they be required to make profile comparison results immediately available to the suspects?

* Author of original letter to ABC.

TABLE 1—*ASTRID spreadsheet input table of the STR profile shared by known and unknown individuals.*

STR Profile	Allele 1	Allele 2
CSF1PO	14	9
TPOX	12	12
TH01	7	7

TABLE 2—*ASTRID spreadsheet output table of the group membership probabilities corresponding to the STR profile in Table 1.*

	Posterior probabilities
Ashkenazi	0.000
Moroccan	0.000
Yemeni	0.000
Ethiopian	0.004
Known	0.996

TABLE 3—*Within-locus allele relative identifying potential, decreasing downward.*

LOCI		
CSF1PO Alleles	TPOX Alleles	THO
14	13	10
7	7	9.3
8	12	8
9	10	7
13	11	9
10	9	6
12	8	
11		

I argue that a thoroughly sub-threshold $P[U \equiv K]$ is a very useful result with regard to any suspect, because it forces investigators to look, not only for other, potentially more fruitful evidence, but also for other suspects. A mismatch, of course, also strongly tends to exonerate the suspect completely.

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Commentary on George JR, Davis GG. Comparison of antiepileptic drug levels in different cases of sudden death. J Forensic Sci 1998;43:595–603.

Sir:

Various studies indicate that sudden unexplained death syndrome (SUDS) of patients with epilepsy is associated with the occurrence of seizures as well as with undectable or "subtherapeutic" serum levels of antiepileptic drugs (AEDs). George and Davis reported on postmortem serum concentrations of carbamazepine (CBZ), phenobarbital (PB), phenytoin (PHT), valproic acid (VPA), and felbamate (FBM) of 115 epileptic patients (1). Subtherapeutic AED serum levels were found in 69% of 52 persons with SUDS, in 75% of eight cases where a seizure precipitated an accident causing death, and in 34% of 44 control patients, for whom death was considered unrelated to epilepsy (the remaining 11 cases were unclassified). The patients whose death was directly related to the epilepsies exhibited a significantly greater incidence of subtherapeutic AED levels than the control group. But, in accordance to a recent experimental study on rabbits concerning CBZ and PHT (2) also patients with epilepsy showed a significant decrease in CBZ, PB and PHT serum concentrations shortly after death (3). The ratio of premortem to postmortem serum levels was 1.65 (95% confidence interval 1.56–1.74) for PB, 1.34 (1.10–1.57) for PHT and 1.16 (1.08–1.24) for CBZ (3). Moreover, it cannot be excluded that VPA and FBM serum concentrations also decrease after death, but data are still lacking. If the postmortem decrease of AED serum levels is not considered as in the case of the cited study (1), the calculated portion of subtherapeutic levels will be overestimated. On the other side the portion of patients with "therapeutic" or "toxic" levels will be underestimated. Nevertheless, we assume that in the study of George and Davis (1) the difference in subtherapeutic serum concentrations between the two groups (epilepsy-related and epilepsy-unrelated causes of death) remains significant even if the postmortem decrease of serum levels would be considered.

However, it should be mentioned that the comparison of pre- and postmortem concentrations with so-called therapeutic ranges is problematic for several reasons. The recommendations for the therapeutic range of serum levels are not uniform. It should be kept in mind that the individual therapeutic serum level may differ from the recommended therapeutic range and that the evaluation of serum levels should primarily depend on the clinical condition of the patient and not on therapeutic ranges. Furthermore, the measured pre- and postmortem AED serum concentrations depend on the analytical method.

Our critical remarks may also be valid for older and recently published studies (e.g., the study of Kloster & Engelskjøn (4)) on postmortally determined serum concentrations of AEDs and in respect to suspected non-compliance in patients with SUDS.

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Author's Response

Sir:

I thank Drs. May and Schnabel for drawing our attention to work recently published in the neurological literature that has important ramifications for the practice of forensic pathology. Drs. May and Schnabel go on to distill the practical point of interpreting postmortem anticonvulsant levels by saying that "It should be kept in mind that the individual therapeutic serum level may differ from the recommended therapeutic range and that the evaluation of serum levels should primarily depend on the clinical condition of the patient and not on the therapeutic ranges." We had hoped to make just this point in our article in the final paragraph of the Discussion. However the point is made, it is an important one. Ideally, a forensic pathologist will be able to discuss a specific case with the decedent's personal physician, thereby learning what was an effective therapeutic concentration in that particular individual.

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Commentary on the American Board of Criminalistics (ABC) Certification Process

Sir:

In the ABC Certification News (Volume 6, Issue 1, Summer 1999), we were notified that another route of certification was being implemented for Technical Specialists in Drug Analysis and Molecular Biology. The following letter was sent to the ABC Board of Directors & Examinations Committee on August 06, 1999. The opinions expressed in the letter may be of interest to the forensic science community.

Re: Technical Specialists—Drug Analysis, Molecular Biology

The American Board of Criminalistics (ABC) is a professional organization that "was formed by a majority of the nation's forensic science associations to establish a certification process." (1). This certification is defined as "a voluntary process of peer review by which a practitioner is recognized for attaining the professional qualifications necessary to practice in one or more disciplines of criminalistics" (1). Nowhere in the purpose or definition of the certification process is there mention of certifying individuals whose nature of work is "Drug Analysis" or "Molecular Biology" in the absence of demonstration of competency in criminalistics. The ABC certification process does not include professional certification of "Technical Specialist—Drug Analysis" and "Technical Specialist—Molecular Biology."

As mentioned in the American Board of Criminalistics Certification Program document, the California Association of Criminalists (CAC) developed a program, which "recognized that the changing nature of the work required increasing specialization, but maintained a strong commitment to a solid foundation in the full range of criminalistics" (2). Since the incorporation of the American Board of Criminalistics in 1989, this organization "has seen basic knowledge of other forensic disciplines, as measured by a General Knowledge Examination, as essential to a certification program."

These statements indicate that a knowledge of criminalistics of a certified member is both important and essential. In fact, there was a need for the testing of the candidate's knowledge to be standardized. As such, the "ABC was incorporated in 1989 in response to a need perceived by many criminalists for a national certification program."

With the development of new scientific techniques and procedures for physical evidence analysis, there must necessarily be changes in the operation of the laboratories where the analyses are performed. The trend in most forensic laboratories is toward increased specialization and away from the generalist or "holistic" approach to problem solving.

Admittedly, increased specialization necessitates that forensic laboratories hire individuals with precisely defined skills. Many of these individuals do not have a sufficient understanding of the basic principles of criminalistics. Often, however, laboratories confer the title of "criminalist" upon these technical specialists. A technical specialist does not become a criminalist by virtue of a title or by working in a forensic laboratory but rather by the knowledge, skills, and abilities (KSA's) needed to be a criminalist. Criminalistics is "concerned with the recognition, identification, individualization, and evaluation of physical evidence using the methods of the natural sciences in matters of legal significance" (3). Thus, it is a science that draws on many disciplines. Technical specialists who work within a forensic environment can be exposed to many different disciplines during physical evidence analysis. Regardless of the specialization that practitioners engage in, the ABC "supports the philosophy that forensic scientists must have this broad understanding of many aspects of forensic science"(2). It is through the General Knowledge Examination (GKE) that this broad understanding is tested. To further this argument, the Certification Program Structure embodies a four concept approach whose second concept is "a general understanding of a field is needed before specializing." The GKE tests four subject areas, of which not any one subject area is more significant than another (4).

In a Certification News publication (Volume 6, Issue 1, Summer 1999), we were astounded to find that the ABC is assuming the responsibility of certification of Technical Specialists. The newsletter states that "these practitioners find themselves serving as specialists" and "many of these specialists may have little or no formal interactions with case investigators, and/or the nature of the samples provided for examination"(5). Paradoxically, the article also mentions "that all practitioners in any laboratory with the name ''forensic'' in its title should be expected to pursue opportunities to gain a well-rounded competence in understanding and managing multidisciplinary casework"(5).

Since the Technical Specialist Examination serves as "one important part of the overall measure of accomplishment necessary to become certified as a professional *criminalist*"(5), and since "many of these specialists may have little or no formal interactions with case investigators, and/or the nature of the samples provided for examination"(5), how does the Technical Specialist in drug analysis or molecular biology become a criminalist after successful challenge of the Technical Specialist Examination? For example, it can be argued that the responsibilities of a Technical Specialist employed in a forensic DNA laboratory and one employed in a research DNA laboratory are similar with the only difference being the nature of the workplace.

The introduction of this route of certification contradicts the original goals and objectives of the ABC. The ideological fault of this certification procedure is that it places the principles of criminalistics secondary to those of the specialty area. This aspect of the examination procedure is upsetting. Since the proposed Technical Specialist Examination contains a "Specialty Examination Component" and a "Forensic Science Core," one wonders what the difference is between this examination route and the one already established, which is the combination of the GKE with the Specialty Examination (SE)?

We sincerely hope that we have conveyed to you our deepest concern at the direction the ABC is taking with the introduction of the Technical Specialist Examination. Our concern is selfish in that we do not desire to see the esteemed field of criminalistics reduced to a mere patchwork of scientific disciplines where falsely proclaiming criminalists tarnish the reputations of those who are truly knowledgable. The introduction of this new examination cannot strengthen criminalistics, but has the potential to cripple it.

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ABC Response

Sir:

I thank the authors for taking the time to express your concerns and address your questions regarding the American Board of Criminalistics' Technical Specialist Certification program. I am grateful that we have had the opportunity to discuss this in person, as your sentiments are strongly felt and deserved the reasoned discourse that only face-to-face conversation allows.

As we discussed, there is no doubt that the provision of certification for Technical Specialists (TS) in both Molecular Biology and Drug Analysis represents a departure from the current ABC programs of certification. In fact, in all communications regarding TS certification, the Board has insisted that distinctions between the Diplomate, Fellow and Technical Specialists must be made clear to both practitioners and criminal justice stakeholders.

Ultimately, the ABC Board decided that the provision of TS certification appropriately extended professional certification to a category of forensic practitioners for whom certification was desired and appropriate. These practitioners are just as strongly defined as criminalists as are Diplomates and Fellows of the ABC. However, they are different in their demonstrated scope and level of competency with respect to managing multidisciplinary casework.

The differences embodied in the descriptions of Diplomates, Fellows and Technical Specialists do not denigrate the field of criminalists. Indeed, by rejecting a narrow definition of criminalistics in favor of one that incorporates the realities of today's forensic science laboratories—in which we criminalists work—the ABC believes that the extension of certification to Technical Specialist will ultimately result in a stronger profession. Having more professional criminalists meet the objective, peer–based challenge of certification will absolutely improve the credibility of the entire field.

It is a policy of inclusion and comprehensiveness that has guided ABC to this point. ABC is jointly managed by its member organizations. We recognize our joint responsibility to provide professional certification pathways for as many varieties of criminalists as possible, because we believe that certification is the best objective means to consistently gauge professional competency and foster true professional development among practitioners.

It is my sincere hope that you will continue to contribute your passion for this process by becoming active in Board and Examination Committee governance and subcommittee activities. When future calls for nominees and volunteers are made, your representation of NEAFS or other forensic organizations to which you may belong will help assure the on-going vitality of the ABC and the field of criminalistics.

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