

Letters to the Editor

Virtual Reality

Dear Sir:

Accident reconstructionists have recently begun using what some are calling "virtual reality-style" videotapes to demonstrate what happened in traffic accident cases. An engineer teaming up with a computer-generated special effects company can produce such a videotape, which simply allows the viewer to imagine himself or herself occupying a vehicle in an accident. Other views of the accident are then also easily producible.

What would be even better would be to allow engineers, insurance people, jurors, test subjects, and others to participate in the accident using virtual reality computer simulations to determine first-hand what actions were available and reasonable to a driver. Jurors, for example, would to some degree be relieved of having to sort out conflicting opinions of experts.

The virtual reality operator in an accident could begin with the initial conditions that created the accident situation and follow through with differing actions. Of course the consequences of each action would not only have to follow the laws of physics but the particular characteristics of the vehicles involved.

Physical sensations such as acceleration, deceleration, and centrifugal force could be provided by tilting the operator's cabin as is done in amusement park rides to simulate flying, falling, and other actions.

Computer programs that recreate accidents on-screen from an overhead and other views already exist. Hopefully the facts that great detail is not necessary and most accidents occur in a very short span of time could limit the enormous amounts of computer memory required for virtual reality. Once this possible use is fully considered, many other similar applications will occur to forensics experts.

The field of accident reconstruction and other forensic services could greatly benefit from virtual reality development in these areas.

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Removable Dentures

Dear Sir:

In February 1976, I wrote an article advocating the marking of removable dentures, both full and partial dentures. This article appeared in the *Journal of the American Dental Association*. As a result of this article and constant pressure by members of the Odontology Section on their representatives in the state legislatures over a period of years, to date there are 17 states that have mandatory marking of all removable dentures. We have been hoping that this system would become nationwide in all 50 states.

I recommended that a stainless steel strip with a thickness of .001 inch be embedded in the denture. In case of fire, the strip would remain. With those patients who refused to have any identification in the denture, I suggested that a pink strip of paper with fluorescent ink writing be placed in the denture. Under UV light, the writing becomes visible.

I am happy that Dr. Sathyavagiswaran was able to identify the unknown John Doe because of denture markings.

George Furst, DDS
Librarian, Historian
Odontology Section

Commentary on "Reduction of Specular Reflectance on Projectiles and Toolmarks by Ammonium Chloride Fuming" (*J. Forensic Sci.*, Vol. 38, No. 4, July 1993, pp. 840-842)

Dear Sir:

The paper by Rios and Thornton reminded me of one of my first chemistry experiments many years ago and prompted a little impromptu research. Ammonium chloride is well known for its property of sublimation, or more correctly, of heat dissociation and re-association on cooling:



The result achieved by Thornton and Rios using ammonium hydroxide and hydrochloric acid can be achieved by exposing the cool surface of the metal to be coated to the fumes liberated by heating ammonium chloride.

I placed about 100mg of NH_4Cl on a 125mm (5 inch) borosilicate watch-glass and put this on a hot-plate set to 300°C [in a fume-cupboard, of course]. A piece of lead foil bearing some striated toolmarks was rested "marks down" on the watch-glass. Fuming was carried out for 5 minutes after the fumes first appeared, but the marks may be removed for inspection at any stage. The result was an even coating of NH_4Cl over the fumed area of the foil.

This procedure, although requiring more equipment than the "liquid" method, avoids the use of concentrated HCl and ammonia solution.

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L.A. Morgue Goes Hollywood

Dear Sir:

On August 23, 1993, the *New York Post* reported that the Los Angeles County Coroner's Office not only performs medicolegal autopsies, but, also partakes in the punishment of young drivers convicted of D.W.I. and the sale of macabre morgue memorabilia. We believe that medical examiners should not participate in the punishment phase of the criminal justice system, nor should they profit from the dead.

The primary role of the medical examiner is to investigate all deaths occurring suddenly, suspiciously, outside the presence of a physician, or as a result of foul play. Homicides must be reported to the district attorney. The medical examiner is supposed to be a medical-governmental agency acting independently of the judiciary and prosecutors' offices. Since the medical examiner must be a physician, he is obliged to abide by the World Medical Association and American Medical Association (AMA) which opposes physician participation in the torture, inhumane treatment, or punishment of detained or imprisoned individuals.

In the past, the state has manipulated doctors to participate in unethical activities, including judicial executions, medical experimentation, and euthanasia. One must only recall the atrocities committed by Nazi doctors during World War II, physicians practicing in the Soviet Union, South America, and South Africa in the 1970s and '80s, and even in New York City at the turn-of-the-century when doctors were used to weed out

the "undesirable" (that is, sickly individuals unable to work) immigrants coming from Europe.

In the 1980s, Californian judges initiated compulsory morgue visits for young, first-time drunk driving offenders. These punishments were designed as a shock treatment to teach drunk drivers lessons about the fragility of human life. The concept was broadened to include punishment of drug dealers. However, in 1986, the Suffolk County Medical Examiner on Long Island rightly opposed a judge's order to use the autopsy as a form of punishment for a convicted drug dealer. The medical examiner regarded the court order as torture and a violation of patient confidentiality. Since an autopsy is a surgical procedure, it would be inappropriate to convert it into a public spectacle.

Medical participation in judicial punishment is in direct opposition to the traditional role of the physician as healer. Although doctors work within the confines of the law, they should not participate in judicial punishment as puppets of prosecutors and judges. Medical examiners are supposed to perform autopsies and report their findings without bias to juries in criminal proceedings. If pathologists begin to participate in judicial punishment, they will assume new roles as judge, jury, and executioner. It is up to national medical associations and local medical societies to enforce the established codes of ethics with regard to medical involvement in judicial punishment.

One need only remember the fate of Dr. Thomas Noguchi, the "Coroner to the Stars," who was dismissed from his duties for publicly disclosing information concerning the deaths of several Hollywood celebrities in the 1980s. Although Dr. Noguchi might have lacked some discretion and irritated the rich and powerful in the entertainment industry, he merely reported the facts and never exploited the dead by selling designer toe tags, death certificates, T-shirts, and beach towels. Profits from the sale of morgue memorabilia should not be earmarked for rehabilitation programs for young offenders. This practice is unprofessional and sends the wrong message to society. The politicians who ousted Dr. Noguchi should re-evaluate the current activities at the L.A. Coroner's Office and stop them immediately.

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Author's Response

Dear Sir:

The Los Angeles County Department of Coroner has participated in the Youthful Drunk Driver Visitation Program (YDDVP) since August 1989. The program is in accordance with California Vehicle Code Section 23145. It is an alternative sentencing procedure for youthful, first time offenders with preference for those under 21 years of age who are sentenced to probation. The judiciary has no authority to compel the department to participate in the program. Furthermore, the law requires that probationers be given the option to participate in the YDDVP prior to sentencing.

This is an educational alternative sentence which includes a lecture, group discussion, video presentation, and 35 mm slides to portray the consequences of irresponsible behavior like driving drunk. Participants are then given a tour of the autopsy room. However, they do not view specific autopsies. At the conclusion of the tour, participants are asked to evaluate the entire experience. The evaluations indicate that the participants leave with an enlightened sense of respect for human life and the potential grief and destruction that may result from irresponsible behavior.

In addition, the program also includes a visit to emergency rooms at participating hospitals to observe life saving techniques in alcohol related cases. Participants are then

required to generate a 500 word essay for the judge to describe the impact of the program on their lives. The whole program is an educational/therapeutic experience, not punitive action.

I would like to strongly emphasize that the program in California, as opposed to the stated example in Suffolk County, Long Island, does not deal with drug dealers or gang members, but youths who were arrested for driving under the influence of alcohol.

Doctors Taff and Boglioli seem to be emotionally charged in their letter and are obviously misinformed by a press account that attempts to bring discredit to a creative effort that deals compassionately with a very serious problem. Anyone who has dealt with media relations understands that just because it is in print, does not necessarily make it gospel truth.

Our department has been a Continuing Medical Education provider for many years and for a few years has hosted an annual West Coast Seminar. Some items, like mugs and pins, which were imprinted with the West Coast Seminar Logo were given to participants of the seminar and also made available for purchase as gifts if requested.

The Administration of the Department of Coroner expanded on this practice and used a slightly different logo on similar items, including tote bags, T-shirts, mugs, pins, and now beach towels, the sale of which has helped the department generate revenue to offset the activities in support of the YDDVP.

The alleged "gift shop" quoted in recent press accounts is a portion of a supply closet which is where the T-shirts, beach towels, etc., are stored.

Doctors Taff and Boglioli's statements saying that we profit from the dead is misleading. The Los Angeles County Department of Coroner does not engage in the sale of death certificates or any items related to individual decedents and maintains the highest standards in the nation in the care of our dead.

In the future, if this creative program for youthful offenders shows no recidivism in the participants the Department of Coroner will continue to remain as a participant. For any medical examiner to take a neutral attitude toward drunk driving would be in the words of Winston Churchill, "to be impartial . . . between the fire brigade and the fire."

As a Chief Medical Examiner-Coroner who is a board certified internist, geriatrician, forensic pathologist, and infectious disease specialist, I would like to use this letter to illustrate that times have changed. All aspects of government service, including that of a Medical Examiner-Coroner, need to reassess their mission, needs, priorities and alternate sources of funding.

Lakshmanan Sathyavagiswaran, M.D.
Chief Medical Examiner-Coroner
County of Los Angeles

Dr. Sathyavagiswaran expresses his appreciation to Christopher Rogers, M.D., Chief Forensic Medicine Division; Anthony T. Hernandez, Interim Director; Craig Harvey, Chief, Investigations Division; Joseph J. Muto, Chief Forensic Laboratories Division and Gary L. Siglar for their contributions to this response.

A Discussion of "Postmortem Alcohol Production in Fatal Aircraft Accidents,"
(*J. Forensic Sci.*, Vol. 38, No. 4, July 1993, pp. 914-917)

Dear Sir:

I read with interest Canfield et al's article on postmortem alcohol production in the July 1993 issue. In order to better define the role of bacteria in postmortem alcohol

production the next step to be performed should be postmortem blood cultures for the purpose of identifying species of bacteria that produce alcohol.

Stephen D. Cohle, M.D.
Forensic Pathologist

Author's Response

Dear Sir:

The species of bacteria normally responsible for postmortem alcohol is known and has been reported by Janet E. L. Cory, *Journal of Applied Bacteriology*, 1978, 44, pages 39–46. However, the presence of bacteria capable of producing ethanol in a specimen does not necessarily mean the alcohol found in the specimen is from postmortem alcohol. The amount of postmortem alcohol produced in a specimen is a function of temperature, availability of nutrients, species of bacteria, and preservatives placed in the specimen. One could have a species of bacteria capable of producing alcohol and not have postmortem alcohol if the condition for postmortem alcohol production is not right. The absence of bacteria capable of producing postmortem alcohol would prove the alcohol found was from ingestion. Our laboratory is exploring a possible solution to the question of postmortem alcohol.

Dennis V. Canfield, Ph.D.
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A Discussion of "A Computer Program for the Estimation of Time of Death" (*J. Forensic Sci.*, Vol. 38, No. 4, July 1993, pp. 816–820)

Dear Sir:

The article by Dr. Niels Lynnerup presenting a new computer program for calculations of time of death using the equations of Marshall and Hoare [1] raises questions about the application of this technique. Dr. Lynnerup has graciously supplied me with a copy of his program. It is well written and easy to use. However, I am concerned that the unwary investigator may be easily misled by the apparent "exactness" of the answers provided by the program. The pressures on medical examiners to provide exact times of death seem to be never ending. A computer program that provides answers to the "exact" minute increases the possibility that the medical examiner or others will succumb to these pressures.

Dr. Lynnerup's article relies on the prior work of Marshall and Hoare [1]. The assumptions of this model (that ambient temperature be known and is constant and that the temperature of the body at the time of death is unknown) are rarely if ever realized in practice. Another potential source of error is that small variations in temperature measurements can produce large changes in the calculated time of death. This is illustrated well using Dr. Lynnerup's program. An error of plus or minus one degree centigrade is the usual reproducibility of commercially available portable thermometers. An example of how such variation in measured body temperature can alter the calculated results is given below. A variation of plus or minus one degree can produce a variation of four hours in time of death in the example given. The actual error could be even larger if similar variations in temperature of the body at death and variation in known ambient temperature are considered.

Assumptions: Height 182 cm (72 inches)
 Weight: 70 Kg (154 pounds)
 Temperature of body at death 37 degrees C
 Ambient temperature: 10 degrees C
 Body assumed clothed and supine

Temperature at death	Calculated time since death
21 C	21 hours 33 minutes
20 C	23 hours 27 minutes
19 C	25 hours 33 minutes

Reference

- [1] Marshall, T. K. and Hoare, F. E., "Estimating the Time of Death. The Rectal Cooling After Death and Its Mathematical Expressions," *Journal of Forensic Sciences*, 1962, Vol. 7, pp. 56-81.

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Author's Response

Dear Sir:

Thank you for the interest expressed for my article and computer program [1]. The following can be stated clearly concerning the issue of "exactness": The program does not pretend to be able to furnish an exact Time of Death. The program is explicitly made to carry out multiple calculations, in order to allow the user to assess the impact of varying temperatures at death and ambience temperatures. This is very clearly stated in the article. For the same reason no statistics are presented, as this could give the user the (wrong) impression, that the single calculations are accurate within a definite degree of variation or error. This is not the case, as is well shown by Dr. Lauridson in his calculations, and this is in fact exactly the intended use of the program.

A copy of the program can be obtained by mailing a 3.5" DOS-formatted disc to the author at address below.

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Further Commentary on "Police and Their Sidearms" (*J. Forensic Sci.*, Vol. 38, No. 1, 1993, pp. 11-12; Vol. 38, No. 5, 1993, pp. 1021-1027)

Dear Sir:

The letter by Wilber, in the January 1993 *Journal of Forensic Sciences*, was troublesome, in that it relied heavily upon publications of the National Institute of Justice

(NIJ)—a group whose work has repeatedly been discredited by well reputed scientists [1–4]. But Wilber's answers to well-founded criticisms of that letter (in the September 1993 issue) revealed so many additional misconceptions that further comment is essential.

It is incomprehensible that Wilber could rely upon both "FBI sources" and the NIJ's severely flawed Relative Incapacitation Index (RII). The RII ranked handgun bullet effectiveness by the size of the temporary cavity produced in gelatin. In 1976, MacPherson pointed out the RII's flaws [1]: however, it took the sacrifice of two FBI agent lives in the "Miami Shootout" *ten years later* (April 1986) to prove his point. Early in that gunfight, a "high RII" FBI bullet stopped short of one felon's heart (after penetrating only eight inches). This wounded felon, far from incapacitated, then went on to kill two agents and wound five.

In 1987, the FBI hosted a wound ballistics workshop. This workshop unanimously repudiated the NIJ's RII. The FBI then set up their own testing program to assure that, in the future, their bullets would possess the critical attribute that the NIJ had ignored—the capacity to penetrate deeply enough to reliably reach and disrupt vital body structures.

Most law enforcement agencies followed the FBI's lead and adopted the more deeply penetrating heavier (and lower velocity) bullets. In January of 1993, the FBI invited forensic pathologists, trauma surgeons, law enforcement firearms trainers, and ordnance engineers—thirty-seven in all—to a wound ballistics symposium to revisit handgun bullet effectiveness and see how the bullets they had recommended were performing. Senior firearms trainers from five large police departments reported excellent results with the heavier more deeply penetrating bullets. This recent symposium unanimously affirmed the findings and recommendations of the FBI's 1987 wound ballistics workshop.

Ruben Flores and Eugene Wolberg are well informed and respected experts who understand bullet wounding mechanisms: Wolberg was a presenter at the latest FBI wound ballistics symposium. Their criticisms of Wilber's letter were well founded and accurate. Wilber appeared dumbfounded by Wolberg's correct assertion "... the amount of kinetic energy that is 'transferred' to the body is of little importance in the production of an incapacitating wound and the overall reaction of the person shot." Although Wilber pointed out the relationship between the temporary cavity a bullet produces and "the energy delivered to tissues," he failed to mention that, with handgun bullets, most of that energy is simply wasted because the cavity produced is not large enough to reliably disrupt most body tissues: they are flexible and elastic; they just act as shock absorbers; being stretched below their elastic limits does not damage these tissues. Perhaps the following citation [5] will help him understand: it is from a study in which animals were placed near grenade explosions and then the injuries produced were evaluated by autopsy.

The mere delivery into the animal's body of a large number of fragments, or of a large amount of kinetic energy by the missiles, will not have rapidly fatal, or even necessarily serious, results. Many cases have been observed in which a shift of a few millimeters in the path of the missile would have changed the outcome from prompt death to survival, or vice versa.

The folly of the NIJ's RII was to promote the less reliable wounding mechanism (cavitation) and neglect the essential one (penetration): and there is a basic reciprocal relationship between the two. I think that Wilber will agree that even the highest velocity .357 Magnum bullet, whose wounding potential is largely used up by its temporary cavity pushing aside loops of bowel, is likely to have a less deleterious effect on the body than the slowest 38 Special bullet that passes through the heart or the aorta. If all it took for a bullet to incapacitate was the delivery of kinetic energy, body armor would not protect the wearer—but it does—think about it.

Those who wish to improve their understanding of wound ballistics should banish the words "kinetic energy" from their vocabulary. These words have all too often served

as the refuge of the uninformed: it is just too easy to say "the wound was caused by transferred kinetic energy" (in place of a meaningful explanation of how tissues were disrupted (crushed from direct bullet impact? or torn from being displaced beyond their elastic limits by the temporary cavity?). If editors and readers start demanding that authors come out from behind the "kinetic energy" smokescreen and start explaining *how* the damage was done, *where* it was done, and *how much* was done (much like the wound description from an well written autopsy report) they will promote more thoughtful discourse which is certain to increase the understanding and accurate communication of the principles of wound ballistics.

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References

- [1] MacPherson, D., Relative Incapacitation BULListics. Guns & Ammo, April 1976. Reprinted in a shortened version in the Wound Ballistics Review 1(2):12-15, 1992.
- [2] FBI Wound Ballistics Workshop, Firearms Training Unit, FBI Academy, Quantico, VA, September 1987.
- [3] Jason, A., Fackler, M. L. Body Armor Standards: A Review and Analysis. Wound Ballistics Review 1(1):14-37, 1991.
- [4] Office of Technology Assessment, Police Body Armor Standards and Testing, Vol I, OTA-ISC-534, Washington, DC, GPO, August 1992.
- [5] Light, F. W., Jr. Some aspects of the pathology of wounding by the Mk. II grenade and by single fragments, as observed in goats. Milit Med 122:415-428, 1958.

Author's Response

Dear Sir:

Thank you for the opportunity to respond to the criticism of my communications (JFS. Jan. 93, p. 11-; JFS. Sept. 93, p. 1023-) by M. L. Fackler. I have read a number of his papers with interest but without total agreement. I will try to respond constructively to his concerns.

First of all, I may have been remiss in failing to emphasize with vigor the fact that, in terms of incapacitation potential, among the assortment of handguns now available to the police, a plethora satisfy the requirement. There still are official statistics that seem to show that some police officers are at a disadvantage in a fire fight with an outlaw. My thesis is (as is true for other forensic scientists with whom I have conversed) that more realistic firearms training is indicated: "Shot-placement skill may be the weakest aspect of police firearms performance. But it is correctable." My point has been that the various commercially available cartridge-handgun combinations are intrinsically quite adequate, in terms of power and accuracy, to incapacitate dangerous suspects. The weak link is deficient shot placement. I further suggest that "Firearms training should emphasize close encounter, surprise, bad environmental conditions, shackle effect of gear, and the like."

Fackler refers to a paper by Light (1958) dealing with the random excursion of hand-grenade fragments into experimental living targets and uses that information for some purpose not apparent. Light and I were fellow scientists, decades ago, at The Army Chemical Center, Maryland. It was his team of biomedical scientists who developed the crucial data supporting the change from the 30-06 rifle and cartridge to the high velocity M-15 and its following versions: essentially a .22 caliber center-fire round that drives

the bullets (50–60 grains) at velocities (100 yards) of nearly 3000 feet per second and delivering energies (100 yards) of around 1000 foot-pounds.

There is some puzzle about Fackler's reference to a bullet that was fired by an FBI agent and it penetrated 8 inches into the chest of an outlaw who was not incapacitated. Fackler asserts that the bullet "stopped short of the felon's heart." Eight inches penetration would be almost perforation of the chest in many adult males. Apparently the example illustrates my point that shot placement is a critical element in a fire fight.

I maintain that in considering firearm effectiveness we are dealing with, first of all, force factors: magnitude, duration, direction, manner of application. But we also have an unique target, the human body with its unique organismic factors: heterogeneity, polyphasicness, visco-elasticity, non-isotropicness, damped system of levers and links, and inertia. We must also consider the sol-gel reversibility of protoplasm.

"All protoplasmic gelations appear to involve processes of polymerization whereby elongate macromolecular complexes are formed by the bonding together of a number of protein subunits, or monomers, initially present in the system prior to its gelation." (Marsland, 1970) The basic gel structure of all living cells is subject to depolymerization (that is, The elaborate structural support skeleton of all living cells made of many individual protein building blocks can be caused to fall apart) in the presence of elevated pressures. Different parts of the living cell are disparately malleable to increases in ambient pressure. The solation (or process of becoming more liquid-like or fluid) resulting from increased pressure is accompanied by the suspension of definite cellular operations and the failure of the normal structural wholeness of the cell and performance of the tissue composed of such cells.

Passage of a high velocity bullet through living tissue brings about the progression of a pressure wave moving outward from the passing bullet and through the ambient tissue. There is evidence that a shock wave moves ahead of the high velocity missile. It may generate a pressure of 60 atmospheres (1000 pounds per square inch). These elevated pressures have been reported, additionally, to be in some instances as high as 100 atmospheres; the duration of the peak pressure is quite short. At some loci the materialized pressures are so high as to effect a weakening of gel (or solid) structure of the tissue or organ subjected to the pressure. Stretching even of a mild sort in such weakened tissue would be destructive. At some point under certain conditions the imposed pressures might be high enough to cause complete solation (liquefaction).

The crucial aspect is the weakening of cellular structural integrity by solation of the basic molecular structure in response to high imposed pressures. Such affected cells (and the tissues that they form) would be exquisitely prone to deformation or even collapse. As the peak pressure moves onward, the modified tissues would gelate (return to solid state) and any deformations would be preserved. Repair of such modified tissues would follow the usual biological mode of wound healing.

Therefore, is it not reasonable to suggest that serious damage to tissues may transpire at noteworthy distances from the bullet itself as a consequence of bullet-imposed elevated hydrostatic pressures bringing about some solation of the cellular protoplasm at various loci? Definite physical or mechanical contact of the destroyed tissue with the passing bullet is non-essential to elucidate the wounds observed.

The development of these pressures in tissue requires the use of energy (that is, the capacity to do work). The energy available for exchange from bullet to target (living tissue) varies directly with the square of the impact velocity or directly with the mass. There is no need to appeal to "hunch factors" or magic attributes of pet loadings or the like to explain physical wounding by a bullet. The laws of physics carry on in living tissue just as they do in armor plate or automobile bodies. If one ignores this basic truism, befogging and bewildering of the science of ballistics is sure to obtain. Such carelessness is a grave disservice to all who are involved in the technical advances in

ballistic science. (It is true that some bullets may impact the living body at such low velocities as to produce no significant pressure waves. These missiles then act like a hunting arrow or a knife. They cause injury by contact. Their effectiveness in wounding mandates precise bullet-placement.)

By way of recapitulation, it seems tenable to say that the mass and the velocity of a bullet determine its wounding capacity. One must acknowledge that neither the bullet nor the target (living body) is a simple, unchanging element. Alone and together they bring about a complex set of conditions that are listed in this communication as aspects of bullet construction and of characteristics of the living body. They are consequential in determining the outcome of a specific incident of cartridge-firearm-target usage circumstances. They are also the most variable and unclarifiable facets of any given firearms encounter.

The following equation tries to include these realities:

$$W = E \times 1/T \times 1/A \times K$$

where W is the wound; E, energy transfer in foot pounds; 1/T, period of E transfer in seconds; 1/A, area through which E is propagated in square inches; K, organismic (tissue) factors. From this it is evident that the nature of a gunshot wound depends on: missile velocity, missiles weight, missile shape or "presenting" area, missile construction (tendency to splinter or distort), flight characteristics (number of gyrations per unit length about axis of missile, density and cohesion of tissues in flight path. (Presswalla, 1978) The value of K for human gunshot wounds is still uncertain because the organismic factors of the living body are so refractory to inclusion as a simple, single number value. (Sellier, 1982)

A comprehensive, readable, balanced, and superbly illustrated discussion of this question is available in Zajtchuk, Bellamy, and Jenkins (1990).

The last paragraph of Fackler's letter advocates the type of censorship which has no place in scientific discourse.

References and Suggested Reading

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- Zajtchuk, R, DP Jenkins, and RF Bellamy, editors. 1990. *Textbook of Military Medicine*. Part 1, Volume 5. Superintendent of Documents, U.S. Government Printing Office, Washington. 396 pp.

Addendum to "Automated Data Analysis of Fire Debris Samples Using Gas Chromatography-Mass Spectrometry and Macro Programming," (*J. Forensic Sci.*, Vol. 38, No. 6, November 1993, pp. 1354-1362)

Dear Sir:

In my recent article, referenced above, I presented a flow chart and described a computer program I have authored which assists in the analysis of fire debris samples by

gas chromatography-mass spectrometry. A listing of the program was not included with my article. However, the program could be of great benefit to those who wish to use a similar methodology in their laboratory.

The program was written for the Hewlett-Packard Mass Selective Detector with a UNIX-based Data Station running Version A.01.03 software. As described in my article, the program requires two user created files to be present, the RIDATA text file and the ARSON library of mass spectra. In addition, modifications to the program may be necessary for those running later versions of the Hewlett-Packard software.

! An arson analysis macro for the Hewlett-Packard
! UNIX data stations
! written by Jack Nowicki, Illinois State Police

NAME ARSONMAC
CPSTOP ON
ON ERROR E1
FILE
DEFDIRECTORY filename\$

! Send header information to working file
!MACRO sample
!sample
TAB HEADER,“/chem/arson/TICFILE”,,DONTASK
OPEN “/chem/arson/TICFILE” FOR APPEND AS #1
PRINT #1,“”

! Read in retention times of n-alkanes
DIM C(16)
OPEN “/chem/arson/RIDATA” FOR INPUT AS #2
FIR I=1 TO 16
INPUT #2,C(I)
NEXT I

! Send the TIC to the working file
Z=3
TIC
GETSCALARS
START=XLOW
END=XHIGH
MAX=250000
DOLABELS
SCREENPRINT 3,“/chem/arson/TICFILE’,,,,APPEND
CLOSE #1

! Perform library search sub-routine
SEARCHIT “/chem/arson/TICFILE”

! Send alkane ion profile to working file
Z=2
OPEN “/chem/arson/CHROFILE” FOR OUTPUT AS #1
PRINT #1,“FILE NAME: ”+SAMPLENAME\$
PRINT #1,“”

```

CHRO START:END,57,71,85,99
EXTRACT
EXCHANGE
EXTRACT
EXCHANGE
EXTRACT
ADD
ADD
ADD
DRAW 2
GETSCALARS
ANNOTATE 2,,"ALKANES",XLOW+.1,.9*YHIGH,ADD
SCREENPRINT 2,,"/chem/arson/CHROFILE",,,,,APPEND

```

! Send aromatic ion profiles to working file

```

END=C(8)
CHRO START:END,91,105,119,133
EXTRACT
EXCHANGE
EXTRACT
EXCHANGE
EXTRACT
ADD
ADD
ADD
DRAW 2
GETSCALARS
ANNOTATE 2,,"AROMATICS",XLOW+.1,.9*YHIGH,ADD
SCREENPRINT 2,,"/chem/arson/CHROFILE",,,,,APPEND

```

! Send polynuclear aromatic ion profiles to working file

```

START=C(6)
END=C(10)
MAX=100000
CHRO START:END,128,142,156
EXTRACT
EXCHANGE
EXTRACT
ADD
ADD
DRAW 2
GETSCALARS
ANNOTATE 2,,"NAPHTHALENES",XLOW+.1,.9*YHIGH,ADD
SCREENPRINT 2,,"/chem/arson/CHROFILE",,,,,APPEND
CLOSE

```

! Print everything out, clean up the memory, and exit

```

PRINTFILE "/chem/arson/TICFILE"
PRINTFILE "/chem/arson/CHROFILE"
REMOVE C
DEFDIRECTORY /chem/msd
CPSTOP OFF

```

RETURN

! Error handling subroutine

E1:

CPSTOP OFF

REPORTERROR

CLOSE

REMOVE C

RETURN

! Peak identification subroutine

NAME SEARCHIT

PARAMETER FILE\$

OPEN FILE\$ FOR APPEND AS #1

! If more than seven peaks, go to another page

IF NPEAKS>7 THEN

PRINT #1,CHR\$(12)

ELSE

PRINT #1,""

ENDIF

IF YHIGH>MAX THEN

EXC Z

PRINT #1," PEAK # RET TIME RI QUALITY COMPOUND"

PRINT #1,""

! For each peak perform the following loop

N=1

WHILE N<=NPEAKS DO

PEAKNUMBER N

! Use the retention index calculation subroutine

RICALC

! Search the arson.1 library

PBMSEARCH "chem/database/ARSON.1"

GETSCALARS RESULTS ,PBM,1

IF NUM_HITS>0 THEN

FOUNDIT=0

HITINDEX=1

QUALITY=100

! Look for hit with quality >49 and within retention index

! window

WHILE (FOUNDIT=0) AND (HITINDEX<=NUM_HITS) AND (QUALITY>49)

DO

GETSCALARS RESULTS ,PBM,HITINDEX

IF (RI>RET_INDEX-5) AND (RI<RET_INDEX+5) THEN

FOUNDIT=1

ENDIF

HITINDEX=HITINDEX+1

ENDWHILE

IF FOUNDIT=0 THEN

QUALITY=0

ENDIF

```

ELSE
  QUALITY=0
ENDIF

```

```

! If no hits found, search the Wiley library
IF QUALITY=0 THEN
  PBMSEARCH "/chem/database/WILEY.1"
  GETSCALARS RESULTS ,PBM,1
  ! If quality>90 then make tentative identification
  ! else call it unknown
  IF QUALITY<90 THEN
    QUALITY=0
    HIT_NAME$="UNKNOWN"
  ELSE
    HIT_NAME$="*" + HIT_NAME$
  ENDIF
ENDIF
ENDIF

```

```

! Send search results to working file
PRINT USING #1,"3#8#.3#9#7#",N,RET_TIME,RI,QUALITY
PRINT #1, " ",HIT_NAME$
N=N+1
EXCHANGE
ENDWHILE
ELSE
PRINT #1,"NO SIGNIFICANT PEAKS"
ENDIF
PRINT #1,CHR$(12)
CLOSE #1
RETURN

```

```

! Retention index calculation subroutine
NAME RICALC
RI=0
IF RET_TIME>=C(1) AND RET_TIME<=C(16) THEN
  INDEX= 1
  WHILE RET_TIME>C(INDEX) DO
    BASE=100*(INDEX+4)
    LOW=C(INDEX)
    HIGH=C(INDEX+1)
    INDEX=INDEX+1
  ENDWHILE
  B=LOG(RET_TIME/LOW)
  Q=LOG(HIGH/LOW)
  RI=BASE+(100*B/Q)
ENDIF
RETURN

```

```

! Subroutine that scales and integrates the TIC
NAME DOLABELS
GETSCALARS
DRAW Z,X,START:END,0:YHIGH*1.1

```

```
IF YHIGH>MAX THEN
ENTER
MULT=YHIGH/10000
NORMALIZE
IF YHIGH>500000 THEN
  INITT 12
ELSE
  INITT 13
ENDIF
INT
EXCHANGE
EXCHANGE Y,Z
N=1
WHILE N<=NPEAKS DO
  PEAKSPECTRA N,,,Z
  ROLL -1
  L=(PEAKHEIGHT*MULT)+(YHIGH/50)
  ANNOTATE Z,,VAL$(N),START_TIME,L,,ADD
  N=N+1
ENDWHILE
ENDIF
RETURN
```

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Erratum

A misprint appeared in the May 1994 issue (Vol. 39, No. 3, p. 593, p. 604).

The Author's Response (to "Commentary on Police and Their Sidearms") was written by Dr. C. G. Wilber. Dr. Wilber is the Director of the Forensic Science Laboratory, Colorado State University, Fort Collins, CO 80523. We apologize for any inconvenience this may have caused.