# FBI

FBI
# Law Enforcement Bulletin

June 1991
Volume 60
Number 6

## Features

Page 19

**1** **Pharmaceutical Diversion and Abuse** 130303
By Thomas C. Babicke

**6** **ROP-ing in Fences** 130304
By James Trainum, Nancy Brown, and Raymond Smith, Jr.

**12** **Drug Abuse and Testing in Law Enforcement**
By Andrew J. Harvey 130305

**16** **Plateauing in Law Enforcement** 130306
By James M. Childers

**19** **Gunshot Primer Residue** 130307
By Roger W. Aaron

**24** **Military Support to Civilian Law Enforcement Agencies** 130308
By R. Barry Cronin

**27** **Detaining Suspected Drug Couriers: Recent Court Decisions** 130309
By William U. McCormack

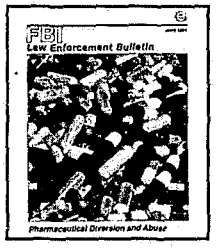
Page 27

## Departments

*5* **Book Review**

*22* **The Bulletin Reports**

*10* **Police Practices**




***The Cover:*** *Prescription medication misuse and abuse contributes to the drug problems in this country. See article p. 1.*

**United States Department of Justice**
**Federal Bureau of Investigation**
**Washington, DC 20535**

**William S. Sessions, Director**



***Editor***—Stephen D. Gladis, D.A.Ed.
***Managing Editor***—Kathryn E. Sulewski
***Art Director***—John E. Ott
***Assistant Editors***—Alice S. Cole
Karen F. McCarron
***Production Manager***—Andrew DiRosa
***Staff Assistant***—Carolyn F. Thompson

The *FBI Law Enforcement Bulletin* (ISSN-0014-5688) is published monthly by the Federal Bureau of Investigation, 10th and Pennsylvania Avenue, N.W., Washington, D.C. 20535. Second-Class postage paid at Washington, D.C., and additional mailing offices. Postmaster: Send address changes to *FBI Law Enforcement Bulletin*, Federal Bureau of Investigation, Washington, D.C. 20535

ISSN 0014-5688 USPS 383-310

# Gunshot Primer Residue
## The Invisible Clue

By
ROGER W. AARON

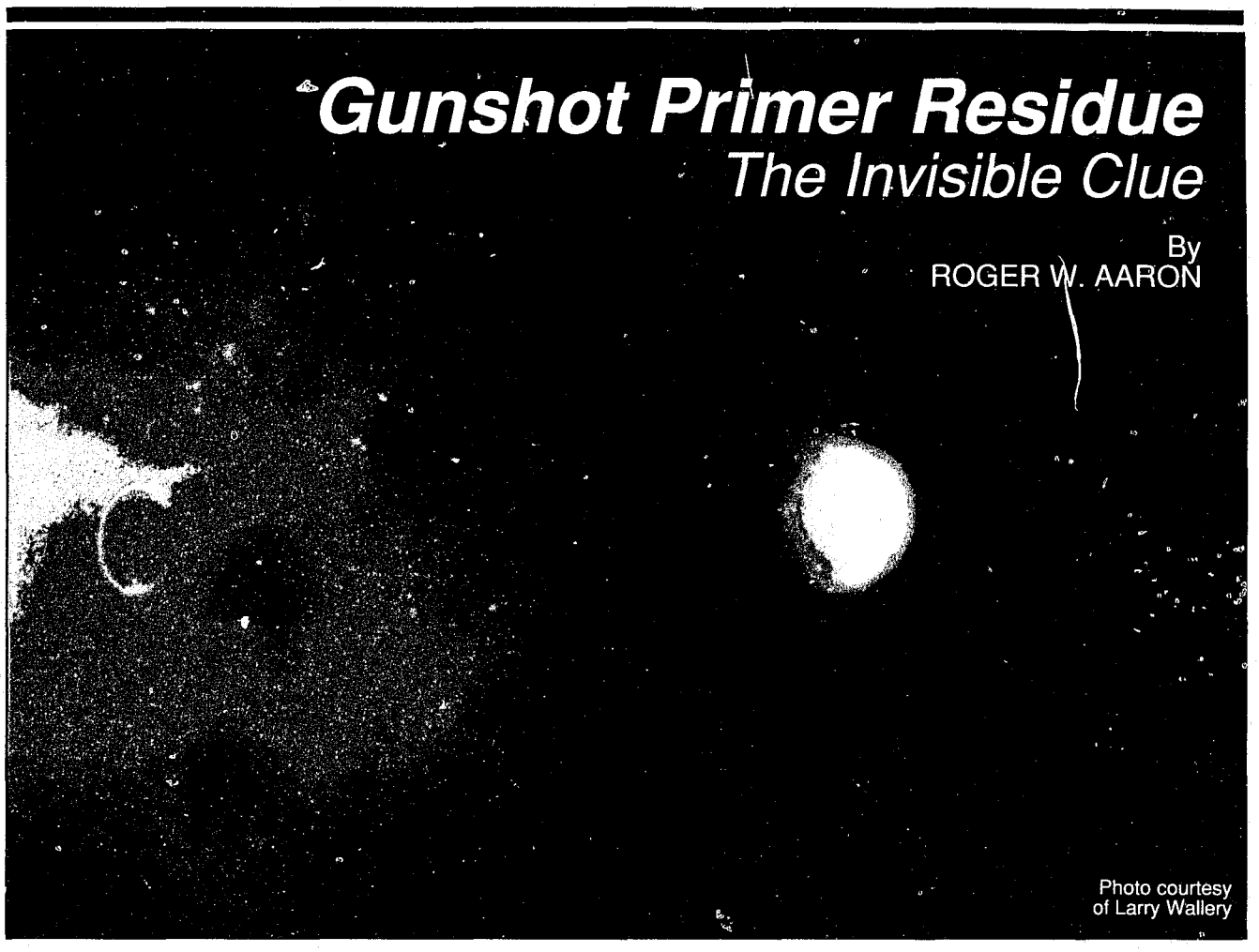


Photo courtesy of Larry Wallery

During an early morning armed robbery of a convenience store, the sole clerk is shot. A suspect is arrested 20 minutes later, several blocks away without a weapon. On his hands, however, is gunshot primer residue (GSR), an invisible clue that could be used by investigators in this and most other crimes involving a firearm. Unfortunately, in many such instances, this valuable evidence would not be made available to investigators or jurors. Why not? There are various reasons, including an unfamiliarity with proper procedures for collecting GSR for analysis. This article addresses the strengths and weaknesses of these processes and offers suggestions for more effective use of this often overlooked evidence.

### Background

The explosion inside a firing cartridge burns the gunpowder so completely that no analytical technique has yet been developed that consistently identifies the remaining trace quantities of unburned powder on the hands or clothing of the shooter. However, several procedures to accomplish this have been tried over the years. In the first attempts to associate an individual with a firearm, the hands were coated with a film of paraffin in order to lift off residual nitrites. This residue then could be visualized with diphenylamine.

This procedure was abandoned over 20 years ago, however, because nitrites do not provide sufficient specificity, and because large deposits are necessary to yield an adequate color development. Still, even today, many investigators erroneously refer to the "paraffin test" when discussing modern gunshot primer residue analysis.

Continued investigation into applications of neutron activation

analysis identified two noncombustible primer mixture components, barium and antimony, as detectable residues from the discharge of most ammunition.[1] It was this discovery that led to the reliable tests available to the law enforcement community today.

## Procedure

In the most common analytical protocol, cotton swabs moistened with diluted nitric acid are wiped over the web and palm areas of each hand. Neutron activation analysis (NAA) or atomic absorption spectroscopy (AA) is used to determine the quantities of barium and antimony on the swabs from both areas of each hand. Since neither barium nor antimony is unique to GSR, it is necessary to find both elements in amounts within the range found on the hands of persons who are known to have recently fired a weapon (a control group).

In another method, technicians use adhesive disks to pick up microscopic particles of GSR from the hands. A scanning electron microscope (SEM) equipped to conduct energy dispersive X-ray analysis (EDXA) is used to detect particles containing barium and antimony. SEM-EDXA produces a visual image of particles, thereby providing the analyst with useful size and shape information. Additionally, the barium and antimony are shown to occur specifically within these particles, as opposed to being part of general background contamination. This technique has gained support in recent years due to the development of automated systems that simplify and eliminate much of the lengthy and tedious searching process.

There are variations and combinations of these methods. However, they all rely, at least in part, on finding barium and antimony as presumptive evidence of GSR.

## Collecting Evidence

Gunshot primer residue is much like chalk on the hands of a school teacher using a blackboard. The minute the teacher walks away from the board, chalk loss starts through mechanical actions, such as rubbing the hands together, putting them in pockets, rubbing them against clothing, or handling objects. Therefore, officers are instructed to collect GSR evidence immediately upon making an arrest. Generally, there is little hope of finding adequate quantities of barium and antimony to associate an individual with a weapon after 3 hours of normal hand activities. And, washing the hands removes essentially all GSR deposits.

Unfortunately, ideal GSR collection procedures are at odds with the fundamental precept of immediately handcuffing arrestees' hands behind their backs. This cuffing procedure can greatly decrease the amount of GSR because the outer webs of the hands are pressed against the body. Any improper procedures should be addressed by arresting officers and crime scene personnel since they could lead to elimination or contamination of this potentially valuable evidence.

GSR collection kits are available at police supply stores and through catalogs. The deceptively simple appearance of these kits implies that acceptable substitutes can be made from standard drugstore items. However, this practice

*Special Agent Aaron is assigned to the FBI Laboratory in Washington, DC.*

***"The real value of the GSR test is that it can associate an individual with a firearm."***

can introduce multiple errors into the collection process. These errors can be avoided by using collection kits and questionnaires prepared commercially or by knowledgeable laboratory personnel.

### Important Points

The real value of the GSR test is that it can associate an individual with a firearm. It is important, however, to note that this does not identify that person as the shooter. GSR can settle on any hand placed near a weapon as it is fired. A person can pick up GSR simply by handling a dirty weapon or discharged ammunition components. It is also possible, but very unlikely, that residue would be deposited on hands by other means. Thus, placing an individual in an environment of GSR generally puts that person in the presence of a firearm.

At the same time, failure to find GSR on the hands does not mean that a person tested did not handle or fire a weapon. For example, many test firings under controlled conditions in the FBI Laboratory do not deposit sufficient quantities of the material to allow identification. A firearm may produce deposits on five consecutive firings but not on the sixth. A weapon may simply not be sufficiently dirty or not handled enough to effect a transfer.

As noted earlier, GSR could have been deposited but later removed through washing or normal use of the hands. A finding of inconclusive amounts of barium and antimony simply means that the analyst can offer no opinion of value associating a tested individual with a firearm. The situation is analogous to a fingerprint analyst having no opinion concerning a particular person's presence at a crime scene if print analysis is inconclusive.

The tests using neutron activation analysis (NAA) or atomic absorption spectroscopy (AA) for determining the total barium and antimony in each sample does not constitute an unequivocal identification of GSR. When elevated levels of both elements are found in a sample, the results are reported as being consistent with those obtained from persons known to have discharged a firearm. It is unlikely, but possible, to get independent environmental contamination of both elements in one or more of the four specimens collected from each person tested.

Barium and antimony can be found in trace amounts on most hands, and it is not uncommon to detect elevated levels in samples from a nonshooter's hands. In a recent study, the FBI Laboratory analyzed samples from the hands of persons who had not been near a firearm. Of 267 sets of hand samples analyzed, 9 (3 percent) had significantly elevated levels of both elements and most of these were eliminated as being consistent with GSR by other parameters relevant to GSR tests.[2]

Analysis of GSR on the victim has little value in a suicide-homicide situation and should not be used routinely on the victim as an investigative tool. More gunshot residue goes out of the weapon's barrel with the bullet than escapes near the handle. If the victim of a close range shooting attempts to grab the gun or instinctively shields the head, significant deposits can be left on the hands. Laboratory analysis cannot reliably determine whether the deposit was made in this manner or was the result of a self-directed firing.

> ***"...failure to find GSR on the hands does not mean that a person tested did not handle or fire a weapon."***

Likewise, suspects at the crime scene should only be sampled if they do not admit to or cannot otherwise be associated with a weapon at the approximate time of the shooting. The person who just returned from a hunting trip or claims to have struggled with the victim (or assailant) over the weapon before the shooting, for example, generally should not be tested for GSR.

Accurate identification of GSR largely depends on the prior experiences of the laboratory performing the analysis to determine what is expected from specific areas of

the hands after handling weapons. Such information is not generally available, except for these specifically defined and studied areas of the hands. Thus, surfaces, such as automobile windows, clothing, and parts of the body other than these specific areas of the hands, are usually not suitable for GSR examinations.

Several factors can affect the analysis of unfamiliar surfaces, including environmental barium and antimony contamination and the potential for previous exposure to GSR. The latter concern is significant because GSR is not volatile and will generally remain on a surface until it is mechanically removed. Thus, GSR on the clothing of a suspected shooter can be explained by that person handling a weapon while wearing the garment several weeks earlier.

> ***"...surfaces, such as automobile windows, clothing, and parts of the body other than these specific areas of the hands, are usually not suitable for GSR examinations."***

## Conclusion

The detection of gunshot primer residue on the hands of an individual confirms that this person was in an environment of the material within a few hours preceding the collection of samples. This would likely result from firing a weapon, handling a weapon or ammunition, or being in close proximity to a weapon as it is discharged by another person.

Failure to detect GSR on the hands indicates that the test offers no information of value in determining whether an individual had been in the presence of the material. With the exception of very few well-defined situations, nothing more should be inferred from the results of GSR tests.

To avoid useless analysis, officers should *not* collect samples if:

- The person can be associated recently with a firearm by a witness,
- The hands were washed or more than a few hours have elapsed since the shooting,
- The ammunition used in the shooting does not contain both barium and antimony.

Setting these parameters saves time and eliminates much of the misunderstanding and confusion surrounding GSR tests. Like any analytical process, certain conditions must exist to ensure a useful GSR analysis. **LEB**

**Footnotes**

[1] "Special Report on Gunshot Residues Measured by Neutron Activation Analysis," U.S. Atomic Energy Commission Report GA 9829, National Technical Information Service, U.S. Department of Commerce, Springfield, Virginia, 1970.

[2] D.G Havekost, C.A. Peters, and R.D. Koons, "Barium and Antimony Distributions on the Hands of Nonshooters," *Journal of Forensic Science*, JFSCA, vol. 35, No. 5, September 1990.

## EPA Manual

The U.S. Environmental Protection Agency (EPA) has developed a manual to provide introductory information on solid and hazardous waste management programs under the Resource Conservation and Recovery Act (RCRA). The 1990 edition of the ***RCRA Orientation Manual*** contains updated information that reflects the many regulatory changes that have transpired since the original manual was issued in 1985.

The manual is divided into seven sections. The first section provides an introduction to the RCRA. Sections II to IV outline the various subtitles of the act. The manual then addresses the regulation of medical waste and examines RCRA's relationship to other environmental laws. The final section covers the public's role in the RCRA program. Each section includes an overview of what is covered, illustrations and figures highlighting the text, and a summary of key points presented.

*To obtain a copy of this manual, contact the U.S. Government Printing Office, Washington, DC, (202) 783-3238. Request GPO Document 055-000-00354-5.*