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***Gunshot Residue and Cross Contamination:
An Introductory Lesson***
By Steven Howard

Police are happy to point out: "The suspect tested positive for GSR and this proves he shot the victim." To the first part I respond: "So the hell what?" To the second part: "Maybe!"



What is gunshot residue (GSR)? The Trace Evidence Procedures Manual defines GSR as "a particle with a spherical or molten appearance (non-crystalline) containing the elements Pb, Ba, and Sb." The reality is that about 99 percent of the time, the police and people like me do not really test for gunpowder residue. Instead, we test for primer residue.

To understand GSR, we will first look at gunpowder. Gunpowder is a combination of chemicals that, once ignited, burn at a predictable rate. This burning produces expanding gases that create pressure and force the bullet down the barrel and towards the target. In the beginning, the only gunpowder was black powder. This is a combination of 75 percent potassium nitrate (also known as saltpeter), 15 percent charcoal, and 10 percent sulfur. Nitrate is the base fuel of all gunpowders although they take many different chemical forms.

Smokeless powders generally come in two forms: single-based or double-based. Single-based gunpowder has a chemical called cellulose hexanitrate, which the industry calls nitrocellulose. I refer to gunshot wounds as "nitrocellulose-induced lead poisoning." Double-based gunpowder is a combination of nitrocellulose and glycerol trinitrate, which is what we call nitroglycerin. There are triple-based powders out there, but they are somewhat rare.

CSI (crime scene investigation) technicians take a swab sample from a person or an article and test for a combination of chemicals from gunpowder residues, primer residues, and lead residues. It is important to note that, increasingly, companies are producing ammunition that has no lead in their primers or their powders. This is done to make it safer for use in indoor ranges. This "lead free" ammunition keeps the shooter from inhaling the toxic metal and risking cancer.

Gunpowder residue takes several forms — unburned particles of gunpowder, partially burned particles of gunpowder, and completely burned gunpowder soot. Unburned particles are pieces of gunpowder that are left when the barrel of the firearm is too short for the powder to catch on fire before the particles leave the muzzle of the firearm.

Partially burned particles are pieces of powder that start to ignite, but do not burn up completely before they strike something. Both unburned and partially burned powder will test positive for nitrates. Nitrates are the fuel that makes the gunpowder burn. A problem exists because it is possible to test positive for nitrates by coming in contact with an endless list of things in our everyday lives. Fertilizers and fuels top the list. Obtaining a false-positive is so easy that most police departments do not waste their time testing for nitrates.

Soot is the residue that remains when the powder burns completely. Like nitrates, it is possible to get soot from an endless list of things in our everyday lives. Car exhausts, fireplaces, and even cigarettes have soot.

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Primers

Primers are the small cups or circles on the base of the cartridges. They ignite the gunpowder with a small explosion — similar to a child's cap pistol. This is where life gets interesting for police. Most primers contain a combination of the metals and chemicals barium (Ba) nitrate, lead (Pb) styphnate, and antimony (Sb) sulfide. Again, the ammunition industry is rapidly moving away from lead to avoid the health risks. Moreover, gigantic mountains of regulations surround both Pb (lead) and Ba (barium). Other elements can be found, including (but not limited to) calcium silicide, tetrazine, zirconium, glass, and pentaerythritol tetranitrate.

Lead residue can come from three sources: the bullet, primer, and powder. Many bullets have exposed lead at their bases. The fire and heat from the burning powder vaporize a very small portion of the bullet's lead, and this vapor settles on everything around it. If the bullet is not jacketed, the lead wears off on the barrel and is further vaporized. Routinely, you can see lead vapor trails from high-performance rounds with exposed lead bases such as full metal jacket 223/5.56 military rounds.

Both Pb and Sb are contained in common items such as tire weights. Barium is another base element that is seen in nature very regularly. Like the other two elements, it is also heavily regulated because of its toxic nature. The real telltale sign of primers and GSR is magnesium (Mg). This is added to the primer's mixture to add heat. Magnesium burns at extremely high temperatures, and when the primer fires it throws big pieces of flaming Mg into the powder.

These are the things that the CSI technicians are looking for when they run a test. The fact that they do not find all the chemicals does not mean it is not GSR, and even if they do, it does not mean that the person fired a gun.

If they find some GSR, these materials can come from many different sources. It may or may not be GSR. There have been changes in the chemical ingredients of powders and primers, but many labs have been unable to keep up with these changes. A discussion of these changes is beyond the scope of this article.

Cross Contamination

Cross contamination happens when GSR is introduced from a source other than the accused person firing a gun.

If the lab technicians find GSR, it can come from anywhere. Police take the view that if you haven't just left the firing range, you fired the murder weapon. This argument holds great weight if you live in a society where guns are rare, such as Singapore or Japan. If you live in other places in the world, including the United States, that argument means nothing.

GSR lasts nearly forever. It can land on anything and stay there indefinitely. Because so many people in this country shoot guns and the things in their lives are covered with GSR, an individual will be covered with GSR when he or she comes in contact with these people or anything they touched. If tested, the individual will test positive for GSR. The police point of view goes something like this: "You could have, therefore we think you did, therefore you did, therefore you're guilty." It is human nature to see what you want to see, and the police want to see that which will solve the crime. I am far more open-minded because I know just how many different ways someone can come in contact with GSR.

The rule is simple. If someone tests negative, it can prove he or she is innocent. But if the test is positive, it means nothing one way or the other.

How can a person come in contact with GSR? That's easy. Shake my hand! If someone shoots just a few rounds, he or she will become covered with GSR. From there, the person's clothing becomes saturated with it. When the person sits in a car, the inside of the car becomes covered. Any seat the person sits in becomes impregnated with it. Most of all, static electricity and wind will move and embed the GSR in and on everything in the car. If the person doesn't wash his or her coat, every time that coat is picked up that person's hands will be covered with GSR. If you shake that person's hand, you will test as if you just fired a gun. Give that person a bear hug, and you will test as if you have just been in a gunfight.

Anyone who goes to a range can fire between 200 and 2,000 rounds in a day. CSI tests are geared around the theory that a person will fire only one shot. One shot can make someone test positive for anywhere from 2 to 20,000 particles. In the Robert Blake case, they test-fired the pistol in question and the test shooter's hands tested positive for 2,440 particles.

It is generally believed that most of the big particles will fall off within two hours. I do not agree. If the skin of the accused is oily, greasy, or if the accused uses lotion or cream, the GSR can stay on for days. If someone goes shooting, gets covered with GSR, and then goes to bed, the GSR will be on the pillowcase. If the person then applies face cream before bed — even if the person washes — that person can recontaminate himself or herself, or a spouse, for some time to come.

The vast majority of GSR will fall off sooner or later. But where does it go? Unlike DNA that breaks down in time, GSR is made up of heavy metals that last almost forever.

As an expert witness, I travel a great deal. Whenever possible, I drive. Why? When I travel, I know I will be subjected to the nitrate testers (called "sniffers") at the airport. These are machines that are so sensitive that if the bag contains as little as one .22 cartridge, the machine will activate. In light of all the shooting and reloading I do, I live in a sea of GSR and nitrates.

To stay out of trouble with the sniffer machines, I go to a friend's house the night before each flight. I wash everything, including my suitcase. I go out and buy new shoes. Sure enough, the machines will pass me without trouble. After I test-fire weapons, I have to repeat the process.

On one trip, after a friend took me to the shooting range for a test, the sniffer machine went wild. The authorities, while always frightened, are almost always polite. I was detained and thoroughly questioned, and my person and belongings were further tested. They tested my shirt, shoes, bag, and hands. All tested positive. My friend had given me a ride to the airport in the same truck that we had taken to the range. He had given me a goodbye hug. The sniffer went off even when everything had been washed just minutes before I put them on and went straight to the airport.

I assume some phone calls were made to see if I was telling the truth. After my bags were searched and nearly torn apart, I was told that I had to either submit to a "very close pat-down" by a male officer, or I would be detained and forced to submit to a strip search. Anyone who knows me knows I am not shy. "Let's cut to the chase!" I told them. I began taking my clothes off as the females in the room dashed out the door (such frightened people). It is just that easy to set off these machines. This is why I don't take people to the airport unless I drive their car. And I do not give them goodbye hugs. If you buy a used car from me, you will test positive indefinitely — unless you have the inside of the car steam-washed and detailed. You might still test positive even after that. It is just that simple. The machines used to test for the GSR particles can detect one particle!

The Chicago Study

The Journal of Forensic Science published a study in July 2007 that was conducted by the Chicago Police Department. According to the study, the chances of being contaminated with GSR by the police are "very low." Yet the study's own statistics state clearly that out of 201 tests performed on cars, benches, holding cells, etc., 23 samples tested positive. In my mind, the study proves that there is a better than 1 in 10 chance of putting innocent people in jail as a result of cross contamination.

This study was conducted in Chicago, where very few people own guns, and fewer people still, actually shoot. What would the results be in Lansing, Mich., Farmington, N.M., or Atlanta, Ga., where owning guns is far less restricted and shooting guns is a weekly event?

The Chicago study was cited recently in a trial where the accused was arrested very quickly after he was said to have fired over 10 rounds of 9 mm Luger, shooting three people to death and chasing (while firing and running through the cloud of GSR gas) other people. The lab technician found a total of four particles. One particle was found on the chest, three on the stomach, and none on the hands, sleeves, or face. The suspect should have been covered from head to toe with hundreds of particles, even under the worst conditions. The accused man could have gotten that many particles when he was frisked by the police, or when he was put in the car, or dropped his jacket on my couch. Yet, in the minds of the police and the prosecutors, this was clear and convincing evidence that the accused man had murdered three people and fired over 10 rounds.

This study also states that vinyl is less prone to hold GSR than cloth. This is true for as far as it goes. The rule is that if any given surface does not hold a substance when it comes in contact with that substance, then it is more likely to transfer that substance to anything that it touches. What does this mean in plain English? If you throw a handful of wheat flour against glass, some will stick. If you then put your hand on the glass, your hand is going to pick up

more of the flour than if the flour was on cloth.

What to Do About A Positive GSR Test

1. Get a particle count. Get it during the discovery stage. If the count is 2000+ on the face, hands, and other areas, your client has problems. Is the count 20 or less? An individual can get that by coming in contact with the police or other people.
2. Demand a breakdown of the residue. If all three elements are not included, it may not be GSR. Even if all three are present, if there is a high percentage of iron, it may be brake pad residue and not GSR at all. Also, some .22 rim-fire ammunition does not contain all three (Pb, Sb, and Ba) elements. If the police department claims your client is the shooter because the GSR test contains the three elements, but the ammunition used in the crime does not contain all three, then "Houston, we have a problem!"
3. Demand photos of the GSR. If the particles are not spheroid shaped, this may also be proof that the residue comes from brake linings and thus is not GSR.
4. Question the police. Did police officers take any steps to prevent cross contamination? Did they wash their hands? Did they clean their cars? Did they bag the hands of the suspect by means of a sandwich bag and a rubber band? Police in the United Kingdom have been bagging hands since the 1940s. Few police departments in this country ever bag a suspect's hands. Police officers should simply slip a clean evidence bag over each of the suspect's hands and secure it in place with a rubber band or, better yet, a "flex-cuff." I realize that this is really high tech, but I truly believe the police in this country can handle this level of technology. Some police departments are now saying: "if you don't bag them, we don't test them."

Look at GSR Tests in A Different Way

GSR tests should still be done, but done more carefully and for different reasons. The police do not take steps to prevent cross contamination, and many times they do not test at all when they really should. The next big problem is that police do not view GSR tests in the correct light. The ideological problem is that police and prosecutors are in the conviction business. Generally, they do not care about evidence that tends to prove suspects innocent.

If the police can catch someone quickly after a shooting and take the necessary steps to prevent cross contamination, and if the person still tests negative, this should be compelling evidence that the person in question is innocent.

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