As professional investigators, we place ourselves at a higher risk of encountering and being attacked by belligerent or violent individuals due to the nature of our contact with the public. We need to be prepared with a game plan as to how we would react to an individual with a weapon. Part of that preparation includes selecting the most effective firearm and ammunition combination for dealing with the type of threats we might face.
Before any discussion of terminal ballistics can take place, there are two simple truths that should be recognized. 1) A gun is one of those things that you would rather have and not need, than need and not have. 2) The absolute best gun (and ammunition) to have in a gunfight is the one you have.

There is valuable information available concerning terminal ballistics that can assist in selecting the most appropriate firearms caliber and ammunition combination. The problem is that much of this information is confusing, complicated, sometimes controversial, and based on incomplete or inaccurate observations. Much is unscientific at best, and some are myths. So how do we distinguish the facts from fiction?

The subject of terminal ballistics really is not all that confusing and complicated. I will try to cut through the minutia by using a practical, common sense approach based on credible research conducted by experts in the field.

*Terminal ballistics*, a sub-field of ballistics, is the study of the behavior of a projectile (or bullet) when it hits its target. We see primarily three principal types of research on terminal ballistics that are readily available to the public:

**Empirical Observations**
These are observations made on “the street” or the battlefield by police officers and soldiers who were involved in lethal force confrontations. They are analyses of real-life shooting incidents.

**Scientific Studies**
Scientific studies involve testing bullets fired from various weapons into a test medium, such as ballistic gelatin or animal flesh to attempt to simulate and predict how those bullets will perform when used against a human being. These are controlled, documented studies conducted by doctors, scientists and forensic experts utilizing the scientific method.

**Post-Mortem Observations**
Post-mortem observations are usually conducted, as part of an autopsy, by medical examiners, doctors, surgeons, or other medical personnel on deceased human beings with gunshot wounds. The wounds are explored and observations concerning the damage and injuries caused by gunshots are documented. The bullets are sometimes retrieved and also analyzed.

Now let’s examine the deficiencies of each type of research. Many “studies” based on empirical observations are promoted as being somehow better and more valid than the work being done by trained researchers, surgeons and forensic labs, claiming that the “street” is the real laboratory. [1] The problem with empirical observations is that they are incomplete. Empirical observations don’t tell us why a threat stopped fighting, or how exactly they were incapacitated. Most combats are not single shot affairs because each combatant keeps firing at his adversary until it is clear that the adversary is incapacitated. For this reason, the person shot usually has multiple wounds, and assessing
the relative contribution of each to the incapacitation is often ambiguous or controversial. Also, many “stops” are psychological, not physiological—the bad guy either faints or makes a voluntary decision to stop fighting. [9] Thus, even well documented encounters may not give any useful data about “one shot” bullet effectiveness.[5] In addition, observations that are not documented on video are subject to the interpretations and filters of the witness/participant, which can skew results.

Scientific studies are generally the best predictor of bullet performance, but they too are often incomplete. When a bullet is shot into ballistic gelatin, the only traits that can be quantified are the bullet’s terminal ballistic mechanical performance characteristics and wounding effects. Gelatin does not reveal “how effective” a bullet is, because “effectiveness” is a result that cannot be measured in a test medium. Wound effectiveness is a consequence of shot-placement (the bullet’s path through the body) and penetration.[3] Also, gelatin or some other simulated flesh does not contain human bones. It is impossible to predict the effect that human bones can have on a bullet, yet there is a great likelihood that a bullet fired at a human being will result in striking bone. Another limitation commonly seen is that many scientific studies do not take into account the effects of any intermediate objects that a bullet may have to pass through before reaching the intended target. Intermediate objects can be heavy winter clothing, car doors, auto glass, walls or even the bad guy’s hand or arm.

Post-mortem observations are just as incomplete as empirical observations, because once again we are only getting half of the story. A medical examiner (ME) may be able to determine which bullet caused the death of the individual being examined, but the ME does not know whether that shot caused an immediate incapacitation, or how long it took before the threat was unable to continue fighting. Just because an individual died of a gunshot wound does not mean he was immediately incapacitated. Most studies show that immediate incapacitation is more the exception than the rule. The entire back story of what happened before the individual got to the autopsy table is missing, which is important contextual information for studying the effectiveness of ammunition.[11]

So, if all of the principal types of research into terminal ballistics are deficient or incomplete, then what options do we have? I recommend utilizing all three sources. All three sources taken together, looked at like pieces of a puzzle, can be assembled and evaluated in their own context. This will allow the layman to avoid the pitfalls of one-track thinking and make a competent decision based on all of the available evidence.

**TERMINAL BALLISTICS 101**

How do bullets incapacitate a threat? There are two critical and equally important elements. The first of these elements is through the mechanism of wounding. There are four components of projectile wounding that we need to know about: 1) penetration (of blood bearing organs or arteries) 2) permanent cavity (destruction of tissue) 3) temporary cavity, and 4) fragmentation.[6]

**Penetration**

A bullet crushes the tissue it strikes during penetration, and it may impel the surrounding tissue outward away from the bullet path. When you shoot an attacker in the torso, the goal is to produce fatal hemorrhage by rupturing the heart or a major blood vessel so he will quickly collapse. These vital structures lie deep within an average-sized person’s torso at armpit height, and you should choose a bullet that will not only penetrate deeply enough to reach them, but to go through them and crush a hole in them from any angle.[2] Because of this, a bullet should have the capacity to penetrate at least 12 inches of tissue, with a preferable penetration value of 18 inches.[1] The 12-inch minimum penetration performance guideline ensures the bullet has sufficient penetration potential to reach and pass through vitals; not only when penetration conditions are favorable, but unfavorable as well, such as when a bullet has to perforate arm muscle and bone before it enters the upper torso. Penetration doesn’t mean a thing unless vitals are damaged and destroyed. This is why shot placement is so important. A deep penetrating bullet that plows past vital structures without going through them is just as ineffective as a shallow penetrating bullet that stops an inch short of the heart.[3]

**Permanent Cavity**

A penetrating bullet crushes tissue to form a hole called the permanent cavity. Tissue crush is responsible for the permanent cavity and tissue stretch is responsible for the so-called temporary cavity. These are the sole wounding mechanisms of a projectile and the basic foundation needed to understand the effects of a projectile on tissue.[4] “Effectiveness” is a consequence of the bullet’s permanent wound track (cavity) through the body. Shot placement is a critical aspect in producing an effective wound, and this factor is entirely independent of, and is more important than, any attribute that can be ascribed to bullet performance, except penetration. To reliably be “effective” a bullet must pass through vital cardiovascular organs or damage the central nervous system.[2] An example as to how this relates to bullet design and selection is the difference between a full metal jacket (FMJ) bullet and a jacketed hollow point (JHP) bullet. A 9mm FMJ bullet, with its smooth, semi-point, streamlined shape is less efficient in crushing tissue and creating a permanent wound track than an expanded hollow point bullet. A round nose FMJ bullet crushes a permanent cavity in soft tissue that averages approximately 66 percent of the bullet’s diameter. Whereas the blunt, non-aerodynamic shape of an expanded JHP bullet crushes a permanent cavity that averages approximately 82 percent of the bullet’s expanded diameter. A 9mm FMJ bullet that penetrates the heart is not going to produce as effective a wound track as a 9mm JHP bullet which has expanded to .60 caliber that penetrates the heart. The rate of blood loss through the hole produced by the FMJ is not going to be as fast as the hole produced by the expanded JHP. Therefore the JHP bullet’s wounding efficiency, based on its ability to create a larger permanent cavity, is superior to the FMJ bullet.[3]

**Temporary Cavity**

The walls of certain parts of the permanent cavity may be dilated and stretched outward for a few milliseconds after the projectile passes.[4] The effect is called the temporary cavity and can be compared to a wake produced by a boat. The boat (the projectile) cuts through water, and produces a wake (the temporary cavity) in its path, where the water eventually returns to a normal resting state.[6] The temporary cavity, depending on the velocity of the bullet, can be several times larger than the diameter of the bullet. An important difference between handgun cartridges and powerful rifle cartridges is that while the temporary cavity of a handgun bullet is not usually large enough to stretch tissues beyond their elastic limits, the temporary cavity of a rifle bullet is usually large enough to do so. This is one reason why a rifle is vastly preferable to a pistol in a gunfight. Each round can be much, much more destructive. [5] The temporary cavity with handgun calibers does not always cause a lot of tissue damage because skeletal muscle is tolerant of lower energy bullets (i.e. velocities of 2000 fps or less).[7] As a rule of thumb, the denser the organ, the greater the damage. Solid organs such as the liver are not resistant to stretch, while additional organs such as skin, lungs, muscles and bowels are resistant to stretch cavitation and considered to be good shock absorbers.[6]
that manage to exit the arm and penetrate the torso are going to produce minimal wounding effect. Pre-fragmented bullets require best case conditions to produce maximum wounding effect.[3]

Now that we have a basic understanding of wounding mechanics, we can discuss the second, and no less, critical element of how bullets incapacitate a threat: shot placement.

SHOT PLACEMENT
Shot placement is as critically important as wounding, because a bullet wound will not stop a determined attacker if it is not directed at the central nervous system (CNS) or a vital, blood bearing organ, artery or vein. These two types of targets are commonly known as Type I and Type II shots.

Type I shots occur when the threat is shot in the Central Nervous System (CNS) which is the brain and spinal cord. A well placed shot to the CNS causes immediate incapacitation, where the threat will no longer be able to function because of the loss of brain activity.[6]

With Type II shots, however, incapacitation in not immediate. Type II works through lack of oxygen to the brain as a result of the loss of blood pressure and/or bleeding. These types of shots rely upon rapid or delayed forms of incapacitation that can be attributed to blood loss. They are dependent upon shot placement to vital organs, veins and arteries that are located at armpit height center mass, or the pelvic girdle. Type II forms of incapacitation may also rely upon the creation of multiple wound channels to ensure rapid blood loss.[6]

Type I shots are not caliber dependent. Even a small caliber firearm that creates a small permanent cavity or wound channel in the CNS can cause immediate incapacitation. Given good bullet placement, a .25 ACP FMJ can work as well as a .45 ACP Black Talon.[5] With Type II shots even if the thoracic artery (the largest artery in the human body) is completely severed from a handgun round, it would still take approximately 4.6 seconds for a human being to lose 20% of their blood volume, which would then begin to impair the central nervous system.[8] Because a Type II shot requires adequate penetration, it is caliber-dependant. That is, a large caliber bullet is needed to ensure rapid blood loss. To further ensure rapid blood loss, multiple wound channels should be created.[6]

Now that we understand the basics of wounding mechanisms and the importance of shot placement, how do we select our ideal self-defense round? Don’t we want the round with the most “knock down” power?
The bottom line is that kinetic energy does not wound. Temporary cavity does not wound. The much discussed “shock” of bullet impact is a fable and “knock down” power is a myth. Being knocked down solely by the force (kinetic energy) of the bullet is false. Handguns do not impart any type of “knock down” power per se. Nor do rifle rounds. In fact, being struck by a bullet is often compared to being struck by a fast ball or being stung by a bee.[6] The critical element is penetration. The bullet must pass through large, blood bearing organs and be of sufficient diameter to promote rapid bleeding.[1]

To demonstrate this point, we can analyze the Trooper Coates shooting. In November 1992, South Carolina Highway Patrolman Mark Coates shot an attacker four times in the torso with his four inch Smith & Wesson .357 Magnum revolver. His attacker, an obese adult male who weighed almost 300 pounds, absorbed the hits and shortly thereafter returned fire with one shot from a single-action North American Arms .22 caliber mini-revolver. Coates was fatally wounded when the tiny bullet perforated his left upper arm and penetrated his chest through the armhole of his vest where the bullet cut a major artery. Coates, who was standing next to the passenger-side front fender of the assailant’s car when he was hit by the fatal bullet, was very quickly incapacitated. The slaying was recorded by the video camera mounted in Coates’ cruiser.[9]

Trooper Coates fired four 145 grain Winchester SilverTip .357 Magnum bullets directly into his assailant’s heavy abdomen, achieving solid hits with each. These particular bullets penetrate deeper than 125 grain JHPs, however none ruptured any vital cardiovascular structures. During the initial ground struggle, Coates was shot twice, but his vest protected him. After fighting off his attacker, Coates quickly climbed to his feet and emptied his revolver. At that particular moment the assailant was still lying on the ground. The combination of the assailant’s obesity and the unusual angle at which the bullets entered his body worked to the disadvantage of Trooper Coates.[9]

The Coates shooting exemplifies the fable of energy transfer, especially when encountering a determined attacker. The .357 Magnum cartridge is regarded by many as the ultimate man stopper, a true one-shot stop wonder. The Winchester 145 grain .357 Magnum cartridge is given a one-shot stopping power rating of 86 percent by Marshall and Sanow. According to this rating system, a single hit ANYWHERE in the torso is supposed to be highly effective in stopping an attacker, regardless of whether or not the bullet destroys vital tissue. But on this night, it failed FOUR TIMES! The assailant easily absorbed four bullets in his body, each delivering over 450 foot pounds of kinetic energy. This is equivalent to being hit four times by a baseball going approximately 210 miles per hour.[9]

None of Coates’ powerful .357 Magnum bullets were effective, but the bad guy’s weak .22 caliber bullet was. The .357 Magnum bullets damaged all their energy into the attacker, whereas the single .22 caliber bullet disrupted vital tissue. The assailant survived the shooting, was convicted of murdering Coates and sentenced to life in prison.[9]

AMMUNITION SELECTION
How do we incorporate all of this information into proper round selection? How do we choose the best caliber, bullet type and manufacturer for a self-defense round?

We now know that shot-placement and adequate penetration are the two primary elements of ‘stopping power’. Both are equal in importance.[3] So what bullet is best? It’s one you can shoot accurately under stress, that’s capable of penetrating deeply enough to inflict fatal hemorrhage and reliably functions in your gun. There’s nothing mystical or complicated about handgun ammunition wounding effectiveness. It’s simple: placement and penetration.[2]

There are a couple of things we may want to consider before making our choice:

- Jacketed hollow points deform. Bullet deformation takes the form of expansion, fragmentation, core-jacket separation, bending, flattening, etc, which reduces (and consumes) kinetic energy.[10]
- Jacketed hollow points that shed their jacket inside the body are losing bullet weight and velocity usually before hitting vital organs.[11]
Farnham conducted another test with auto glass:

"We were able to conduct testing on the windshields of a 1991 Lincoln sedan. We had been advised that, when shooting from inside a vehicle out, or outside a vehicle in, the windshield will cause the bullet to deviate up to six inches from the point of aim. This general rule held true with every high-performance pistol round we tried. All but one, that is. Cor-Bon DPX stayed directly on target even after penetrating laminated, angled, windshield glass. There was NO deflection at all. There was also no disintegration of the bullet, as it passed through from either direction. Point of aim was point of impact, both ways! Two calibers were tested: DPX 45 ACP from a Glock 30, and the DPX 40S&W from a Beretta 96."[12]

With smaller caliber cartridges such as .22 LR, .25 ACP, and .32 ACP, you're better off selecting a non-expanding bullet that might exceed 18 inches of penetration than to choose a bullet that expands and underpenetrates. When a bullet expands, the increased diameter and non-aerodynamic shape acts like a parachute to quickly slow and stop the bullet as it penetrates flesh. These tiny bullets lack the mass and momentum to achieve adequate penetration after they expand.[9] Bullet selection should be based on penetration first, and expansion should be considered a bonus, when and if it occurs.

Given adequate penetration a larger diameter bullet will have an edge in wounding effectiveness. It will damage a blood vessel smaller projectile barely misses. The larger permanent cavity may lead to faster blood loss. Given reliable penetration, the only way to increase bullet effectiveness is to increase the severity of the wound by increasing the size of the hole made by the bullet. Any bullet that will not penetrate through vital organs from less than optimal angles is not acceptable. Of those that penetrate, the edge is always with the bigger bullet. Although such an edge clearly exists, its significance cannot be quantified.[1]

It is my opinion that any solid copper HP cartridge, 9mm or larger should be sufficient for incapacitation given proper shot placement. In the case of JHP bullets, I would limit my choice to a .40 S&W or larger caliber. I don't think that anything larger than .45 ACP is a realistic choice for fast, controllable and accurate shots as is needed in a self-defense situation. Weapons larger than .45 ACP also tend to be difficult to conceal. My personal choice is for Corbon DPX 9mm. I chose 9mm for one reason—I like to shoot.

Training with .45 ACP will cost you double 9mm, and I train a lot which greatly improves my shot placement skills to make up for any edge lost in selecting a smaller diameter caliber. I also carry Corbon DPX .357 Mag in a sub-nosed revolver. If I am going to carry a low capacity handgun, I want a powerful cartridge that has a good record of incapacitation.

Unless you're clairvoyant, you cannot predict the exact circumstances of any self-defense situation you might find yourself in. Therefore, your goal in choosing a bullet for personal defense should be to select one that you can shoot fast and accurately under stress, and that will be effective in as many different scenarios as possible. Your bullet must be able to penetrate deeply enough to contact and destroy tissue that is critical to the immediate survival of your attacker. The concepts of shot placement and penetration are simple—too simple for some people to accept. But these factors are the most important in stopping a homicidal attack.[9] PI

Craig Lawrence CPP, CAS is an NRA Certified Law Enforcement Firearms Instructor and has been an Illinois State Certified Firearms Instructor for the past 20 years. He is a licensed Private Detective and the Chief Instructor for United Risk International's Training Division. Contact: (847) 593-9995 or www.urtraining.com.

WORKS CITED
[5] [I] Comparative Firearm and Caliber Information, P Bullet Velocity and Weight as Related to Effectiveness I The Fackeller's Case, Lincoln R. Carr, retrieved from www.regunz.m/Sources/ Last visited August 11, 2012

42 PI magazine | November/December 2012