INTRODUCTION

The FBI Paper: Handgun Wounding Factors And Effectiveness.

The FBI Paper: The FBI's 10MM Pistol.

Images of the "official" FBI copy of: Handgun Wounding Factors And Effectiveness released in response to a FOIA request (PDF version only due to the size of the images).
This publication contains the FBI papers: Handgun Wounding Factors And Effectiveness - & - The FBI's 10MM Pistol.

The following is from the Forward of the FBI paper: Handgun Wounding Factors And Effectiveness (1989).

The selection of effective handgun ammunition for law enforcement is a critical and complex issue. It is critical because of that which is at stake when an Officer is required to use his handgun to protect his own life or that of another. It is complex because of the target, a human being, is amazingly endurable and capable of sustaining phenomenal punishment while persisting in a determined course of action. The issue is made even more complex by the dearth of credible research and the wealth of uninformed opinion regarding what is commonly referred to as "stopping power".

In reality, few people have conducted relevant research in this area, and fewer still have produced credible information that is useful for law enforcement agencies in making informed decisions.

This article brings together what is believed to be the most credible information regarding wound ballistics. It cuts through the haze and confusion, and provides common-sense, scientifically supportable, principles by which the effectiveness of law enforcement ammunition may be measured. It is written clearly and concisely. The content is credible and practical.

The information contained in this article is not offered as the final word on wound ballistics. It is, however, an important contribution to what should be an ongoing discussion of this most important of issues.

The FBI paper was published in the FBI's Law Enforcement Bulletin; but as of 2004, it was no longer available to the general public. At that time I wanted an "official" FBI copy of the paper for use as a credible reference and a basis for use of the information on my web site www.pointshooting.com

I requested a copy from the FBI Library in Quantico, VA, and received a copy of the report which was available on the web. It was not an "official" copy, so in August 2004, I filed a Freedom Of Information Act request for the report. I received an "official" copy of the FBI report in May 2005 after an initial denial, and appeal of that denial.

It was and still is an excellent resource. I believe that the info in it is of value to the millions of law abiding folks who have a handgun for self defense. And it may help some realize that a gun is not a magical self defense wand that will ward off evil and assure their safety and security.

.........
The FBI's 10MM Pistol details the process that led to the FBI's decision to move to a 10 mm (.40 caliber) pistol. As such it is an excellent historical document and also provides one with an insight to the thinking used to support the decision. Also included are my comments. Both papers are included in the MobiPocket, Kindle, and PDF editions that are available via the web or my site www.pointshooting.com.

The Arial font has been used to make the text easier to read. Some e-readers may use a different font as a default.

The PDF version also contains the scanned pages of the "official" copy of Handgun Wounding Factors and Effectiveness. The images are two large to be readable on most e-readers.

The cover includes the FBI name and Seal as provided in the FOIA release, and the mention that the publication is a FOIA release. That was done to identify the publication as containing a FOIA release of the FBI paper. The FBI has been advised of that.

THE FBI PAPER: HANDGUN WOUNDING FACTORS AND EFFECTIVENESS

U.S. Department of Justice

Handgun Wounding Factors and Effectiveness

Special Agent UREY W. PATRICK

Firearms Training Unit

FBI Academy

Quantico, Virginia

July 14, 1989

Forward

The selection of effective handgun ammunition for law enforcement is a critical and complex issue. It is critical because of that which is at stake when an Officer
is required to use his handgun to protect his own life or that of another. It is complex because of the target, a human being, is amazingly endurable and capable of sustaining phenomenal punishment while persisting in a determined course of action. The issue is made even more complex by the dearth of credible research and the wealth of uninformed opinion regarding what is commonly referred to as "stopping power".

In reality, few people have conducted relevant research in this area, and fewer still have produced credible information that is useful for law enforcement agencies in making informed decisions.

This article brings together what is believed to be the most credible information regarding wound ballistics. It cuts through the haze and confusion, and provides common-sense, scientifically supportable, principles by which the effectiveness of law enforcement ammunition may be measured. It is written clearly and concisely. The content is credible and practical.

The information contained in this article is not offered as the final word on wound ballistics. It is, however, an important contribution to what should be an ongoing discussion of this most important of issues.

John C. Hall
Unit Chief
Firearms Training Unit

[Footnotes are shown as (1) (2)....]

---------

Introduction

The handgun is the primary weapon in law enforcement. It is the one weapon any Officer or agent can be expected to have available whenever needed. Its purpose is to apply deadly force to not only protect the life of the Officer and the lives of others, but to prevent serious physical harm to them as well.(1) When an Officer shoots a subject, it is done with the explicit intention of immediately incapacitating that subject in order to stop whatever threat to life or physical safety is posed by the subject. Immediate incapacitation is defined as the sudden (2) physical or mental inability to pose any further risk or injury to others.

The concept of immediate incapacitation is the only goal of any law enforcement shooting and is the underlying rationale for decisions regarding weapons, ammunition, calibers and training. While this concept is subject to conflicting theories, widely held misconceptions, and varied opinions generally distorted by
personal experiences, it is critical to the analysis and selection of weapons, ammunition and calibers for use by law enforcement Officers.(3,4)

Tactical Realities

Shot placement is an important, and often cited, consideration regarding the suitability of weapons and ammunition. However, considerations of caliber are equally important and cannot be ignored. For example, a bullet through the central nervous system with any caliber of ammunition is likely to be immediately incapacitating.(5) Even a .22 rimfire penetrating the brain will cause immediate incapacitation in most cases. Obviously, this does not mean the law enforcement agency should issue .22 rimfires and train for head shots as the primary target. The realities of shooting incidents prohibit such a solution.

Few, if any, shooting incidents will present the Officer with an opportunity to take a careful, precisely aimed shot at the subjects head. Rather, shootings are characterized by their sudden, unexpected occurrence; by rapid and unpredictable movement of both Officer and adversary; by limited and partial target opportunities; by poor light and unforeseen obstacles; and by the life or death stress of sudden, close, personal violence. Training is quite properly oriented towards "center of mass" shooting. That is to say, the Officer is trained to shoot at the center of whatever is presented for a target. Proper shot placement is a hit in the center of that part of the adversary which is presented, regardless of anatomy or angle.

A review of law enforcement shootings clearly suggests that regardless of the number of rounds fired in a shooting, most of the time only one or two solid torso hits on the adversary can be expected. This expectation is realistic because of the nature of shooting incidents and the extreme difficulty of shooting a handgun with precision under such dire conditions. The probability of multiple hits with a handgun is not high. Experienced Officers implicitly recognize that fact, and when potential violence is reasonably anticipated, their preparations are characterized by obtaining as many shoulder weapons as possible. Since most shootings are not anticipated, the Officer involved cannot be prepared in advance with heavier armament. As a corollary tactical principle, no law enforcement Officer should ever plan to meet an expected attack armed only with a handgun.

The handgun is the primary weapon for defense against unexpected attack. Nevertheless, a majority of shootings occur in manners and circumstances in which the Officer either does not have any other weapon available, or cannot get to it. The handgun must be relied upon, and must prevail. Given the idea that one or two torso hits can be reasonably expected in a handgun shooting incident, the ammunition used must maximize the likelihood of immediate incapacitation.

Mechanics of Projectile Wounding
In order to predict the likelihood of incapacitation with any handgun round, an understanding of the mechanics of wounding is necessary. There are four components of projectile wounding.(6) Not all of these components relate to incapacitation, but each of them must be considered. They are:

(1) Penetration. The tissue through which the projectile passes, and which it disrupts or destroys.

(2) Permanent Cavity. The volume of space once occupied by tissue that has been destroyed by the passage of the projectile. This is a function of penetration and the frontal area of the projectile. Quite simply, it is the hole left by the passage of the bullet.

(3) Temporary Cavity. The expansion of the permanent cavity by stretching due to the transfer of kinetic energy during the projectiles passage.

(4) Fragmentation. Projectile pieces or secondary fragments of bone which are impelled outward from the permanent cavity and may sever muscle tissues, blood vessels, etc., apart from the permanent cavity.(7,8) Fragmentation is not necessarily present in every projectile wound. It may, or may not, occur and can be considered a secondary effect.(9)

Projectiles incapacitate by damaging or destroying the central nervous system, or by causing lethal blood loss. To the extent the wound components cause or increase the effects of these two mechanisms, the likelihood of incapacitation increases. Because of the impracticality of training for head shots, this examination of handgun wounding relative to law enforcement use is focused upon torso wounds and the probable results.

**Mechanics of Handgun Wounding**

All handgun wounds will combine the components of penetration, permanent cavity, and temporary cavity to a greater or lesser degree. Fragmentation, on the other hand, does not reliably occur in handgun wounds due to the relatively low velocities of handgun bullets. Fragmentation occurs reliably in high velocity projectile wounds (impact velocity in excess of 2000 feet per second) inflicted by soft or hollow point bullets.(10) In such a case, the permanent cavity is stretched so far, and so fast, that tearing and rupturing can occur in tissues surrounding the wound channel which were weakened by fragmentation damage.(11,12) It can significantly increase damage(13) in rifle bullet wounds.

Since the highest handgun velocities generally do not exceed 1400-1500 feet per second (fps) at the muzzle, reliable fragmentation could only be achieved by constructing a bullet so frangible as to eliminate any reasonable penetration. Unfortunately, such a bullet will break up too fast to penetrate to vital organs. The best example is the Glaser Safety Slug, a projectile designed to break up on
impact and generate a large but shallow temporary cavity. Fackler, when asked to estimate the survival time of someone shot in the front mid-abdomen with a Glaser slug, responded, "About three days, and the cause of death would be peritonitis."(14)

In cases where some fragmentation has occurred in handgun wounds, the bullet fragments are generally found within one centimeter of the permanent cavity. "The velocity of pistol bullets, even of the new high-velocity loadings, is insufficient to cause the shedding of lead fragments seen with rifle bullets."(15) It is obvious that any additional wounding effect caused by such fragmentation in a handgun wound is inconsequential.

Of the remaining factors, temporary cavity is frequently, and grossly, overrated as a wounding factor when analyzing wounds.(16) Nevertheless, historically it has been used in some cases as the primary means of assessing the wounding effectiveness of bullets.

The most notable example is the Relative Incapacitation Index (RII) which resulted from a study of handgun effectiveness sponsored by the Law Enforcement Assistance Administration (LEAA). In this study, the assumption was made that the greater the temporary cavity, the greater the wounding effect of the round. This assumption was based on a prior assumption that the tissue bounded by the temporary cavity was damaged or destroyed.(17)

In the LEAA study, virtually every handgun round available to law enforcement was tested. The temporary cavity was measured, and the rounds were ranked based on the results. The depth of penetration and the permanent cavity were ignored. The result according to the RII is that a bullet which causes a large but shallow temporary cavity is a better incapacitator than a bullet which causes a smaller temporary cavity with deep penetration.

Such conclusions ignore the factors of penetration and permanent cavity. Since vital organs are located deep within the body, it should be obvious that to ignore penetration and permanent cavity is to ignore the only proven means of damaging or disrupting vital organs.

Further, the temporary cavity is caused by the tissue being stretched away from the permanent cavity, not being destroyed. By definition, a cavity is a space (18) in which nothing exists. A temporary cavity is only a temporary space caused by tissue being pushed aside. That same space then disappears when the tissue returns to its original configuration.

Frequently, forensic pathologists cannot distinguish the wound track caused by a hollow point bullet (large temporary cavity) from that caused by a solid bullet (very small temporary cavity). There may be no physical difference in the wounds. If there is no fragmentation, remote damage due to temporary cavitation
may be minor even with high velocity rifle projectiles.(19) Even those who have espoused the significance of temporary cavity agree that it is not a factor in handgun wounds:

"In the case of low-velocity missiles, e.g., pistol bullets, the bullet produces a direct path of destruction with very little lateral extension within the surrounding tissues. Only a small temporary cavity is produced. To cause significant injuries to a structure, a pistol bullet must strike that structure directly. The amount of kinetic energy lost in tissue by a pistol bullet is insufficient to cause remote injuries produced by a high velocity rifle bullet."(20)

The reason is that most tissue in the human target is elastic in nature. Muscle, blood vessels, lung, bowels, all are capable of substantial stretching with minimal damage. Studies have shown that the outward velocity of the tissues in which the temporary cavity forms is no more than one tenth of the velocity of the projectile. (21) This is well within the elasticity limits of tissue such as muscle, blood vessels, and lungs. Only inelastic tissue like liver, or the extremely fragile tissues of the brain, would show significant damage due to temporary cavitation.(22)

The tissue disruption caused by a handgun bullet is limited to two mechanisms. The first, or crush mechanism is the hole the bullet makes passing through the tissue. The second, or stretch mechanism is the temporary cavity formed by the tissues being driven outward in a radial direction away from the path of the bullet. Of the two, the crush mechanism, the result of penetration and permanent cavity, is the only handgun wounding mechanism which damages tissue.(23) To cause significant injuries to a structure within the body using a handgun, the bullet must penetrate the structure. Temporary cavity has no reliable wounding effect in elastic body tissues. Temporary cavitation is nothing more than a stretch of the tissues, generally no larger than 10 times the bullet diameter (in handgun calibers), and elastic tissues sustain little, if any, residual damage.(24,25,26)

The Human Target

With the exceptions of hits to the brain or upper spinal cord, the concept of reliable and reproducible immediate incapacitation of the human target by gunshot wounds to the torso is a myth.(27)

The human target is a complex and durable one. A wide variety of psychological, physical, and physiological factors exist, all of them pertinent to the probability of incapacitation. However, except for the location of the wound and the amount of tissue destroyed, none of the factors are within the control of the law enforcement Officer.

Physiologically, a determined adversary can be stopped reliably and immediately only by a shot that disrupts the brain or upper spinal cord. Failing a hit to the central nervous system, massive bleeding from holes in the heart or major blood
vessels of the torso causing circulatory collapse is the only other way to force incapacitation upon an adversary, and this takes time. For example, there is sufficient oxygen within the brain to support full, voluntary action for 10-15 seconds after the heart has been destroyed. (28)

In fact, physiological factors may actually play a relatively minor role in achieving rapid incapacitation. Barring central nervous system hits, there is no physiological reason for an individual to be incapacitated by even a fatal wound, until blood loss is sufficient to drop blood pressure and/or the brain is deprived of oxygen. The effects of pain, which could contribute greatly to incapacitation, are commonly delayed in the aftermath of serious injury such as a gunshot wound. The body engages survival patterns, the well known "fight or flight" syndrome.

Pain is irrelevant to survival and is commonly suppressed until some time later. In order to be a factor, pain must first be perceived, and second must cause an emotional response. In many individuals, pain is ignored even when perceived, or the response is anger and increased resistance, not surrender.

Psychological factors are probably the most important relative to achieving rapid incapacitation from a gunshot wound to the torso. Awareness of the injury (often delayed by the suppression of pain); fear of injury, death, blood, or pain; intimidation by the weapon or the act of being shot; preconceived notions of what people do when they are shot; or the simple desire to quit can all lead to rapid incapacitation even from minor wounds. However, psychological factors are also the primary cause of incapacitation failures.

The individual may be unaware of the wound and thus has no stimuli to force a reaction. Strong will, survival instinct, or sheer emotion such as rage or hate can keep a grievously injured individual fighting, as is common on the battlefield and in the street. The effects of chemicals can be powerful stimuli preventing incapacitation. Adrenaline alone can be sufficient to keep a mortally wounded adversary functioning. Stimulants, anesthetics, pain killers, or tranquilizers can all prevent incapacitation by suppressing pain, awareness of the injury, or eliminating any concerns over the injury. Drugs such as cocaine, PCP, and heroin are disassociative in nature. One of their effects is that the individual "exists" outside of his body. He sees and experiences what happens to his body, but as an outside observer who can be unaffected by it yet continue to use the body as a tool for fighting or resisting.

Psychological factors such as energy deposit, momentum transfer, size of temporary cavity or calculations such as the RII are irrelevant or erroneous. The impact of the bullet upon the body is no more than the recoil of the weapon. The ratio of bullet mass to target mass is too extreme.

The often referred to "knock-down power" implies the ability of a bullet to move its target. This is nothing more than momentum of the bullet. It is the transfer of
momentum that will cause a target to move in response to the blow received.

"Isaac Newton proved this to be the case mathematically in the 17th Century, and Benjamin Robins verified it experimentally through the invention and use of the ballistic pendulum to determine muzzle velocity by measurement of the pendulum motion."(29)

Goddard amply proves the fallacy of "knock-down power" by calculating the heights (and resultant velocities) from which a one pound weight and a ten pound weight must be dropped to equal the momentum of 9mm and .45ACP projectiles at muzzle velocities, respectively. The results are revealing. In order to equal the impact of a 9mm bullet at its muzzle velocity, a one pound weight must be dropped from a height of 5.96 feet, achieving a velocity of 19.6 fps. To equal the impact of a .45ACP bullet, the one pound weight needs a velocity of 27.1 fps and must be dropped from a height of 11.4 feet. A ten pound weight equals the impact of a 9mm bullet when dropped from a height of 0.72 inches (velocity attained is 1.96 fps), and equals the impact of a .45 when dropped from 1.37 inches (achieving a velocity of 2.71 fps).(30)

A bullet simply cannot knock a man down. If it had the energy to do so, then equal energy would be applied against the shooter and he too would be knocked down. This is simple physics, and has been known for hundreds of years.(31) The amount of energy deposited in the body by a bullet is approximately equivalent to being hit with a baseball.(32) Tissue damage is the only physical link to incapacitation within the desired time frame, i.e., instantaneously.

The human target can be reliably incapacitated only by disrupting or destroying the brain or upper spinal cord. Absent that, incapacitation is subject to a host of variables, the most important of which are beyond the control of the shooter. Incapacitation becomes an eventual event, not necessarily an immediate one. If the psychological factors which can contribute to incapacitation are present, even a minor wound can be immediately incapacitating. If they are not present, incapacitation can be significantly delayed even with major, unsurvivable wounds.

Field results are a collection of individualistic reactions on the part of each person shot which can be analyzed and reported as percentages. However, no individual responds as a percentage, but as an all or none phenomenon which the Officer cannot possibly predict, and which may provide misleading data upon which to predict ammunition performance.

Ammunition Selection Criteria

The critical wounding components for handgun ammunition, in order of importance, are penetration and permanent cavity.(33) The bullet must penetrate sufficiently to pass through vital organs and be able to do so from less than
optimal angles. For example, a shot from the side through an arm must penetrate at least 10-12 inches to pass through the heart. A bullet fired from the front through the abdomen must penetrate about 7 inches in a slender adult just to reach the major blood vessels in the back of the abdominal cavity. Penetration must be sufficiently deep to reach and pass through vital organs, and the permanent cavity must be large enough to maximize tissue destruction and consequent hemorrhaging.

Several design approaches have been made in handgun ammunition which are intended to increase the wounding effectiveness of the bullet. Most notable of these is the use of a hollow point bullet designed to expand on impact.

Expansion accomplishes several things. On the positive side, it increases the frontal area of the bullet and thereby increases the amount of tissue disintegrated in the bullets path. On the negative side, expansion limits penetration. It can prevent the bullet from penetrating to vital organs, especially if the projectile is of relatively light mass and the penetration must be through several inches of fat, muscle, or clothing.(34)

Increased bullet mass will increase penetration. Increased velocity will increase penetration but only until the bullet begins to deform, at which point increased velocity decreases penetration. Permanent cavity can be increased by the use of expanding bullets, and/or larger diameter bullets, which have adequate penetration.

However, in no case should selection of a bullet be made where bullet expansion is necessary to achieve desired performance.(35) Handgun bullets expand in the human target only 60-70% of the time at best. Damage to the hollow point by hitting bone, glass, or other intervening obstacles can prevent expansion. Clothing fibers can wrap the nose of the bullet in a cocoon like manner and prevent expansion. Insufficient impact velocity caused by short barrels and/or longer range will prevent expansion, as will simple manufacturing variations. Expansion must never be the basis for bullet selection, but considered a bonus when, and if, it occurs. Bullet selection should be determined based on penetration first, and the unexpanded diameter of the bullet second, as that is all the shooter can reliably expect.

It is essential to bear in mind that the single most critical factor remains penetration. While penetration up to 18 inches is preferable, a handgun bullet MUST reliably penetrate 12 inches of soft body tissue at a minimum, regardless of whether it expands or not. If the bullet does not reliably penetrate to these depths, it is not an effective bullet for law enforcement use.(36)

Given adequate penetration, a larger diameter bullet will have an edge in wounding effectiveness. It will damage a blood vessel the smaller projectile barely misses. The larger permanent cavity may lead to faster blood loss.
Although such an edge clearly exists, its significance cannot be quantified.

An issue that must be addressed is the fear of over penetration widely expressed on the part of law enforcement. The concern that a bullet would pass through the body of a subject and injure an innocent bystander is clearly exaggerated. Any review of law enforcement shootings will reveal that the great majority of shots fired by Officers do not hit any subjects at all. It should be obvious that the relatively few shots that do hit a subject are not somehow more dangerous to bystanders than the shots that miss the subject entirely.

Also, a bullet that completely penetrates a subject will give up a great deal of energy doing so. The skin on the exit side of the body is tough and flexible. Experiments have shown that it has the same resistance to bullet passage as approximately four inches of muscle tissue. (37)

Choosing a bullet because of relatively shallow penetration will seriously compromise weapon effectiveness, and needlessly endanger the lives of the law enforcement Officers using it. No law enforcement Officer has lost his life because a bullet over penetrated his adversary, and virtually none have ever been sued for hitting an innocent bystander through an adversary. On the other hand, tragically large numbers of Officers have been killed because their bullets did not penetrate deeply enough.

**The Allure of Shooting Incident Analyses**

There is no valid, scientific analysis of actual shooting results in existence, or being pursued to date. It is an unfortunate vacuum because a wealth of data exists, and new data is being sadly generated every day. There are some well publicized, so called analyses of shooting incidents being promoted, however, they are greatly flawed. Conclusions are reached based on samples so small that they are meaningless. The author of one, for example, extols the virtues of his favorite cartridge because he has collected ten cases of one shot stops with it. (38)

Preconceived notions are made the basic assumptions on which shootings are categorized. Shooting incidents are selectively added to the "data base" with no indication of how many may have been passed over or why. There is no correlation between hits, results, and the location of the hits upon vital organs.

It would be interesting to trace a life-sized anatomical drawing on the back of a target, fire 20 rounds at the "center of mass" of the front, then count how many of these optimal, center of mass hits actually struck the heart, aorta, vena cava, or liver. (39) It is rapid hemorrhage from these organs that will best increase the likelihood of incapacitation. Yet nowhere in the popular press extolling these studies of real shootings are we told what the bullets hit.
These so-called studies are further promoted as being somehow better and more valid than the work being done by trained researchers, surgeons, and forensic labs. They disparage laboratory stuff, claiming that the "street" is the real laboratory and their collection of results from the street is the real measure of caliber effectiveness, as interpreted by them, of course. Yet their data from the street is collected haphazardly, lacking scientific method and controls, with no noticeable attempt to verify the less than reliable accounts of the participants with actual investigative or forensic reports. Cases are subjectively selected (how many are not included because they do not fit the assumptions made?). The numbers of cases cited are statistically meaningless, and the underlying assumptions upon which the collection of information and its interpretation are based are themselves based on myths such as knock-down power, energy transfer, hydrostatic shock, or the temporary cavity methodology of flawed work such as RII.

Further, it appears that many people are predisposed to fall down when shot. This phenomenon is independent of caliber, bullet, or hit location, and is beyond the control of the shooter. It can only be proven in the act, not predicted. It requires only two factors to be effected: a shot and cognition of being shot by the target. Lacking either one, people are not at all predisposed to fall down and don't. Given this predisposition, the choice of caliber and bullet is essentially irrelevant. People largely fall down when shot, and the apparent predisposition to do so exists with equal force among the good guys as among the bad. The causative factors are most likely psychological in origin. Thousands of books, movies, and television shows have educated the general population that when shot, one is supposed to fall down.

The problem, and the reason for seeking a better cartridge for incapacitation, is that individual who is not predisposed to fall down. Or the one who is simply unaware of having been shot by virtue of alcohol, adrenaline, narcotics, or the simple fact that in most cases of grievous injury the body suppresses pain for a period of time. Lacking pain, there may be no physiological effect of being shot that can make one aware of the wound. Thus the real problem: if such an individual is threatening one's life, how best to compel him to stop by shooting him?

The factors governing incapacitation of the human target are many, and variable. The actual destruction caused by any small arms projectile is too small in magnitude relative to the mass and complexity of the target. If a bullet destroys about 2 ounces of tissue in its passage through the body, that represents 0.07 of one percent of the mass of a 180 pound man. Unless the tissue destroyed is located within the critical areas of the central nervous system, it is physiologically insufficient to force incapacitation upon the unwilling target. It may certainly prove to be lethal, but a body count is no evidence of incapacitation.

Probably more people in this country have been killed by .22 rimfire's than all
other calibers combined, which, based on body count, would compel the use of .22's for self-defense. The more important question, which is sadly seldom asked, is what did the individual do when hit?

There is a problem in trying to assess calibers by small numbers of shootings. For example, as has been done, if a number of shootings were collected in which only one hit was attained and the percentage of one shot stops was then calculated, it would appear to be a valid system. However, if a large number of people are predisposed to fall down, the actual caliber and bullet are irrelevant. What percentage of those stops were thus preordained by the target? How many of those targets were not at all disposed to fall down? How many multiple shot failures to stop occurred? What is the definition of a stop? What did the successful bullets hit and what did the unsuccessful bullets hit?

How many failures were in the vital organs, and how many were not? How many of the successes? What is the number of the sample? How were the cases collected? What verifications were made to validate the information? How can the verifications be checked by independent investigation?

Because of the extreme number of variables within the human target, and within shooting situations in general, even a hundred shootings is statistically insignificant. If anything can happen, then anything will happen, and it is just as likely to occur in your ten shootings as in ten shootings spread over a thousand incidents. Large sample populations are absolutely necessary.

Here is an example that illustrates how erroneous small samples can be. I flipped a penny 20 times. It came up heads five times. A nickel flipped 20 times showed heads 8 times. A dime came up heads 10 times and a quarter 15 times. That means if heads is the desired result, a penny will give it to you 25% of the time, and nickel 40% of the time, a dime 50% of the time and a quarter 75% of the time. If you want heads, flip a quarter. If you want tails, flip a penny. But then I flipped the quarter another 20 times and it showed heads 9 times - 45% of the time. Now this "study" would tell you that perhaps a dime was better for flipping heads. The whole thing is obviously wrong, but shows how small numbers lead to statistical lies. We know the odds of getting a head or tail are 50%, and larger numbers tend to prove it. Calculating the results for all 100 flips regardless of the coin used shows heads came up 48% of the time.

The greater the number and complexity of the variables, the greater the sample needed to give meaningful information, and a coin toss has only one simple variable it can land heads or it can land tails. The coin population is not complicated by a predisposition to fall one way or the other, by chemical stimuli, psychological factors, shot placement, bone or obstructive obstacles, etc.; all of which require even larger numbers to evidence real differences in effects.

Although no cartridge is certain to work all the time, surely some will work more
often than others, and any edge is desirable in one's self defense. This is simple
logic. The incidence of failure to incapacitate will vary with the severity of the
wound inflicted.(40) It is safe to assume that if a target is always 100%
destroyed, then incapacitation will also occur 100% of the time. If 50% of the
target is destroyed, incapacitation will occur less reliably. Failure to incapacitate
is rare in such a case, but it can happen, and in fact has happened on the
battlefield.

Incapacitation is still less rare [reliable] if 25% of the target is destroyed.

Now the magnitude of bullet destruction is far less (less than 1% of the target)
but the relationship [between destruction and incapacitation] is unavoidable.

The round which destroys 0.07% of the target will incapacitate more often than
the one which destroys 0.04%. However, only very large numbers of shooting
incidents will prove it. The difference may be only 10 out of a thousand, but that
difference is an edge, and that edge should be on the Officers side because one
of those ten may be the subject trying to kill him.

To judge a caliber's effectiveness, consider how many people hit with it failed to
fall down and look at where they were hit. Of the successes and failures, analyze
how many were hit in vital organs, rather than how many were killed or not, and
correlate that with an account of exactly what they did when they were hit.

Did they fall down, or did they run, fight, shoot, hide, crawl, stare, shrug, give up
and surrender? ONLY falling down is good. All other reactions are failures to
incapacitate, evidencing the ability to act with volition, and thus able to choose to
continue to try to inflict harm.

Those who disparage science and laboratory methods are either too short
sighted or too bound by preconceived (or perhaps proprietary) notions to see the
truth. The labs and scientists do not offer sure things. They offer a means of
indexing the damage done by a bullet, understanding of the mechanics of
damage caused by bullets and the actual effects on the body, and the basis for
making an informed choice based on objective criteria and significant statistics.

The differences between bullets may be small, but science can give us the
means of identifying that difference. The result is the edge all of law enforcement
should be looking for. It is true that the streets are the proving ground, but give
me an idea of what you want to prove and I will give you ten shootings from the
street to prove it. That is both easy, and irrelevant. If it can happen, it will happen.

Any shooting incident is a unique event, unconstrained by any natural law or
physical order to follow a predetermined sequence of events or end in
predetermined results. What is needed is an edge that makes the good result
more probable than the bad.
Science will quantify the information needed to make the choice to gain that edge. Large numbers (thousands or more) from the street will provide the answer to the question "How much of an edge?". Even if that edge is only 1%, it is not insignificant because the guy trying to kill you could be in that 1%, and you won't know it until it is too late.

**Conclusions**

Physiologically, no caliber or bullet is certain to incapacitate any individual unless the brain is hit. Psychologically, some individuals can be incapacitated by minor or small caliber wounds. Those individuals who are stimulated by fear, adrenaline, drugs, alcohol, and/or sheer will and survival determination may not be incapacitated even if mortally wounded.

The will to survive and to fight despite horrific damage to the body is commonplace on the battlefield, and on the street. Barring a hit to the brain, the only way to force incapacitation is to cause sufficient blood loss that the subject can no longer function, and that takes time. Even if the heart is instantly destroyed, there is sufficient oxygen in the brain to support full and complete voluntary action for 10-15 seconds.

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. The critical element is penetration. The bullet must pass through the large, blood bearing organs and be of sufficient diameter to promote rapid bleeding. Penetration less than 12 inches is too little, and, in the words of two of the participants in the 1987 Wound Ballistics Workshop, "too little penetration will get you killed."(42,43)

Given desirable and reliable penetration, the only way to increase bullet effectiveness is to increase the severity of the wound by increasing the size of hole made by the bullet. Any bullet which will not penetrate through vital organs from less than optimal angles is not acceptable. Of those that will penetrate, the edge is always with the bigger bullet.(44)

**References/Endnotes**

1 FBI Deadly Force Policy.

2 Ideally, immediate incapacitation occurs instantaneously.


5 Wound Ballistic Workshop: "9mm vs .45 Auto", FBI Academy, Quantico, VA, September, 1987. Conclusion of the Workshop.

6 Josselson, A., MD, Armed Forces Institute of Pathology, Walter Reed Army Medical Center, Washington, D.C., lecture series to FBI National Academy students, 1982-1983.


10 Josselson, A., MD, Armed Forces Institute of Pathology, Walter Reed Army Medical Center, Washington, D.C., lecture series to FBI National Academy students, 1982-1983.


13 Fragmenting rifle bullets in some of Fackler's experiments have caused damage 9 centimeters from the permanent cavity. Such remote damage is not found in handgun wounds. Fackler stated at the Workshop that when a handgun bullet does fragment the pieces typically are found within one centimeter of the wound track.


23 Wound Ballistic Workshop: "9mm vs. .45 Auto", FBI Academy, Quantico, VA, September, 1987. Conclusion of the Workshop.


27 Wound Ballistic Workshop: "9mm vs. .45 Auto", FBI Academy, Quantico, VA, September 1987. Conclusion of the Workshop.

28 Wound Ballistic Workshop: "9mm vs. .45 Auto", FBI Academy, Quantico, VA, September 1987. Conclusion of the Workshop.

29 Goddard, Stanley: "Some Issues for Consideration in Choosing Between 9mm and .45ACP Handguns", Battelle Labs, Ballistic Sciences, Ordnance Systems and Technology Section, Columbus, OH, presented to the FBI Academy, 2/16/88, pages 3-4.

30 Goddard, Stanley: "Some Issues for Consideration in Choosing Between 9mm and .45ACP Handguns", Battelle Labs, Ballistic Sciences, Ordnance Systems
and Technology Section, Columbus, OH, presented to the FBI Academy, 2/16/88, pages 3-4.

31 Newton, Sir Isaac, Principia Mathematica, 1687, in which are stated Newton's Laws of Motion. The Second Law of Motion states that a body will accelerate, or change its speed, at a rate that is proportional to the force acting upon it. In simpler terms, for every action there is an equal but opposite reaction. The acceleration will of course be in inverse proportion to the mass of the body. For example, the same force acting upon a body of twice the mass will produce exactly half the acceleration.

32 Lindsay, Douglas, MD, presentation to the Wound Ballistics Workshop, Quantico, VA, 1987.

33 Wound Ballistic Workshop: "9mm vs. .45 Auto", FBI Academy, Quantico, VA, September, 1987. Conclusion of the Workshop.

34 Jones, J.A.: Police Handgun Ammunition. Southwestern Institute of Forensic Sciences at Dallas, 523D Medical Center Drive, Dallas, TX, 1985.

35 Wound Ballistic Workshop: "9mm vs. .45 Auto", FBI Academy, Quantico, VA, September, 1987. Conclusion of the Workshop.

36 Wound Ballistic Workshop: "9mm vs. .45 Auto", FBI Academy, Quantico, VA, September 1987. Conclusion of the Workshop.


38 He defines a one shot stop as one in which the subject dropped, gave up, or did not run more than 10 feet.

39 This exercise was suggested by Dr. Martin L. Fackler, U.S. Army Wound Ballistics Laboratory, Letterman Army Institute of Research, San Francisco, California, as a way to demonstrate the problematical results of even the best results sought in training, i.e., shots to the center of mass of a target. It illustrates the very small actually critical areas within the relatively vast mass of the human target.

40 Severity is a function of location, depth, and amount of tissue destroyed.

41 The numbers can be held down to reasonable limits by a scientific approach that collects objective information from investigative and forensic sources and sorts it by vital organs struck and target reactions to being hit. The critical questions are what damage was done and what was the reaction of the
THE FBI'S 10MM PISTOL

NOTE: This paper details the process that led to the FBI's decision to move to a 10 mm (.40 caliber) pistol.

The paper was in the 1989 FBI Law Enforcement Bulletin, file 89nov002.txt. It is not new, but gives us the data and an insight into the thinking used to support the decision.

I have taken the liberty to add *******'s before and after portions of the article which also can be found in the FBI paper: Handgun Wounding Factors And Effectiveness.

THE FBI'S 10MM PISTOL

By

John C. Hall

Special Agent/Unit Chief

Firearms Training Unit

FBI Academy

Quantico, Virginia

For several decades, FBI Agents carried the .38 caliber revolver as a standard
firearm. Now, after extensive testing and evaluation, the FBI is converting to a new semiautomatic pistol. The new pistol, built to FBI specifications and chambered for a new cartridge - the 10mm, will be issued to all FBI Agents to replace existing revolvers. This article describes the process that led to this decision.

BACKGROUND

The authority for FBI Agents to carry firearms was first granted in 1934. Although pistols were sometimes issued or permitted on a limited basis, the revolver predominated as the FBI sidearm. The first significant shift occurred in 1981, when Special Weapons and Tactics (SWAT) teams were equipped with large capacity 9mm pistols. Since then, 9mm pistols have also become the issue weapons for the FBI's Hostage Rescue Team (HRT) and special surveillance teams.

For the general Agent population, however, revolvers remained the issue weapon, though the increasing use of pistols reflected a growing recognition that the modern pistol provides certain advantages over the revolver. Primarily, pistols are generally more compact and portable and provide a larger ammunition capacity. They are also quicker and easier to reload. Moreover, experience has shown that pistols are generally easier to shoot quickly and accurately due to the self cocking operation of the slide following each shot and the more efficient transmission of recoil. What is most important, however, is that pistols have proven to be durable and reliable.

Undoubtedly, interest in pistols intensified when innovative designs of the weapon began to appear on the market during the early 1980s. Whereas the basic revolver design remains much as it was at the turn of the century, the pistol has been virtually refashioned in recent years, providing a wide range of such innovative features as double stacked large capacity magazines, double action triggers, ambidextrous controls, multiple safety devices, and endless varieties of shapes and sizes.

Meanwhile, other events entered into the picture. Instances where law enforcement Officers were confronting more violent, heavily armed subjects appeared to be on the rise. The increasing use of semiautomatic and even fully automatic weapons by certain segments of the criminal element began to raise concerns about the adequacy of law enforcement armament.

SELECTION OF A NEW HANDGUN

In 1987, new impetus was given to the FBI's ongoing evaluation of firearms and ammunition. The Firearms Training Unit, located at the FBI Academy in Quantico, VA, set out to identify the best possible handgun for FBI Agents. Firearms training experts undertook a major testing project to evaluate a variety
of 9mm and .45 caliber pistols then on the market. While several of the pistols tested were effective, none possessed all of the features desired in a general issue FBI weapon. The challenge was to develop a pistol that met the needs of the FBI.

In the meantime, as a response to a growing perception within Agent ranks that a pistol was preferable to the revolver, the Director of the FBI authorized Agents to use personally owned pistols, either 9mm or .45 caliber, as long as the weapons were of approved manufacture and design and the training and qualification standards were met.

A QUESTION OF CALIBER

The most critical, and controversial, issue relating to the selection of a new FBI handgun was that of caliber. Questions have been raised not only about the adequacy of some weapons but also about the wounding effectiveness of some ammunition. Case accounts of shootings document the fact that subjects receiving fatal, but not incapacitating, wounds have been able to return fire and inflict further damage.

WOUND BALLISTICS

As a means of resolving the problem, the FBI convened a Wound Ballistics Seminar at the FBI Academy in September 1987. The participants included noted individuals from the scientific and medical communities from throughout the Nation who possessed relevant expertise in the field of wound ballistics. One of the primary purposes of the seminar was to identify the performance criteria of a bullet most likely to inflict an incapacitating wound on a human target.

A second purpose of the seminar was to determine, if possible, which of the two calibers, the 9mm or the .45, was likely to be most effective in accomplishing that goal. And, although the seminar was unsuccessful in conclusively resolving the caliber question, it did identify the desirable performance criteria of an effective bullet.

Incapacitation, in the law enforcement context, may be simply described as bringing about the immediate cessation of hostile or threatening activities.

Incapacitation may result from psychological or physiological factors. Psychologically, some individuals are predisposed to fall down at the sound of gunfire, while others may continue to fight even though they are seriously -even fatally- wounded. Because a particular person's psychological response to a gunshot wound cannot be predicted, ammunition performance must be viewed from the perspective of physiological incapacitation.
The seminar participants unanimously concluded that physiological incapacitation can be accomplished in one of two ways: damage to the central nervous system (the brain or upper spinal column) or significant loss of blood. Because the placement of a shot in the relatively small, highly mobile target area of the brain cannot be counted upon in an armed confrontation, a bullet must therefore be capable of penetrating the body sufficiently to pass through major arteries and blood-bearing organs to ensure timely physiological incapacitation.

Without adequate penetration, physiological incapacitation cannot be attained.

* * * * * * * * * *

Given adequate penetration, the only reliable way to increase the effectiveness of the wound is to increase its size, thus increasing the amount of tissue damage and the rate of hemorrhage. Thus, the FBI's test program was designed to evaluate bullet penetration and wound size.

**AMMUNITION TEST DESIGN**

With the performance criteria acquired from the Wound Ballistics Seminar, the next step was to design and construct a series of ammunition tests to measure the performance of different rounds against those standards. For that purpose, the Firearms Training Unit established a working group which included personnel from the Special Operations and Research Unit, the Hostage Rescue Team, and the Institutional Research and Development Unit.

The tests were designed to simulate factors realistically. Therefore, if the effects of bullets upon human tissue were to be realistically measured, a substance that would duplicate human tissue was needed. Based upon the research of Dr. Martin Fackler, Director of the Army's Wound Ballistics Laboratory, at the Letterman Institute in San Francisco, 10% ballistic gelatin was selected to simulate soft human muscle tissue. Eight separate penetration tests were conducted by firing bullets into this substance.

Also, since experience demonstrated that bare tissue is seldom visible on a target in a violent confrontation, seven of the eight tests included covering the gelatin with typical clothing material (cotton T shirt material, flannel shirt material, 10 oz. down in a nylon carrier, and denim). To assure validity and standardization, clothing manufacturers were consulted to determine the average thread count in typical underclothing, shirts, and jackets.

Other factors were then considered. Because FBI Agents frequently confront subjects in vehicles, behind doors or walls, and at various distances, clothed gelatin was placed behind windshield glass, car door metal, plaster board and plywood. Again, manufacturers in the construction and automobile industries
were consulted to assure that the materials used replicated substances that bullets would have to pass through in real life situations.

* * * * * * * *

While most of the test shots were fired from a distance of 10 feet, some of the tests were conducted at 20 yards to assess the effects of distance and velocity loss on penetration potential.

* * * * * * * *

Five shots were fired in each of the 8 penetration tests, providing a total of 40 shots for each caliber or bullet type tested.

THE COMPETING CALIBERS

Once the tests were designed, a decision had to be made regarding the calibers to be tested. In pistol cartridges, the two most obvious contenders were the 9mm and .45. The 9mm round tested was the 147 grain subsonic hollow point round produced by Winchester; the .45 round selected for the test was the Remington 185 grain hollow point. The selection of these particular cartridges for testing was based, in large part, on the consensus of the Wound Ballistic Workshop participants that these bullets should provide superior penetration over other hollow point bullets in their respective calibers.

In the meantime, a separate research and development project had been undertaken with the 10mm cartridge to assess its application to law enforcement work. Although the 10mm (.40 caliber) is a relatively new cartridge, with few weapons presently chambered for it, its unique position halfway in size between the 9mm (.35 caliber) and the .45 appeared to offer the possibility of a third viable law enforcement pistol cartridge. In addition, unlike its other competitors, the potential of the new cartridge was virtually untapped.

Samples of commercially available 10mm ammunition were acquired and preliminarily evaluated as to suitability for law enforcement use. The high chamber pressures generated by the commercial loadings, with the resultant heavy recoil and muzzle blast, tended to offset the otherwise excellent performance of the round. Therefore, the FBI Firearms Training Unit decided to create a new loading for the 10mm, one with velocities comparable to those of the competing 9mm and .45 cartridges. A 180 grain hollow point bullet was acquired and handloaded to a velocity of 950 feet per second. This loading not only matched the velocities of the other two cartridges, but it also dramatically reduced recoil and muzzle blast.

In the absence of factory ammunition built to the desired specifications, the 10mm rounds initially subjected to the test protocol were those handloaded by
the Firearms Training Unit staff. Subsequently, factory loaded 10mm ammunition was acquired and built to the desired specifications, which actually met or surpassed the performance of the handloaded test ammunition.

THE TEST PROCEDURES

Because the objective was to test ammunition and not weapons, the initial tests were conducted with industry standard test barrels. These barrels are built to standards established by the Sporting Arms and Ammunition Manufacturing Institute (SAAMI) and are tailored to optimize the ballistic efficiency of each caliber. Test barrel length is determined by the internal ballistics of the caliber. Consequently, the barrel lengths vary with each caliber. For example, the optimal test barrel for the 9mm is 4" in length, while those of the 10mm and .45 are 6".

The immediate concern was the possibility that the longer test barrels for the 10mm and .45 would provide an advantage by increasing their velocities. In reality, it was discovered that increased velocity actually diminishes the penetration performance of hollow point bullets in gelatin by increasing the rate and degree of expansion. It was noted, for example, that both the 10mm and .45 achieved lower velocities, but greater penetration, when fired from shorter pistol barrels than when fired from the longer test barrels with somewhat higher velocities. Thus, the longer test barrels used with the 10mm and .45 worked as a handicap for those two calibers by lessening the degree of penetration. That handicap would have been eliminated by using test barrels of equal lengths, and the disparity between the penetration performance of the 9mm and the two other calibers would have been even greater than that actually attained. Since the longer test barrels were not giving any advantage to the 10mm and the .45 caliber (quite the contrary), the tests were continued with existing equipment.

After initial tests to measure velocity and accuracy, 40 rounds of each caliber were fired by FBI firearms personnel to measure penetration and wound volume. Following each shot, red dye was injected into the wound channel created by the passage of the bullet into the gelatin, and a photograph was taken. Then a separate team from the Institutional Research and Development Unit conducted the measurements to ascertain penetration (measured in inches), bullet expansion, and retained bullet weight. Finally, the volume of tissue displaced (wound size) by the passage of the bullet was computed in cubic inches and recorded.

THE RESULTS

Although penetration and wound size govern handgun wounding effectiveness, penetration is the more critical element. Therefore, a minimum standard of 12" of penetration in the gelatin was established. The following penetration results indicate the number and percentage of rounds in each caliber that met or exceeded the 12" minimum:
10mm - 39 shots out of 40 (97.5%)

.45 - 37 shots out of 40 (92.5%)

9mm - 27 shots out of 40 (67.5%)

As a point of reference, the standard issue .38 Special, 158 grain lead hollowpoint round was fired through the battery of tests. Although the .38 was not a "test" round, and therefore not fired under the same strict test controls, the penetration performance was similar to that of the 9mm, producing acceptable penetration 67.5% of the time.

It should be noted that no maximum penetration standard was established. This reflects the judgment that underpenetration of a handgun bullet presents a far greater risk to the law enforcement Officer than overpenetration does to an innocent bystander.

*******

Considering that approximately 80% of the rounds fired by law enforcement Officers engaged in violent encounters do not strike the intended targets, it was deemed somewhat unrealistic to attach too much significance to the potential risks of overpenetration on the part of those that do.

*******

Nevertheless, in assessing the potential volume of wounds created by the test bullets, greater attention was given to the potential tissue displaced up to a depth of 18". For practical purposes, penetration beyond that range would most likely carry the bullet outside the body.

Averaging the volumetric results over all eight test events, the 10mm and .45 displaced similar volumes of tissue within the desirable penetration range of 18" (4.11 and 4.22 cubic inches respectively) well beyond that displaced by the 9mm and .38 (which respectively measured 2.82 and 2.16 cubic inches).

As an additional consideration, the 10mm was by far the most accurate round tested, consistently providing one hole 10 shot groups at 25 yards of less than an inch (0.77" average) with both handloaded and factory ammunition built to FBI specifications. By contrast, the 9mm averaged 2.3" and the .45 averaged 2".

CONCLUSION

The conclusion was obvious. The best performing round within the parameters of the FBI's test protocol was the 10mm. Accordingly, the Director of the FBI
approved the recommendation that the new 10mm cartridge be adopted as the standard caliber for a new FBI pistol, and that the new pistol be procured in sufficient quantities to replace existing revolvers.

The tests that led to this decision by the FBI are available, on request, to interested law enforcement agencies. Moreover, ammunition testing will continue, and extend to other calibers and bullets available for law enforcement use. As additional test results are compiled, quarterly updates will be automatically mailed to recipients of the original test report. Requests for the test report entitled "Ammunition Test Results" should be mailed to:

Firearms Training Unit
FBI Academy
Quantico, VA 22135

FBI BULLET PERFORMANCE CRITERIA

1. PENETRATION
   a. Minimum Acceptable-12
   b. Maximum Desirable-18

2. SIZE OF THE WOUND (Volume)
   a. Frontal Area of Bullet
   b. Depth of Penetration

FBI STANDARDIZED AMMUNITION TESTS

Test 1 - Bare Gelatin @ 10 feet
Test 2 - Heavy Clothing @ 10 feet
Test 3 - 20 gauge Steel @ 10 feet
Test 4 - Wallboard @ 10 feet
Test 5 - Plywood @ 10 feet
Test 6 - Auto Windshield Glass @ 10 feet
Test 7 - Light Clothing @ 20 yards
MY COMMENTARY

I found the above paper by accident a while ago. It was published in the 1989 FBI Law Enforcement Bulletin - 89nov002.txt.

I believed that it would be good to include it here because:

1. it has info contained in the FBI paper: Handgun Wounding Factors And Effectiveness that is not openly available from the FBI to those outside of Police circles,

2. it is of general interest as it provides insight as to how things are done in the world of the gun, such as testing and weapon adoption,

3. it also points up the thinking or lack thereof that can accompany those things, and

4. even though its focus is on hardware, it has info in it that highlights the need for Point Shooting.

SHOOTABILITY & THE SILVER BULLET

Now, I don't question the need for and the search for, the best penetrating round as detailed in the FBI article. However, in conducting that search, no one apparently gave more than passing attention to the elephant "hiding" in plain view.

That elephant was alluded to and pointed out in the discussion of bullet over-penetration: "Considering that approximately 80% of the rounds fired by law enforcement Officers engaged in violent encounters do not strike the intended targets, it was deemed somewhat unrealistic to attach too much significance to the potential risks of over-penetration on the part of those that do."

No link was made between the armed encounter accuracy rate, which in my opinion is very bad to terrible, and which only could be expected to get worse with the adoption of a "hotter" round with increased recoil force, given the ergonomic related shootability of double stack handguns, and the shooting methods taught for use in armed encounters.

My point is that even if one comes up with a Silver Bullet and a firearm for it, to do its penetration work, the bullet must first hit the target via that handgun and a
shooting method.

There is a direct link between bullet ballistics, the ergonomic related shootability of double stack handguns, and shooting methods. And to not recognize that linkage, and deal with all three aspects concurrently as part of a whole, will perpetuate their negative affects and frustrate improvement.

IMO, what one needs to do, is find a gun that is EZ to shoot accurately and fast, and a shooting method that is effective in real life and death situations, and link them up with the Silver Bullet via chambering or cartridge modification.

Also, and as an attendant issue, according to what one reads on the web there are safety concerns over the .40 cal round. They deal with the design of the cartridge and its physical integrity over time when subject to loading and unloading, and gas pressure issues.

**SHOOTABILITY FACTORS**

- As to shootability in general, a .40 cal is a bigger and higher powered round than a 9mm, and that will make it harder to shoot accurately because of increased recoil force.

- The bulkiness of most gun grips, which is due to their double stack configuration, makes for a poor and ineffectual grip except by those with large hands.

- Grips on guns with single stack magazines can be made slimmer to provide for a more effective and tenacious grip which will result in improved shootability.

- Also, there appears to be no real need for current high capacity and bulky magazines. As according to the literature, seldom if ever are more than 5 shots expended in an armed encounter by an individual Officer. And most Officers carry extra magazines for use if the need for a reload comes up.

- Further, according to the literature, with very few exceptions, there has not been the need for a reload to continue a fight.

Two exceptions that come to mind are the shootout in Miami and the shootout in LA, but those situations were clear exceptions themselves.

And I am aware of a shootout a number of years ago, between a Police Officer on a motorcycle and a perp with an automatic rifle in Hawaii where the perp was killed and the Officer was shot. He reloaded during the encounter. I also am aware of a more recent gunfight in Florida that lasted 51 seconds, in which a wounded Officer who was shot 7 times - once in her gun hand - was able to reload despite her injuries, and shot two of three attackers killing one of them.
am sure that there are other exceptional situations, but they are not the norm.

- Most Officers have been taught Sight Shooting that according to the literature and studies is a patently ineffective method for use in real life and death Close Quarters armed encounters (with an accuracy rate of less than 20%). As such, I feel that Point Shooting needs to be recognized and taught as the PRIMARY shooting method for use in Close Quarters self defense situations.

- According to the stats, if you are going to be shot, there is a 90% chance that that will happen at less than 15 feet. So, the one who knows Point Shooting will have an advantage that could make the difference between living or dying.

- Lastly, the NRA in its: The NRA Guide To The Basics Of Personal Protection In The Home, which was published in 2000, advocates the use of Point Shooting at close quarters.

Return to: Top
........................Index

IMAGES OF THE "OFFICIAL" FBI COPY OF: HANDGUN WOUNDING FACTORS AND EFFECTIVENESS
U.S. Department of Justice
Office of Information and Privacy

Telephone: (202) 514-3642
Washington, D.C. 20530

MAY 27 2005

Re: Appeal No. 05-1196
Request No. 1003439
RLH:ADW:JTR

Dear Mr. Veit:

You appealed from the action of the Headquarters Office of the Federal Bureau of Investigation on your request for access to a report entitled "Handgun Wounding Factors and Effectiveness."

After carefully considering your appeal, and as a result of discussions between the FBI and a member of my staff, I have decided to release the report to you in full, a copy of which is enclosed. With the release of these twenty-one pages, the FBI has provided you with all records that it could locate in its files responsive to your request.

If you are dissatisfied with my action on your appeal, you may seek judicial review in accordance with 5 U.S.C. § 552(a)(4)(B).

Sincerely,

Richard L. Huff
Co-Director

Enclosure
Federal Bureau of Investigation

Freedom of Information / Privacy Acts

Release

Subject: HANDGUN WOUNDING AND EFFECTIVENESS 07-14-89
HANDGUN WOUNDING FACTORS AND EFFECTIVENESS

FBI ACADEMY FIREARMS TRAINING UNIT

FOR LAW ENFORCEMENT DISSEMINATION ONLY
Handgun Wounding Factors and Effectiveness

Special Agent UREY W. PATRICK
FIREARMS TRAINING UNIT
FBI ACADEMY
QUANTICO, VIRGINIA
July 14, 1989
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOREWORD</td>
<td>1</td>
</tr>
<tr>
<td>TACTICAL REALITIES</td>
<td>3</td>
</tr>
<tr>
<td>MECHANICS OF PROJECTILE WOUNDING</td>
<td>4</td>
</tr>
<tr>
<td>MECHANICS OF PROJECTILE WOUNDING</td>
<td>5</td>
</tr>
<tr>
<td>THE HUMAN TARGET</td>
<td>8</td>
</tr>
<tr>
<td>AMMUNITION SELECTION CRITERIA</td>
<td>11</td>
</tr>
<tr>
<td>THE ALLURE OF SHOOTING INCIDENT ANALYSES</td>
<td>13</td>
</tr>
<tr>
<td>CONCLUSIONS</td>
<td>16</td>
</tr>
</tbody>
</table>
FOREWORD

The selection of effective handgun ammunition for law enforcement is a critical and complex issue. It is critical because of what is at stake when an officer is required to use his handgun to protect his own life or that of another. It is complex because the target, a human being, is amazingly endurable and capable of sustaining phenomenal punishment while persisting in a determined course of action. The issue is made even more complex by the dearth of credible research and the wealth of uninformed opinion regarding what is commonly referred to as “stopping power.”

In reality, few people have conducted relevant research in this area, and fewer still have produced credible information that is useful for law enforcement agencies in making informed decisions.

This article brings together what is believed to be the most credible information regarding wound ballistics. It cuts through the haze and confusion, and provides common-sense, scientifically supportable, principles by which the effectiveness of law enforcement ammunition may be measured. It is written clearly and concisely. The content is credible and practical. The information contained in this article is not offered as the final word on wound ballistics. It is, however, an important contribution to what should be an ongoing discussion of this most important of issues.

John C. Hall
Unit Chief
Firearms Training Unit
The handgun is the primary weapon in law enforcement. It is the weapon any officer or agent can be expected to have available whenever needed. Its purpose is to apply deadly force to not only protect the life of the officer and the lives of others, but to prevent serious physical harm to them as well. When an officer shoots a subject, it is done with the explicit intention of immediately incapacitating the subject in order to stop whatever threat to life or physical safety is posed by the subject. Immediate incapacitation is defined as the sudden physical or mental inability to pose any further risk of death or injury to others.

The concept of immediate incapacitation is the only goal of any law enforcement shooting and is the underlying rationale for decisions regarding weapons, ammunition, calibers and training. While this concept is subject to conflicting theories, widely held misconceptions, and varied opinions generally distorted by personal experiences, it is critical to the analysis and selection of weapons, ammunition and calibers for use by law enforcement officers.¹ ² ³ ⁴

¹ FBI Deadly Force Policy
² Ideally, immediate incapacitation occurs instantaneously
TACTICAL REALITIES

Shot placement is an important, and often cited, consideration regarding the suitability of weapons and ammunition. However, considerations of caliber are equally important and cannot be ignored. For example, a bullet through the central nervous system with any caliber of ammunition is likely to be immediately incapacitating. Even a .22 rimfire penetrating the brain will cause immediate incapacitation in most cases. Obviously, this does not mean the law enforcement agency should issue .22 rimfires and train for head shots as the primary target. The realities of shooting incidents prohibit such a solution.

Few, if any, shooting incidents will present the officer with an opportunity to take a careful, precisely aimed shot at a subject's head. Rather, shootings are characterized by their sudden, unexpected occurrence; by rapid and unpredictable movement of both officer and adversary; by limited and partial target opportunities, by poor light and unforeseen obstacles; and by the life or death stress of sudden, close, personal violence. Training is quite properly oriented towards "center of mass" shooting. That is to say, the officer is trained to shoot at the center of whatever is presented for a target. Proper shot placement is a hit in the center of that part of the adversary which is presented, regardless of anatomy or angle.

A review of law enforcement shootings clearly suggests that regardless of the number of rounds fired in a shooting, most of the time only one or two solid torso hits on the adversary can be expected. This expectation is realistic because of the nature of shooting incidents and the extreme difficulty of shooting a handgun with precision under such dire conditions. The probability of multiple hits with a handgun is not high. Experienced officers implicitly recognize that fact, and when potential violence is reasonably anticipated, their preparations are characterized by obtaining as many shoulder weapons as possible. Since most shootings are not anticipated, the officer involved cannot be prepared in advance with heavier armament. As a corollary tactical principle, no law enforcement officer should ever plan to meet an expected attack armed only with a handgun.

The handgun is the primary weapon for defense against an unexpected attack. Nevertheless, a majority of shootings occur in manners and circumstances in which the officer either does not have any other weapon available, or cannot get to it. The handgun must be relied upon, and must prevail. Given the idea that one or two torso hits can be reasonably expected in a handgun shooting incident, the ammunition used must maximize the likelihood of immediate incapacitation.

---

5 Wound Ballistic Workshop "9mm vs .45 Auto", FBI Academy, Quantico, VA, September, 1987

Conclusion of the Workshop
MECHANICS OF PROJECTILE WOUNDING

In order to predict the likelihood of incapacitation with any handgun round, an understanding of the mechanics of wounding is necessary. There are four components of projectile wounding. Not all of these components relate to incapacitation, but each of them must be considered. They are:

(1) Penetration. The tissue through which the projectile passes, and which it disrupts or destroys.

(2) Permanent Cavity. The volume of space once occupied by tissue that has been destroyed by the passage of the projectile. This is a function of penetration and the frontal area of the projectile. Quite simply, it is the hole left by the passage of the bullet.

(3) Temporary Cavity. The expansion of the permanent cavity by stretching due to the transfer of kinetic energy during the projectile’s passage.

(4) Fragmentation. Projectile pieces or secondary fragments of bone which are impelled outward from the permanent cavity and may sever muscle tissues, blood vessels, etc., apart from the permanent cavity. Fragmentation is not necessarily present in every projectile wound. It may, or may not, occur and can be considered a secondary effect.

Projectiles incapacitate by damaging or destroying the central nervous system, or by causing lethal blood loss. To the extent the wound components cause or increase the effects of these two mechanisms, the likelihood of incapacitation increases. Because of the impracticality of training for head shots, this examination of handgun wounding relative to law enforcement use is focused upon torso wounds and the probable results.

---

6 Josseison, A., MD, Armed Forces Institute of Pathology, Walter Reed Army Medical Center, Washington, D.C., lecture series to FBI National Academy students, 1982-1983
9 Fackler, M. L., MD “Missile Caused Wounds”, Letterman Army Institute of Research, Presidio of San Francisco, Ca, Report No. 231, April, 1987
MECHANICS OF HANDGUN WOUNDING

All handgun wounds will combine the components of penetration, permanent cavity, and temporary cavity to a greater or lesser degree. Fragmentation, on the other hand, does not reliably occur in handgun wounds due to the relatively low velocities of handgun bullets. Fragmentation reliably occurs in high velocity projectile wounds (impact velocity in excess of 2000 feet per second) inflicted by soft point or hollow point bullets. In such a case, the permanent cavity is stretched so far, and so fast, that tearing and rupturing can occur in tissues surrounding the wound channel which were weakened by fragmentation damage. It can significantly increase damage in rifle bullet wounds.

Since the highest handgun velocities generally do not exceed 1400-1500 feet per second (fps) at the muzzle, reliable fragmentation could only be achieved by constructing a bullet so frangible as to eliminate any reasonable penetration. Unfortunately, such a bullet will break up too fast to penetrate to vital organs. The best example is the Glaser Safety Slug, a projectile designed to break up on impact and generate a large but shallow temporary cavity. Fackler, when asked to estimate the survival time of someone shot in the front mid-abdomen with a Glaser slug, responded, “About three days, and the cause of death would be pertoitus.”

In cases where some fragmentation has occurred in handgun wounds, the bullet fragments are generally found within one centimeter of the permanent cavity. The velocity of pistol bullets, even of the new high-velocity loadings, is insufficient to cause the shedding of lead fragments seen with rifle bullets. It is obvious that any additional wounding effect caused by such fragmentation in a handgun wound is inconsequential.

Of the remaining factors, temporary cavity is frequently, and grossly, overrated as a wounding factor when analyzing wounds. Nevertheless, historically it has been used in some cases as the primary means of assessing the wounding effectiveness of bullets.

---

10 Josselson, A., MD, Armed Forces Institute of Pathology, Walter Reed Army Medical Center, Washington, D.C., lecture series to FBI National Academy students, 1982-1983
13 Fragmenting rifle bullets in some of Fackler’s experiments have caused damage 9 centimeters from the permanent cavity. Such remote damage is not found in handgun wounds. Fackler stated that when a handgun bullet does fragment the pieces typically are found within one centimeter of the wound track.
16 Lindsey, Douglas, MD “The Idolatry of Velocity, or Lies, Damn Lies, and Ballistics”, Journal of
The most notable example is the Relative Incapacitation Index (RII) which resulted from a study of handgun effectiveness sponsored by the Law Enforcement Assistance Administration (LEAA). In this study, the assumption was made that the greater the temporary cavity, the greater the wounding effect of the round. This assumption was based on a prior assumption that the tissue bounded by the temporary cavity was damaged or destroyed.17

In the LEAA study, virtually every handgun round available to law enforcement was tested. The temporary cavity was measured, and the rounds were ranked based on the results. The depth of penetration and the permanent cavity were ignored. The result according to the RII is that a bullet which causes a large but shallow temporary cavity is a better incapacitator than a bullet which causes a smaller temporary cavity with deep penetration.

Such conclusions ignore the factors of penetration and permanent cavity. Since vital organs are located deep within the body, it should be obvious that to ignore penetration and permanent cavity is to ignore the only proven means of damaging or disrupting vital organs.

Further, the temporary cavity is caused by the tissue being stretched away from the permanent cavity, not being destroyed. By definition, a cavity is a space in which nothing exists. A temporary cavity is only a temporary space caused by tissue being pushed aside. That same space then disappears when the tissue returns to its original configuration.

Frequently, forensic pathologists cannot distinguish the wound track caused by a hollow-point bullet (large temporary cavity) from that caused by a solid bullet (very small temporary cavity). There may be no physical difference in the wounds. If there is no fragmentation, remote damage due to temporary cavitation may be minor even with high-velocity rifle projectiles.19 Even those who have espoused the significance of temporary cavity agree that it is not a factor in handgun wounds.

"In the case of low-velocity missiles, e.g., pistol bullets, the bullet produces a direct path of destruction with very little lateral extension within the surrounding tissues. Only a small temporary cavity is produced. To cause significant injuries to a structure, a pistol bullet must strike that structure directly. The amount of kinetic energy lost in the tissue by a pistol bullet is insufficient to cause the remote injuries produced by a high-velocity rifle bullet."20

References:

The reason is that most tissue in the human target is elastic in nature. Muscle, blood vessels, lung, bowels, all are capable of substantial stretching with minimal damage. Studies have shown that the outward velocity of the tissues in which the temporary cavity forms is no more than one tenth of the velocity of the projectile. This is well within the elasticity limits of tissue such as muscle, blood vessels, and lungs. Only inelastic tissue like liver, or the extremely fragile tissue of the brain, would show significant damage due to temporary cavitation.

The tissue disruption caused by a handgun bullet is limited to two mechanisms. The first, or crush mechanism, is the hole the bullet makes passing through the tissue. The second, or stretch mechanism is the temporary cavity formed by the tissues being driven outward in a radial direction away from the path of the bullet. Of the two, the crush mechanism, the result of penetration and permanent cavity, is the only handgun wounding mechanism which damages tissue. To cause significant injuries to a structure within the body using a handgun, the bullet must penetrate the structure. Temporary cavity has no reliable wounding effect in elastic body tissues. Temporary cavitation is nothing more than a stretch of the tissues, generally no larger than 10 times the bullet diameter (in handgun calibers), and elastic tissues sustain little, if any, residual damage.

23 Wound Ballistic Workshop "9mm vs .45 Auto", FBI Academy, Quantico, VA, September, 1987
24 Conclusion of the Workshop
27 Lindsey, Douglas, MD "The Idolatry of Velocity, or Lies, Damn Lies, and Ballistics", Journal of Trauma 20 1068-1069, 1980
THE HUMAN TARGET

With the exceptions of hits to the brain or upper spinal cord, the concept of reliable and reproducible immediate incapacitation of the human target by gunshot wounds to the torso is a myth.27 The human target is a complex and durable one. A wide variety of psychological, physical, and physiological factors exist, all of them pertinent to the probability of incapacitation. However, except for the location of the wound and the amount of tissue destroyed, none of the factors are within the control of the law enforcement officer.

Physiologically, a determined adversary can be stopped reliably and immediately only by a shot that disrupts the brain or upper spinal cord. Failing a hit to the central nervous system, massive bleeding from holes in the heart or major blood vessels of the torso causing circulatory collapse is the only other way to force incapacitation upon an adversary, and this takes time. For example, there is sufficient oxygen within the brain to support full, voluntary action for 10-15 seconds after the heart has been destroyed.28

In fact, physiological factors may actually play a relatively minor role in achieving rapid incapacitation. Barring central nervous system hits, there is no physiological reason for an individual to be incapacitated by even a fatal wound, until the blood loss is sufficient to drop blood pressure and/or the brain is deprived of oxygen. The effects of pain, which could contribute greatly to incapacitation, are commonly delayed in the aftermath of serious injury such as a gunshot wound. The body engages survival patterns, the well known "fight or flight" syndrome. Pain is irrelevant to survival and is commonly suppressed until some time later. In order to be a factor, pain must first be perceived, and second must cause an emotional response. In many individuals, pain is ignored even when perceived, or the response is anger and increased resistance, not surrender.

Psychological factors are probably the most important relative to achieving rapid incapacitation from a gunshot wound to the torso. Awareness of the injury (often delayed by the suppression of pain), fear of injury, death, blood, or pain, intimidation by the weapon or the act of being shot, preconceived notions of what people do when they are shot, or the simple desire to quit can all lead to rapid incapacitation even from minor wounds. However, psychological factors are also the primary cause of incapacitation failures.

The individual may be unaware of the wound and thus has no stimuli to force a reaction. Strong will, survival instinct, or sheer emotion such as rage or hate can keep a grievously injured individual fighting, as is common on the battlefield and in the street. The effects of chemicals can be powerful stimuli preventing incapacitation. Adrenalin alone can be sufficient to keep a mortally wounded adversary functioning. Stimulants, anesthetics, pain killers, or tranquilizers can all prevent incapacitation by suppressing pain, awareness of injury, or eliminating any concerns over the injury. Drugs such as cocaine, PCP, and heroin are dissociative in nature. One of their effects is that the individual "exists" outside of his body. He sees and experiences what happens to his body, but as an outside observer who can be unaffected by it yet continue to use the body as a tool for fighting or resisting.

---
27 Wound Ballistic Workshop "9mm vs .45 Auto", FBI Academy, Quantico, VA, September, 1987
28 Wound Ballistic Workshop "9mm vs .45 Auto", FBI Academy, Quantico, VA, September, 1987
Physical factors such as energy deposit, momentum transfer, size of the temporary cavity, or calculations such as the RII are irrelevant or erroneous. The impact of the bullet upon the body is no more than the recoil of the weapon. The ratio of bullet mass to target mass is too extreme.

The often referred to “knock-down power” implies the ability of a bullet to move its target. This is nothing more than the momentum of the bullet. It is the transfer of momentum that will cause a target to move in response to the blow received. “Isaac Newton proved this to be the case mathematically in the 17th Century, and Benjamin Robins verified it experimentally through the invention and use of the ballistic pendulum to determine muzzle velocity by measurement of the pendulum motion.”

Goddard amply proves the fallacy of “knock-down power” by calculating the heights (and resultant velocities) from which a one pound weight and a ten pound weight must be dropped to equal the momentum of 9mm and .45ACP projectiles at muzzle velocities, respectively. The results are revealing. In order to equal the impact of a 9mm bullet at its muzzle velocity, a one pound weight must be dropped from a height of 5.96 feet, achieving a velocity of 19.6 fps. To equal the impact of a .45ACP bullet, the one pound weight needs a velocity of 27.1 fps and must be dropped from a height of 11.4 feet. A ten pound weight equals the impact of a 9mm bullet when dropped from a height of 0.72 inches (velocity attained is 19.6 fps), and equals the impact of a .45 when dropped from 1.37 inches (achieving a velocity of 27.1 fps).

A bullet simply cannot knock a man down if it had the energy to do so, then equal energy would be applied against the shooter and he too would be knocked down. That is simple physics, and has been known for hundreds of years. The amount of energy deposited in the body by a bullet is approximately equivalent to being hit with a baseball. Tissue damage is the only physical link to incapacitation, but excluding the central nervous system, it is not a causative factor for incapacitation within the desired time frame, i.e., instantaneously.

The human target can be reliably incapacitated only by disrupting or destroying the brain or upper spinal cord. Absent that, incapacitation is subject to a host of variables, the most important of which are beyond the control of the shooter. Incapacitation becomes an event, not necessarily an immediate one. If the psychological factors which can contribute to incapacitation are present, even a minor wound can be immediately incapacitating. If they are not present, incapacitation can be significantly delayed even with major, survivable wounds.

29 Goddard, Stanley “Some Issues for Consideration in Choosing Between 9mm and .45ACP Handguns,” Battelle Labs, Ballistic Sciences, Ordnance Systems and Technology Section, Columbus, Ohio, presented to the FBI Academy, 2/16/88, pages 3-4
30 Goddard, Stanley “Some Issues for Consideration in Choosing Between 9mm and .45ACP Handguns,” Battelle Labs, Ballistic Sciences, Ordnance Systems and Technology Section, Columbus, Ohio, presented to the FBI Academy, 2/16/88, pages 3-4
31 Newton, Sir Isaac, *Principia Mathematica*, 1687, in which are stated Newton’s Laws of Motion. The Second Law of Motion states that a body will accelerate, or change its speed, at a rate that is proportional to the force acting upon it. In simpler terms, for every action there is an equal but opposite reaction. The acceleration will of course be in inverse proportion to the mass of the body. For example, the same force acting upon a body of twice the mass will produce exactly half the acceleration.
32 Lindsey, Douglas, MD, presentation to the Wound Ballistics Workshop, Quantico, VA, 1987
Field results are a collection of individualistic reactions on the part of each person shot which can be analyzed and reported as percentages. However, no individual responds as a percentage, but as an all or none phenomenon which the officer cannot possibly predict, and which may provide misleading data upon which to predict ammunition performance.
AMMUNITION SELECTION CRITERIA

The critical wounding components for handgun ammunition, in order of importance, are penetration and permanent cavity.8 The bullet must penetrate sufficiently to pass through vital organs and be able to do so from less than optimal angles. For example, a shot from the side through an arm must penetrate at least 10-12 inches to pass through the heart. A bullet fired from the front through the abdomen must penetrate about 7 inches in a slender adult just to reach the major blood vessels in the back of the abdominal cavity. Penetration must be sufficiently deep to reach and pass through vital organs, and the permanent cavity must be large enough to maximize tissue destruction and consequent hemorrhaging.

Several design approaches have been made in handgun ammunition which are intended to increase the wounding effectiveness of the bullet. Most notable of these is the use of a hollow point bullet designed to expand on impact.

Expansion accomplishes several things. On the positive side, it increases the frontal area of the bullet and thereby increases the amount of tissue disintegrated in the bullet's path. On the negative side, expansion limits penetration. It can prevent the bullet from penetrating to vital organs, especially if the projectile is of relatively light mass and the penetration must be through several inches of fat, muscle, or clothing.34

Increased bullet mass will increase penetration. Increased velocity will increase penetration but only until the bullet begins to deform, at which point increased velocity decreases penetration. Permanent cavity can be increased by the use of expanding bullets, and/or larger diameter bullets, which have adequate penetration. However, in no case should selection of a bullet be made where bullet expansion is necessary to achieve the desired performance.35 Handgun bullets expand in the human target only 60-70% of the time at best. Damage to the hollow point by hitting bone, glass, or other intervening obstacles can prevent expansion. Clothing fibers can wrap the nose of the bullet in a cocoon-like manner and prevent expansion. Insufficient impact velocity caused by short barrels and/or longer range will prevent expansion, as will simple manufacturing variations. Expansion must never be the basis for bullet selection, but considered a bonus when, and if, it occurs. Bullet selection should be determined based on penetration first, and the unexpanded diameter of the bullet second, as that is all a shooter can reliably expect.

It is essential to bear in mind that the single most critical factor remains penetration. While penetration up to 18 inches is preferable, a handgun bullet MUST reliably penetrate 12 inches of soft body tissue at a minimum, regardless of whether it expands or not. If the bullet does not reliably penetrate to these depths, it is not an effective bullet for law enforcement use.36

---

33 Wound Ballistic Workshop "9mm vs .45 Auto", FBI Academy, Quantico, VA, September, 1987
Conclusion of the Workshop

34 Jones, J A Police Handgun Ammunition Southwestern Institute of Forensic Sciences at Dallas, 523D Medical Center Drive, Dallas, Texas, 1985

35 Wound Ballistic Workshop "9mm vs .45 Auto", FBI Academy, Quantico, VA, September, 1987
Conclusion of the Workshop

36 Wound Ballistic Workshop "9mm vs .45 Auto", FBI Academy, Quantico, VA, September, 1987
Conclusion of the Workshop
Given adequate penetration, a larger diameter bullet will have an edge in wounding effectiveness. It will damage a blood vessel the smaller projectile barely misses. The larger permanent cavity may lead to faster blood loss. Although such an edge clearly exists, its significance cannot be quantified.

An issue that must be addressed is the fear of over penetration widely expressed on the part of law enforcement. The concern that a bullet would pass through the body of a subject and injure an innocent bystander is clearly exaggerated. Any review of law enforcement shootings will reveal that the great majority of shots fired by officers do not hit any subjects at all. It should be obvious that the relatively few shots that do hit a subject are not somehow more dangerous to bystanders than the shots that miss the subject entirely.

Also, a bullet that completely penetrates a subject will give up a great deal of energy doing so. The skin on the exit side of the body is tough and flexible. Experiments have shown that it has the same resistance to bullet passage as approximately four inches of muscle tissue.

Choosing a bullet because of relatively shallow penetration will seriously compromise weapon effectiveness, and needlessly endanger the lives of the law enforcement officers using it. No law enforcement officer has lost his life because a bullet over penetrated his adversary, and virtually none have ever been sued for hitting an innocent bystander through an adversary. On the other hand, tragically large number of officers have been killed because their bullets did not penetrate deeply enough.

THE ALLURE OF SHOOTING INCIDENT ANALYSES

There is no valid, scientific analysis of actual shooting results in existence, or being pursued, to date. It is an unfortunate vacuum because a wealth of data exists, and new data is being sadly generated every day. There are some well publicized, so called analyses of shooting incidents being promoted, however, they are greatly flawed. Conclusions are reached based on samples so small that they are meaningless. The author of one, for example, extols the virtues of his favorite cartridge because he has collected ten cases of one shot stops with it. Preconceived notions are made the basic assumptions on which shootings are categorized. Shooting incidents are selectively added to the "data base" with no indication of how many may have been passed over or why. There is no correlation between hits, results, and the location of the hits upon vital organs.

It would be interesting to trace a life sized anatomical drawing on the back of a target, fire 20 rounds at the "center of mass" of the front, then count how many of these optimal, center of mass hits actually struck the heart, aorta, vena cava, or liver. It is rapid hemorrhage from these organs that will best increase the likelihood of incapacitation. Yet nowhere in the popular press extolling these studies of real shootings are we told what the bullets hit.

These so called studies are further promoted as being somehow better and more valid than the work being done by trained researchers, surgeons and forensic labs. They disparage laboratory stuff, claiming that the "street" is the real laboratory and their collection of results from the street is the real measure of caliber effectiveness, as interpreted by them, of course. Yet their data from the street is collected haphazardly, lacking scientific method and controls, with no noticeable attempt to verify the less than reliable accounts of the participants with actual investigative and forensic reports. Cases are subjectively selected (how many are not included because they do not fit the assumptions made?) The numbers of cases cited are statistically meaningless, and the underlying assumptions upon which the collection of information and its interpretation are based are themselves based on myths such as knock-down power, energy transfer, hydrostatic shock, or the temporary cavity methodology of flawed work such as RII.

Further, it appears that many people are predisposed to fall down when shot. This phenomenon is independent of caliber, bullet, or hit location, and is beyond the control of the shooter. It can only be proven in the act, not predicted. It requires only two factors to be effected: a shot and cognition of being shot by the target. Lacking either one, people are not at all predisposed to fall down and don't. Given this predisposition, the choice of caliber and bullet is essentially irrelevant. People largely fall down when shot, and the apparent predisposition to do so exists with equal force among the good guys as among the bad. The causative factors are most likely psychological in origin. Thousands of books, movies and television shows have educated the general population that when shot, one is supposed to fall down.

38 He defines a one shot stop as one in which the subject dropped, gave up, or did not run more than 10 feet
39 This exercise was suggested by Dr. Martin L. Fackler, U S Army Wound Ballistics Laboratory, Letterman Army Institute of Research, San Francisco, California, as a way to demonstrate the problematical results of even the best results sought in training i.e., shots to the center of mass of a target. It illustrates the very small actually critical areas within the relatively vast mass of the human target.
The problem, and the reason for seeking a better cartridge for incapacitation, is that individual who is not predisposed to fall down. Or the one who is simply unaware of having been shot by virtue of alcohol, adrenalin, narcotics, or the simple fact that in most cases of grievous injury the body suppresses pain for a period of time. Lacking pain, there may be no physiological effect of being shot that can make one aware of the wound. Thus the real problem: if such an individual is threatening one's life, how best to compel him to stop by shooting him?

The factors governing incapacitation of the human target are many, and variable. The actual destruction caused by any small arms projectile is too small in magnitude relative to the mass and complexity of the target. If a bullet destroys about 2 ounces of tissue in its passage through the body, that represents 0.07 of one percent of the mass of a 180 pound man. Unless the tissue destroyed is located within critical areas of the central nervous system, it is physiologically insufficient to force incapacitation upon the unwilling target. It may certainly prove to be lethal, but a body count is no evidence of incapacitation. Probably more people in this country have been killed by 22 rimfires than all other calibers combined, which, based on body count, would compel the use of 22's for self defense. The more important question, which is sadly seldom asked, is what did the individual do when hit?

There is a problem in trying to assess calibers by small numbers of shootings. For example, as has been done, if a number of shootings were collected in which only one hit was attained and the percentage of one shot stops was then calculated, it would appear to be a valid system. However, if a large number of people are predisposed to fall down, the actual caliber and bullet are irrelevant. What percentage of those shots were thus predetermined by the target? How many of those targets were not at all disposed to fall down? How many multiple shot failures to stop occurred? What is the definition of a stop? What did the successful bullets hit and what did the unsuccessful bullets hit? How many failures were in the vital organs, and how many were not? How many of the successes? What is the number of the sample? How were the cases collected? What verifications were made to validate the information? How can the verifications be checked by independent investigation?

Because of the extreme number of variables within the human target, and within shooting situations in general, even a hundred shootings is statistically insignificant. If anything can happen, then anything will happen, and it is just as likely to occur in your ten shootings as in ten shootings spread over a thousand incidents. Large sample populations are absolutely necessary.

Here is an example that illustrates how erroneous small samples can be. I flipped a penny 20 times. It came up heads five times. A nickel flipped 20 times showed heads 8 times. A dime came up heads 10 times and a quarter 13 times. That means that if heads is the desired result, a penny will give it to you 25% of the time, a nickel 40% of the time, a dime 50% of the time and a quarter 75% of the time. If you want heads, flip a quarter. If you want tails, flip a penny. But then I flipped the quarter another 20 times and it showed heads 9 times - 45% of the time. Now this "study" would tell you that perhaps a dime was better for flipping heads. The whole thing is obviously wrong, but shows how small numbers lead to statistical lies. We know the odds of getting a head or tail are 50%, and larger numbers tend to prove it. Calculating the results for all 100 flips regardless of the coin used shows heads came up 48% of the time.

The greater the number and complexity of the variables, the greater the sample needed to give meaningful information, and a coin toss has only one simple variable. It can land heads or it can land tails. The coin population is not complicated by a predisposition to fall one way or the other, by chemical stimuli, psychological factors, shot placement, bone or obstructive obstacles, etc., all of which require even larger numbers to evidence real differences in effects.
Although no cartridge is certain to work all the time, surely some will work more often than others, and any edge is desirable in one’s self defense. This is simple logic. The incidence of failure to incapacitate will vary with the severity of the wound inflicted. It is safe to assume that if a target is always 100% destroyed, then incapacitation will also occur 100% of the time. If 50% of a target is destroyed, incapacitation will occur less reliably. Failure to incapacitate is rare in such a case, but it can happen, and in fact has happened on the battlefield. Incapacitation is still less rare if 25% of the target is destroyed. Now the magnitude of bullet destruction is far less (less than 1% of the target) but the relationship is unavoidable. The round which destroys 0.07% of the target will incapacitate more often than the one which destroys 0.04%. However, only very large numbers of shooting incidents will prove it. The difference may be only 10 out of a thousand, but that difference is an edge, and that edge should be on the officer’s side because one of those ten may be the subject trying to kill him.

To judge a caliber’s effectiveness, consider how many people hit with it failed to fall down, and look at where they were hit. Of the successes and failures, analyze how many were hit in vital organs, rather than how many were killed or not, and correlate that with an account of exactly what they did when they were hit. Did they fall down, or did they run, fight, shoot, hide, crawl, stare, shrug, give up and surrender? Only falling down is good. All the other reactions are failures to incapacitate, evidencing the ability to act with volition, and thus able to choose to continue to try to inflict harm.

Those who disparage science and laboratory methods are either short sighted or too bound by preconceived (or perhaps proprietary) notions to see the truth. The labs and scientists do not offer sure things. They offer a means of indexing the damage done by a bullet, understanding of the mechanics of damage caused by bullets and the actual effects on the body, and the basis for making an informed choice based on objective data and significant statistics.

The differences between bullets may be small, but science can give us the means of identifying that difference. The result is the edge all of law enforcement should be looking for. It is true that the streets are the proving ground, but give me an idea of what you want to prove and I will give you ten shootings from the street that prove it. That is both easy, and irrelevant. If it can happen, it will happen.

Any shooting incident is a unique event, unconstrained by any natural law or physical order to follow a predetermined sequence of events or end in predetermined results. What is needed is an edge that makes the good result more probable than the bad. Science will quantify the information needed to make the choices to gain that edge. Large numbers (thousands or more) from the street will provide the answer to the question “How much of an edge?” Even if that edge is only 1%, it is not insignificant because the guy trying to kill you could be in that 1%, and you won’t know it until it is too late.

---

40 Severity is a function of location, depth, and amount of tissue destroyed.

41 The numbers can be held down to reasonable limits by a scientific approach that collects objective information from investigative and forensic sources and sorts it by vital organs struck and target reactions to being hit. The critical questions are what damage was done and what was the reaction of the adversary.
CONCLUSIONS

Physiologically, no caliber or bullet is certain to incapacitate any individual unless the brain is hit. Psychologically, some individuals can be incapacitated by minor or small caliber wounds. Those individuals who are stimulated by fear, adrenalin, drugs, alcohol, and/or sheer will and survival determination may not be incapacitated even if mortally wounded.

The will to survive and to fight despite horrific damage to the body is commonplace on the battlefield, and on the street. Barring a hit to the brain, the only way to force incapacitation is to cause sufficient blood loss that the subject can no longer function, and that takes time. Even if the heart is instantly destroyed, there is sufficient oxygen in the brain to support full and complete voluntary action for 10-15 seconds.

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. The critical element is penetration. The bullet must pass through the large, blood bearing organs and be of sufficient diameter to promote rapid bleeding. Penetration less than 12 inches is too little, and, in the words of two of the participants in the 1987 Wound Ballistics Workshop, "too little penetration will get you killed." 42,43 Given desirable and 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 which will not penetrate through vital organs from less than optimal angles is not acceptable. Of those that will penetrate, the edge is always with the bigger bullet. 44

42 Fackler, M L, MD, presentation to the Wound Ballistics Workshop, Quantico, VA, 1987
43 Smith, O'Brien C, MD, presentation to the Wound Ballistics Workshop, Quantico, VA, 1987
44 Fackler, M L, MD, presentation to the Wound Ballistics Workshop, Quantico, VA, 1987
THIS IS THE END.

An AIMED Point Shooting or P&S Publication
www.pointshooting.com