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HANDGUN WOUNDING FACTORS AND EFFECTIVENESS

FBI ACADEMY
FIREARMS TRAINING UNIT

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Handgun Wounding Factors and Effectiveness

Special Agent UREY W. PATRICK

FIREARMS TRAINING UNIT
FBI ACADEMY
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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

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]

1 FBI Deadly Force Policy.
2 Ideally, immediate incapacitation occurs instantaneously.
3 Fackler, M.L., MD: "What's Wrong with the Wound Ballistics Literature, and Why", Letterman Army Institute of Research, Presidio of San Francisco, CA, Report No. 239, July, 1987.
4 Fackler, M.L., M.D., Director, Wound Ballistics Laboratory, Letterman Army Institute of Research, Presidio of San Francisco, CA, letter: "Bullet Performance Misconceptions", International Defense Review 3; 369-370, 1987.

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 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 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.

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[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.[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 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.[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.

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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.

7 DiMaio, V.J.M.: Gunshot Wounds, Elsevier Science Publishing Company, New York, NY, 1987: Chapter 3, Wound Ballistics: 41-49.

8 Fackler, M.L., Malinowski, J.A.: "The Wound Profile: A Visual Method for Quantifying Gunshot Wound Components", Journal of Trauma 25, 522-529, 1985.

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 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.

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[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.

[11] Fackler, M.L., MD: "Ballistic Injury", Annals of Emergency Medicine 15: 12 December 1986.

[12] Fackler, M.L., Surinchak, J.S., Malinowski, J.A.; et.al.: "Bullet Fragmentation: A Major Cause of Tissue Disruption", Journal of Trauma 24: 35-39, 1984.

[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.

[14] Fackler, M.L., M.D., Director, Wound Ballistics Laboratory, Letterman Army Institute of Research, Presidio of San Francisco, CA, letter: "Bullet Performance Misconceptions", International Defense Review 3; 369-370, 1987.

[15] DiMaio, V.J.M.: Gunshot Wounds, Elsevier Science Publishing Company, New York, NY 1987, page 47.

[16] Lindsay, Douglas, MD: "The Idolatry of Velocity, or Lies, Damn Lies, and Ballistics", Journal of Trauma 20: 1068-1069, 1980.

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 incapacitater 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]

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17 Bruchey, W.J., Frank, D.E.: Police Handgun Ammunition Incapacitation Effects, National Institute of Justice Report 100-83. Washington, D.C., U.S. Government Printing Office, 1984, Vol. 1: Evaluation.

18 Webster's Ninth New Collegiate Dictionary, Merriam-Webster Inc., Springfield MA, 1986: "An unfilled space within a mass."

19 Fackler, M.L., Surinchak, J.S., Malinowski, J.A.; et.al.: "Bullet Fragmentation: A Major Cause of Tissue Disruption", Journal of Trauma 24: 35-39, 1984.

20 DiMaio, V.J.M.: Gunshot Wounds, Elsevier Science Publishing Company, New York, NY 1987, page 42.

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]

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21 Fackler, M.L., Surinchak, J.S., Malinowski, J.A.; et.al.: "Bullet Fragmentation: A Major Cause of Tissue Disruption", Journal of Trauma 24: 35-39, 1984.

22 Fackler, M.L., MD: "Ballistic Injury", Annals of Emergency Medicine 15: 12 December 1986.

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

24 Fackler, M.L., MD: "Ballistic Injury", Annals of Emergency Medicine 15: 12 December 1986.

25 Fackler, M.L., Malinowski, J.A.: "The Wound Profile: A Visual Method for Quantifying Gunshot Wound Components", Journal of Trauma 25: 522-529, 1985.

26 Lindsay, 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 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.

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[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.

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.

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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.

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 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 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]

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[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.

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.

[37] Fackler, M.L., M.D., Director, Wound Ballistics Laboratory, Letterman Army Institute of Research, Presidio of San Francisco, CA, letter: "Bullet Performance Misconceptions", International Defense Review 3; 369-370, 1987.

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.

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[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, 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 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 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 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 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?".[41] 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, 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]

[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.