

**Review of Basics of Forensic Consideration
for Gunshot Wounds**

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We are often confronted with an array of both forensic and clinical/medical issues involving trauma - both blunt and penetrating. As in all injuries, evaluation and treatment should begin as soon as possible by the EMS system. This paper will present issues associated with gunshot wounds but is not intended to create the impression that all wounds fit neatly into categories. Each injury is unique and must be evaluated singly. A wound from a .22 cal rifle can be as dangerous as from a high velocity hunting or military rifle. Clinical and timely evaluation by trained physicians and a medical team is the key issue.

Gunshot injuries present a very wide spectrum of possible issues and the external appearance of the wound can be deceptive in terms of the extent of underlying injury to tissues. Initially stable appearing patients can have delayed underlying serious life or limb threatening injury that may be not apparent at the time of initial presentation. Conversely, a penetrating projectile can cause less than expected trauma to tissues even from a relatively high velocity projectile. Therefore, observation and careful individual evaluation is a key issue because of the unpredictable nature of penetrating trauma - both high velocity and low velocity. This can only be accomplished by trained medical professionals within the EMS system (ambulance to emergency medicine department).

Gunshot wounds cause injury by laceration or tearing and also by contusion (bruise). The contused (bleeding under the skin or internally) area may present an area of concern and require close follow-up or immediate surgical consultation and intervention because the bleeding can be serious but not apparent on the surface. For example, in a lower extremity injury involving the femur, 2 liters of blood can fill the upper leg and can cause shock to the victim. Shock is when there is loss of blood in the veins or arteries and leads to loss of consciousness and death.

Also, if vascular structures or bone are in the path of the projectile, the outcome may be associated with extensive damage and tissue loss. In addition, if the projectile hits a fixed structure such as bone, catastrophic injury may occur and bone fragments can become secondary missiles further injuring surrounding tissue. It appears that more dense tissue is more vulnerable especially to high velocity impact. The shockwave from a high velocity projectile traveling through tissue causes a bruise to a blood vessel and then could clog the blood vessel due to swelling of the blood vessel wall. This is especially true of high velocity projectiles from rifles.

There may be still some controversy involving gunshot wounds that appear to initially stable requiring relatively less intervention than others. However, the unique forensic characteristics or ballistics of the weapon may be of some assistance. A knowledge ballistics and wounding profile specific to the weapon may be helpful.

After penetration, bullets have been known to exhibit unpredictable pathways in the body for a myriad of reasons. Many anecdotes can re-enforce these issues in the study of injuries from projectiles -

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focusing on the difficulty in initially predicting outcome - as we know, clinical parameters (blood pressure and shock) can also change over time. It is essential that trained eyes be on the victim immediately. A victim could be hemodynamically (blood loss) stable (look normal) initially but unpredicted outcomes can occur later because of the difficulty in predicting the outcome from any single forensic parameter. The sooner the victim gets evaluated by the emergency medical system - ambulance EMT/paramedic and then physicians - the better the outcome even if the person appears to be stable.

With all this in mind, let us examine some concepts concerning the relationship between the science of ballistic projectile behavior and wound profiles. Knowledge of ballistics can be useful. For example, a shorter barrel and relatively low energy projectile from a short barrel can sometimes be considered to cause less injury. However, there can be extensive and remote injury from the entry point because the projectile ricocheted internally off bone or hit an object on entry. For example, a bullet directly impacting sternum (breastbone) has been known to track subcutaneously around the circumference of the chest and create an exit wound out the back appearing like a through and through injury causing initial concern. Only a superficial injury has occurred from the projectile itself. However, the impact may have caused a cardiac contusion, which can mimic a heart attack.

A review of some basics of ballistics from a forensic vantage point may be of value even though each projectile can have its own unique behavior. Most forensic laboratories have access to a facility where projectiles are fired into gelatin or similar medium to examine these attributes. The behavior of the projectile after firing is characterized by photography or illustrations that show unique characteristics. Comparison is then done with expected behavior. This article contains concepts which were taken from US Army research in the 1960-1970 timeframe but still re-



enforce same basic principals of wounding profiles seen today.

Several variables that will be briefly considered in this presentation: length of the barrel, velocity, shape of the bullet, caliber, weight and stability of the projectile in the air.

Bullet stability after firing

Bullet stability as it travels through the air can be a critical determinant to tissue injury. Ballistic missiles have fins and arrows have fletching to aid stability. Bullets, lacking fins, attain (some) stability from a series of grooves in the barrel of the weapon or "rifling". Bullets otherwise lack stability in the air. In addition, any medium encountered by the bullet along the path of travel (branches of trees or other objects) can start a bullet to become unstable in flight and cause tumbling which can cause more injury since the initial contact with the long axis of the bullet presents more surface area. The bullet hits the tissue straight up rather than from the point or nose forward.

Bullet stability

A fast moving rifle bullet can become unstable as it travels through air. An initial yaw can cause a vortex type pathway then can attain stable flight until it strikes a relatively dense medium which causes sudden instability and tumbling. Tumbling causes more severe injury in surrounding tissue in that the presenting surface area is many times greater than the actual diameter or caliber of the bullet. Therefore, in this case, knowledge of the caliber might not accurately predict the wounding potential. Sudden violent instability of a high energy projectile can also lead to splitting or fragmentation of the projectile as it moves through tissue causing multiple tracts of injury through tissue, also increasing the wounding potential. By contrast, bullets can also travel through and through an extremity without tumbling and cause relatively lesser amount of trauma if there is no encounter with more dense tissue such as bone. Conversely, bullets can also ricochet off bone causing injury to multiple organs.

The velocity of the projectile is associated or proportional to the kinetic injury. Hunting injuries can be devastating because there is much kinetic energy and soft nose bullets that expand on impact, suddenly imparting their kinetic energy to surrounding tissue. These injuries also usually result from a rifle with a long barrel imparting more velocity due to buildup of gases in the longer barrel. The longer barrel imparts more push to the projectile due to buildup of pressure for the hot gas in the barrel that push the bullet out faster. Conversely, armed confrontations from handguns - relatively short barrel - imparts less velocity. However, more powder charge from a magnum cartridge can impart more energy as well.

Therefore we can't always generalize and assume a short barreled pistol causes fewer traumas than a rifle.

Mass and velocity of the bullet

Mass and velocity are the critical factors for both clinical and forensic analysis. Bigger and faster projectiles generally cause more injury because there is more kinetic energy due to increased mass and velocity.

Hunting ammunition generally has a soft point or hollow point bullet - also called expanding bullets. This type ammunition was invented long ago in the latter part of the 19th century. It causes even more tissue trauma by expanding when encountering a denser medium. In this case, virtually all its entire kinetic energy is transferred to the denser medium (tissue) almost immediately upon entrance into tissue.

Military ammunition has a cone-shaped appearance with a brass coating by rule of the Geneva Convention. This is the so-called "Full metal jacket" required by military convention. This type of ammunition is often referred to as "ball ammunition" because it resembles the musket ball used in the 18th century and is thought to cause less wounding potential than an expanding head bullet.

In this paper we have briefly reviewed some concepts associated with forensic analysis of behavior of projectiles. Medical care issues can not be predicted from caliber, length of barrel, velocity and mass, but these concepts are essential for forensic analysis. Each wound is unique and must be evaluated singly from a medical perspective by trained professionals. However, knowledge of forensic variables can greatly assist in understanding the very complex behavior of projectiles.

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The Center for Security and Emergency Management (C4SEM) was established to enhance the capabilities of military security forces, law enforcement officers, emergency responders and local officials to prepare for, respond to, and recover from catastrophic events resulting from natural events, man-made accidents, or terrorist attacks. Since its inception, C4SEM has provided military, federal, state and local departments and agencies with high-quality, hands-on, scenario-driven training, exercises, technical assistance, and strategy development.

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