OBJECTIVES:

1. Participants will be able to define ballistics
2. Participants will be able to describe three factors which influence wounds in gunshot injuries.
3. Participants will be able to anticipate potential trauma team response needs for gunshot victims based on firearm description.

- Ballistics (study of the movement of a bullet)
  - The basics of bullet movement
    - A cartridge contains:
      - Casing – the outside of the cartridge which contains the gunpowder and the bullet
      - Primer – portion of the cartridge at the proximal end which causes a spark when struck
      - Gunpowder – explosive material contained within the casing.
      - Bullet – the projectile in the distal portion of the casing that exits when the gunpowder ignites and expands.
    - When the trigger is pulled, a firing pin within the firearm strikes the primer, causing a spark, which in turn ignites the gunpowder within the casing. As the gunpowder is ignited, it changes from a solid to a gas. Because gas consumes more room than a solid, there is an expansion within the casing that propels the bullet out of the front of the cartridge down the barrel of the firearm. The barrel is grooved, causing the bullet to spin. This spinning gives the bullet more stability as it moves through the air after leaving the barrel.
  - Wounding potential – a number of different factors will affect the wounds that are inflicted on someone who is struck by a firearm:
    - Bullet size – the larger the bullet, the more severe tissue damage is likely to be.
      - The size of a bullet is reported as the diameter of the missile at its widest point. This is also known as the “caliber.”
      - The caliber is reported in $1/100^{th}$ of an inch or in millimeters.
      - The firearm used to propel the bullet must have a barrel that matches the size of the bullet. If the barrel is larger, the bullet will “wobble” within the barrel and will be ejected at an awkward angle, less likely to hit its target. A bullet that is larger than the barrel may get stuck, leading to an explosion within the firearm.

A 22 caliber bullet is $22/100^{th}$ of an inch in diameter at its widest point. A 9 millimeter round is 9 millimeters at its widest point.

- 22 and 25 caliber projectiles are considered small caliber.
- 32 through 38 caliber projectiles are considered medium caliber
- Calibers above 40 are considered large caliber.
Go Boom, Fall Down: Ballistics, Gunshot Wounds and the Human Body

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- Irregular wounds are caused by bullets tumbling before striking the victim, often from being fired through a window or other solid objet prior to striking the person.

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- Bullet mass – the heavier a bullet, the more damage it is likely to inflict. Bullets of equal caliber may be a different weight, therefore causing different wounding potentials.
- Bullet velocity – the faster a bullet is moving when it strikes an object or person, the more damage it is likely to cause.
  - Velocity is dependent on:
    - Amount of gunpowder within the casing
    - Type of firearm used
      - Handguns – small, easily concealed short-barreled guns designed to be held and fired in one hand.
      - Rifles – long-barreled guns, less easy to conceal and designed for long range accuracy. Rifles tend to have greater velocity and potential for damage because of:
        - Longer barrel – longer time for expanding gases from the cartridge to propel the bullet from the end of the barrel.
        - Rifle ammunition tends to contain more gunpowder giving it a higher velocity leaving the barrel.
- Distance of target from the firearm – projectiles will slow down as they move through the air after leaving the barrel, therefore, the farther from the firearm the victim is, the less energy the bullet will tend to have and the less the wounding potential will tend to be.
  - The appearance of the wound caused by the bullet may give hints as to the distance the individual was from the firearm. A gun will tend to propel more than the bullet from its barrel, other substances propelled include:
    - Carbon monoxide and other flaming gases (will travel approximately 2 inches before falling away)
    - Soot (will travel 6 – 7 inches before falling away)
    - Unburned powder
  - Tight contact cutaneous wounds – caused by a gun being held against the skin when fired – carbon monoxide will give the wound edges a red discoloration, and charring from flaming gases will be noted on the wound edges.
  - Close contact cutaneous wounds – soot as well as stippling from gunpowder will be noted on the skin. Soot can be wiped away, but stippling cannot.
  - Mid-range cutaneous wounds – There will be no burns or soot, but stippling may be noted around the bullet wound.
  - Long-range cutaneous wounds – absence of soot, stippling or burns, rather a simple hole with an abrasion around it. If the abrasion is circumferential, the bullet likely struck the surface at a 90 degree angle. If the abrasion
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is uneven, then the bullet likely struck the skin at the point where the abrasion is the most noticeable.

- **Type of bullet**
  - Bullets are often made of soft lead that will deform when they meet resistance, such as tissue.
    - Some bullets are completely covered with a harder metal such as copper that is unlikely to deform. If the entire bullet is covered with a more stable metal, it is referred to as a full-metal jacket and is less likely to deform when it strikes an object.
    - Some bullets are partially covered with a more stable metal such as copper, but the tip is left uncovered. When the uncovered surface meets resistance, such as striking an object or tissue, it flattens and becomes wider. It may even break apart into smaller fragments. This wider surface or multiple fragments will increase the energy dissipated into the tissues and increase the wounding potential. These are called semi-jacketed bullets.
    - Some bullets actually have a hollow point inside the soft metal so that when they strike a firm surface, they actually peel backwards like a mushroom. This dissipates the energy laterally and decreases forward movement of the projectile, causing extensive damage in the area where the projectile comes to rest. These are called hollow-point bullets.

- **Effects of bullets on tissues**
  - Low velocity bullets (travelling less than 1000 feet per second) tend to pass directly through tissue, crushing everything in their path. This is referred to as “crushing” or “permanent cavity”
  - High velocity bullets tend to create a pressure wave within tissue that forces the tissue away from the permanent cavity for a short period of time. This is referred to as “cavitation” or “temporary cavity” and can cause injuries that extend far beyond the actual permanent cavity.
  - In very high velocity gunshot wounds, shock waves may precede the bullet, causing injuries to organs and tissues a great distance away from the permanent cavity.
Bullets may also break apart, causing widespread damage as the various pieces of the bullet travel through tissue. Bullets may also tumble or wobble (yaw) so that the narrowest portion of the projectile does not lead the way. In these cases, the wound that is created will be significantly larger.

Different tissues react differently to projectiles.
- Higher density tissues (liver, spleen, brain) have little elasticity and are more likely to be significantly injured.
- Tissue with higher elasticity (lung and muscle) will tend to suffer less damage as they can stretch and fall back into their original positions with less permanent damage.
- Bone – the effects on bone will depend on the velocity of the projectile when it strikes the bone:
  - High velocity may shatter the bone
  - Mid-velocity may break the bone but spare it from shattering
  - Low velocity may cause the bullet to break into pieces without damaging the bone, but causing extensive damage around the site where the bullet struck the bone.
  - Low velocity bullets may also ricochet off of bone and take a different path through the body than the original trajectory, resulting in tissue damage in places other than those expected by the entrance wound.
- Exit wounds
  - Not all gunshot victims will have an exit wound. If the bullet disintegrated, mushroomed, deformed, or ricocheted, it may remain within the body.
  - Not all exit wounds are larger than entrance wounds. Full metal jackets of low velocity may create nothing more than a permanent cavity whose exit size will closely approximate the entrance wound. The exit will lack the abrasion that is seen on the entrance wound.
  - High velocity bullets or bullets that deform and exit will likely carry large volumes of tissue out with them, resulting in exit wounds that are a different size than entrance wounds.

Shotgun wounds
- Unlike a single projectile from a handgun or rifle, shotgun shells contain multiple metal pellets known as shot.
  - Large pellets are known as buckshot, small pellets as birdshot. A cartridge generally only carries one size pellet.
  - As the pellets leave the barrel, their velocity rapidly decreases. The farther they are from the barrel the greater the distance between the pellets.
Therefore, shotgun blasts at close range can result in devastating tissue damage as a large number of pellets enter into a small area at a great velocity. As the distance between the barrel and the victim increases, velocity decreases and the distance between the pellets increase, decreasing potential tissue damage. There is more likely to be small wounds spread over a large surface area in long-range shotgun wounds.

- Shotgun shells are measured in gauge rather than caliber. The higher the gauge, the smaller the diameter.

Bibliography


