# Wound Ballistics and Firearm Safety

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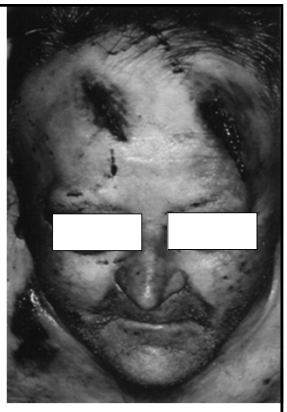
**The fundamental process involved in any trauma is the <u>application of energy</u> to the target.**

A 2kg club, swung at 20 m/sec*, carries 400J of kinetic energy.

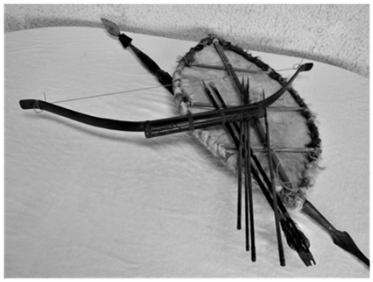
(approx 4lb, 40mph)



**In time, it was discovered that the 'edged weapon', by *concentrating the force,* could produce <u>more damage</u> locally**

**A 2kg sword swung at 20 m/sec also carries 400J of energy.**

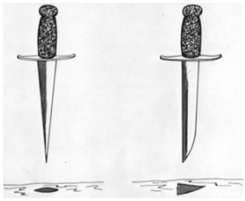
An arrow from a long bow carries 40J



**The spear, or the bow and arrow, allowed the projection of '<u>concentrated force</u>' at a distance from the body.**

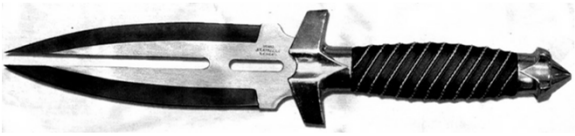
**But the wounding power (and the range) of these edged weapons proved insufficient.**

**Because man-powered edged weapons produce *low velocity, low energy* impacts**

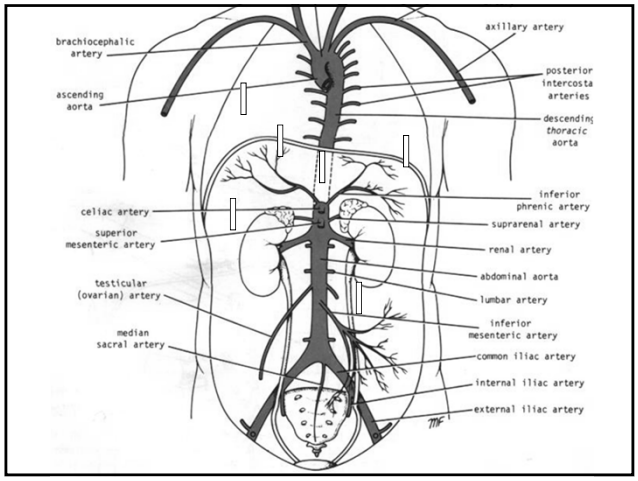


**And the damage they do is largely confined to the profile of the blade.**

**So, if you realise that the principle way to incapacitate your victim with a knife is to cause blood loss …..**



**Even a big knife is relatively unlikely to hit a major vessel first time.**



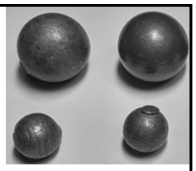

**The <u>firearm</u> represented quantum leap in the ability to apply energy to a target**

**Both in terms of wounding potential and range.**

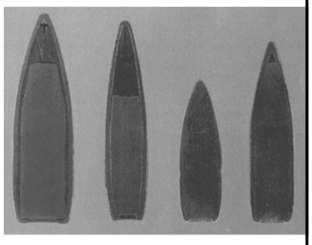
## The early firearms were smooth bore muskets

**They could propel a <u>soft lead ball</u> (hence "Ballistics") hundreds of feet at a target.**

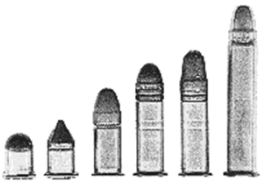
## But the range and the accuracy of these <u>spherical</u> projectiles was limited



**And in time the familiar streamlined 'bullet' was developed.**



## Consider the physics of a typical low velocity (.22 calibre) rifle bullet



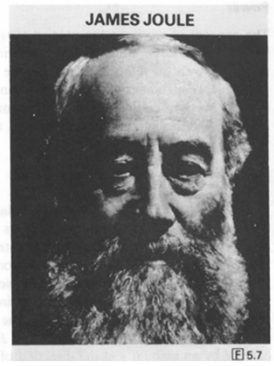
It is a small, blunt nosed, soft lead projectile.

## It has a relatively low mass (~2.5 g) and velocity (~ 300m/sec*)

(1000 fps)

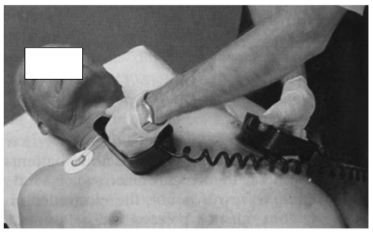
- hence it carries a low kinetic energy (~110J)
- and has a low wounding potential.

## So how much is 110 joules??



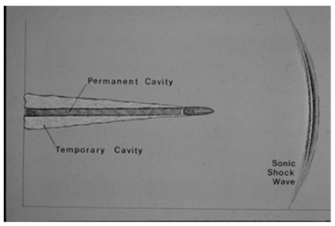

A precordial thump is ~ 50 J.

**A solid punch is ~ 100 J.**



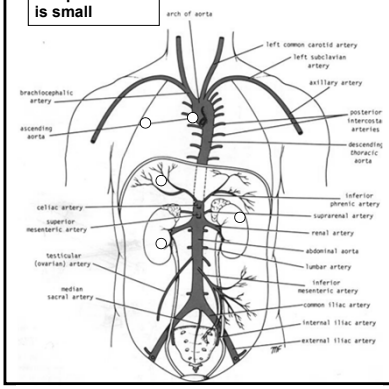
**A typical defibrillation is 300 J.**

## A <u>Low velocity</u> (= low energy) projectile makes only a small hole in the tissues




**The wound is fairly similar to a knife wound, with damage largely confined to the track of the bullet itself.**

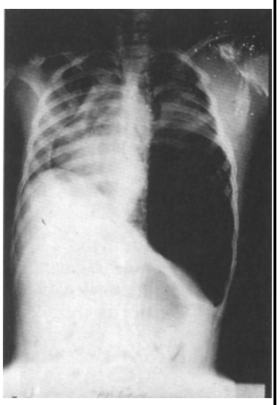
**Like a knife wound, the chance of rapid incapacitation is small**



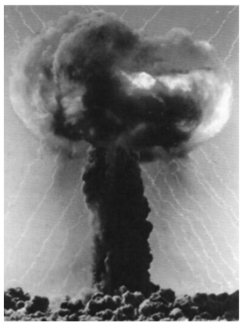

## A low energy projectile cannot be relied upon to <u>immediately disable</u> an opponent

■ Which is not to say that the wound will not subsequently prove fatal,

■ What life threatening injury has this L shoulder GSW produced?.



## So….. how to get more stopping power?



Recall that the prime purpose of a projectile is to transfer energy into a target.

**KINETIC ENERGY is determined by**

**KE = 1/2 mv2**

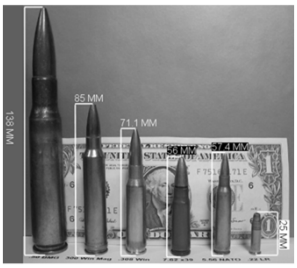
So: weapons designers can more easily add energy to a projectile by increasing its velocity than by increasing its mass.

## For example, a typical low velocity .22 calibre rifle bullet with a mass of 2.5 g and a velocity of 300 m/sec...

- has a kinetic energy of KE = 110J
- its 'one shot stop' rating* ~ 25%

*(chance of immediate incapacitation following a torso shot).

## Whereas the 40% heavier, (3.5 v 2.5g), but 300% faster (930 v 300m/sec), Nato 5.56 mm bullet




- KE = 1500J
- One shot stop ~ 94%.

## And a typical 7.62mm AK 47 bullet*, with a mass of 11 g and a muzzle velocity of 850 m/sec

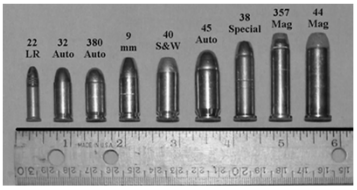

- KE = 4000 J
- One shot stop ~ 97%.

## The std Nato 7.62 mm bullet carries similar energy to the AK47.

9g, 840m/s, 3300J

## And a .50 cal machine gun

- 46 g
- 800m/sec
- 15,000J.



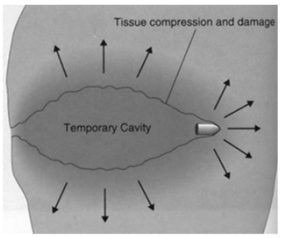

| |  |  |  |  |
|---|---|---|---|---|
| Caliber | 9mm | 45 auto | 44 Magnum | 308 Winchester |
| Weight (gm) | 8 | 14.9 | 15.6 | 9.5 |
| Muzzle Velocity (m/s) | 350 | 260 | 440 | 830 |
| Energy | 490 | 505 | 1510 | 3270 |

## Why would you need so much power?

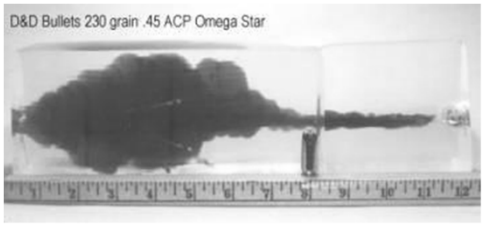
- to hit 'hardened targets'
- to maintain stopping power at a distance
  - a 1500Joule 5.56mm round has lost half its energy at 300m
  - a 525 Joule 9mm bullet has lost half its energy at 100m.

## As a high velocity projectile passes through the body, tissue is accellerated radially away from the bullet track, producing a large "TEMPORARY CAVITY"

- This can cause massive damage which is not just confined to the bullet track.



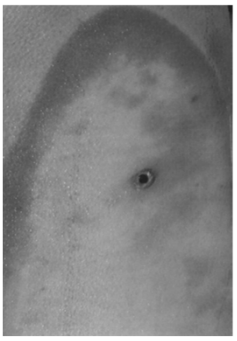
## Temporary cavity of a bullet shown in ballistic gelatin.

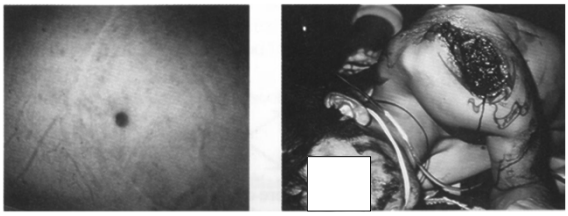



## 9mm temporary cavity in a watermelon

**Femur fracture from 5.56mm M16 round**

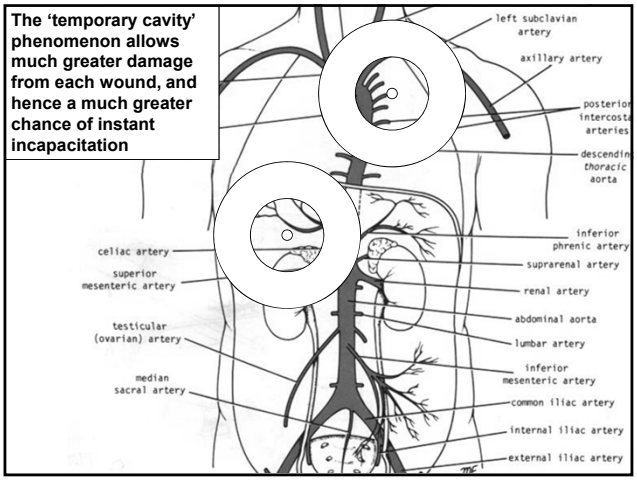
**With high velocity projectiles,the <u>size of the projectile or entry wound</u> is often a poor guide to the severity of the underlying tissue damage.**





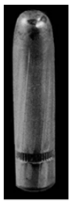
**Exploration of this apparently minor shrapnel wound revealed major underlying muscle injury**

**The 'temporary cavity' phenomenon allows much greater damage from each wound, and hence a much greater chance of instant incapacitation**



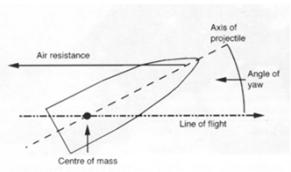

**Extreme damage seen when a high velocity bullet hits the head.**

**But high velocity, jacketed bullets have a tendency to pass all the way through the body**



**And this is undesirable because it means that some of the energy of the bullet is not deposited in the target.**

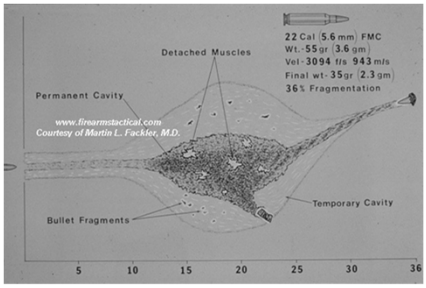
**So military bullets are designed to <u>tumble</u> once they enter the body,**



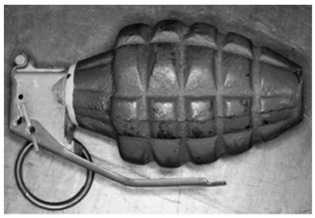

1) is less streamlined
2) may fragment

in either case increasing the rate of energy transfer.

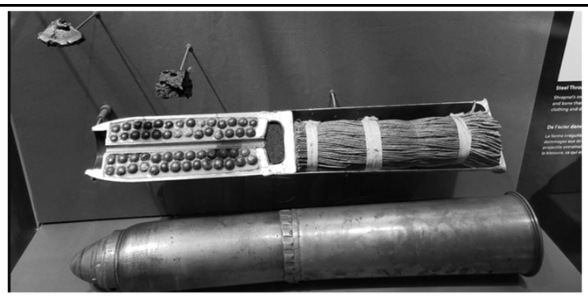
**Fragmentation of a bullet produces smaller, less streamlined particles which decellerate faster in tissue (ie give up energy more rapidly), increasing tissue damage.**




**Explosive munitions, eg grenades or shells, produce many high energy fragments**



**In wartime, they are responsible for the majority of casualties.**



**Shrapnel fragments are often larger, faster and more irregular than bullets, hence carry more wounding potential**

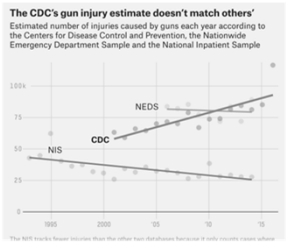

## Multiple Fragment Wounds from an IED

## Terrorists often improvise by adding nails, bolts, ball bearings etc to their bombs

# Domestic Firearms

- Injury frequency
- Statistics
- Gun Safety
- Safe Storage
- Resources for gun safety

# Injury rates from firearms




- WISQARS CDC database
- Discrepancy in the data from multiple sources
  - Likely related to statistical estimation
- Regardless the rate is very high
- Significant contributor to death and disability

| GVA - SIX YEAR REVIEW | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 |
|---|---|---|---|---|---|---|
| Deaths - Willful, Malicious, Accidental | 12,418 | 13,537 | 15,112 | 15,679 | 14,789 | 15,208 |
| Suicides by Gun | 21,386 | 22,018 | 22,938 | 23,854 | PENDING | PENDING |
| Injuries - Willful, Malicious, Accidental | 22,779 | 27,033 | 30,666 | 31,265 | 28,233 | 29,501 |
| Children [age 0-11] Killed or Injured | 603 | 695 | 671 | 733 | 670 | 692 |
| Teens [aged 12-17] Killed or Injured | 2,318 | 2,695 | 3,140 | 3,256 | 2869 | 3,068 |
| Mass Shooting | 269 | 335 | 382 | 346 | 337 | 417 |
| Murder-Suicides | 624 | 530 | 549 | 608 | 621 | 614 |
| Defensive Use [DGU] | 1,531 | 1,393 | 2,001 | 2,107 | 1888 | 1,547 |
| Unintentional Shootings | 1,605 | 1,969 | 2,202 | 2,039 | 1662 | 1,837 |

Number of Deaths, Injuries, Children, Teens killed/injured [actual numbers]
Mass Shooting, Murder-suicides, Defensive Use, Unintentional Shooting [number of incidents]
Suicide numbers supplied by CDC End of Year Report [actual numbers]

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GVA

**GUN VIOLENCE ARCHIVE 2020**
Evidence Based Research - since 2013

PUBLISHED DATE: January 29, 2020

| | | |
|---|---|---|
| Total Number of GV Deaths - ALL Causes[4] | | 3,064 |
| Homicide/Murder/Unintentional/DGU[1] | | 1,150 |
| Suicide[3] | | 1,914 |
| Total Number of Injuries[1] | | 2,081 |
| Mass Shootings[2] | | 21 |
| Mass Murders[2] | | 2 |
| Number of Children (age 0-11)[1] | Killed | 14 |
| | Injured | 42 |
| Number of Teens (age 12-17)[1] | Killed | 56 |
| | Injured | 176 |
| Officer Involved Incident[1] | Killed | 4 |
| Officer Killed or Injured | Injured | 15 |
| Officer Involved Incident[1] | Killed | 99 |
| Subject-Suspect Killed or Injured | Injured | 81 |
| Defensive Use[2] | | 109 |
| Unintentional Shooting[2] | | 163 |
| Murder/Suicides Incidents[3] | | 40 |

# Gun Safety

- **Remove guns from the home**
- **Rules for safe gun ownership**
  - **<u>ALWAYS</u> keep the gun pointed in a safe direction.**
  - **<u>ALWAYS</u> keep your finger off the trigger until ready to shoot.**
  - **<u>ALWAYS</u> keep the gun unloaded until ready to use.**
  - **Know your target and what is beyond it**
  - **Know how to use the gun safely.**
  - **Be sure your gun is safe to operate**
  - **Use only the correct ammunition for your gun**
  - **Wear eye and ear protection**
  - **Never use alcohol or drugs before or while shooting.**

# Safe Storage

- **Store guns out of reach, unloaded and inaccessible to unauthorized persons**
  - **Trigger Locks**
    - **Cables**
    - **Locks**
    - **Biometrics**
  - **Gun Cases**
  - **Strong Boxes and Security Cases**
  - **Locking Steel Gun Cabinets**
  - **Gun Safes**
- **Store guns and ammunition in separate locations**

# Resources

- **https://projectchildsafe.org/parents-and-gun-owners**
- **https://gunsafetyrules.nra.org**
- **https://www.injuryfree.org/safetytpc_display.cfm?PermanentId=ADC74F45-E6D2-4BCA-8D270EDDD0370F76**
- **https://www.thetrace.org/2019/08/children-teens-gun-deaths-data/**
- **https://www.gunviolencearchive.org**