Wound Ballistics and Firearm Safety

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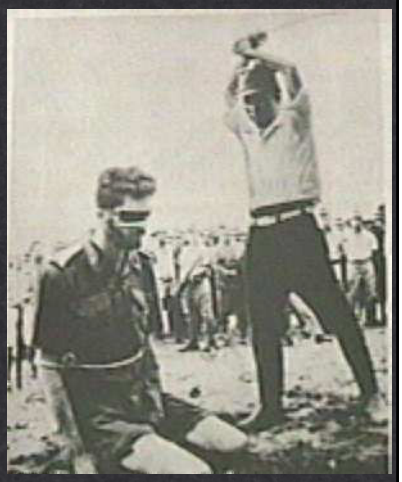
The fundamental process involved in any trauma is the application of energy to the target.

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

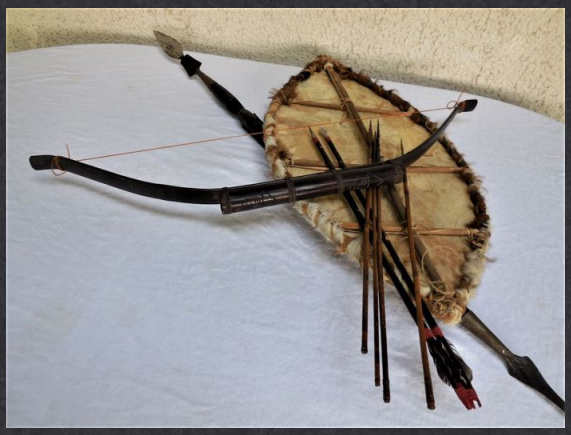
(approx 4lb, 40mph)

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.

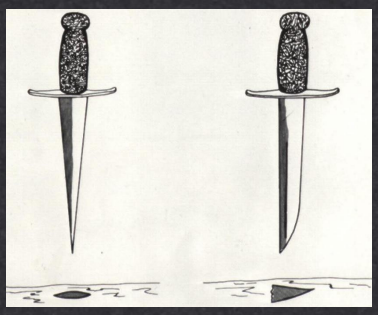
An arrow from a long bow carries 40J



The spear, or the bow and arrow, allowed the projection of ‘concentrated force’ at a distance from the body.

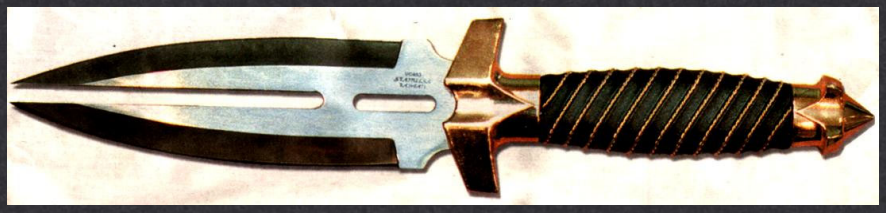
But the wounding power (and the range) of these edged weapons proved insufficient.

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

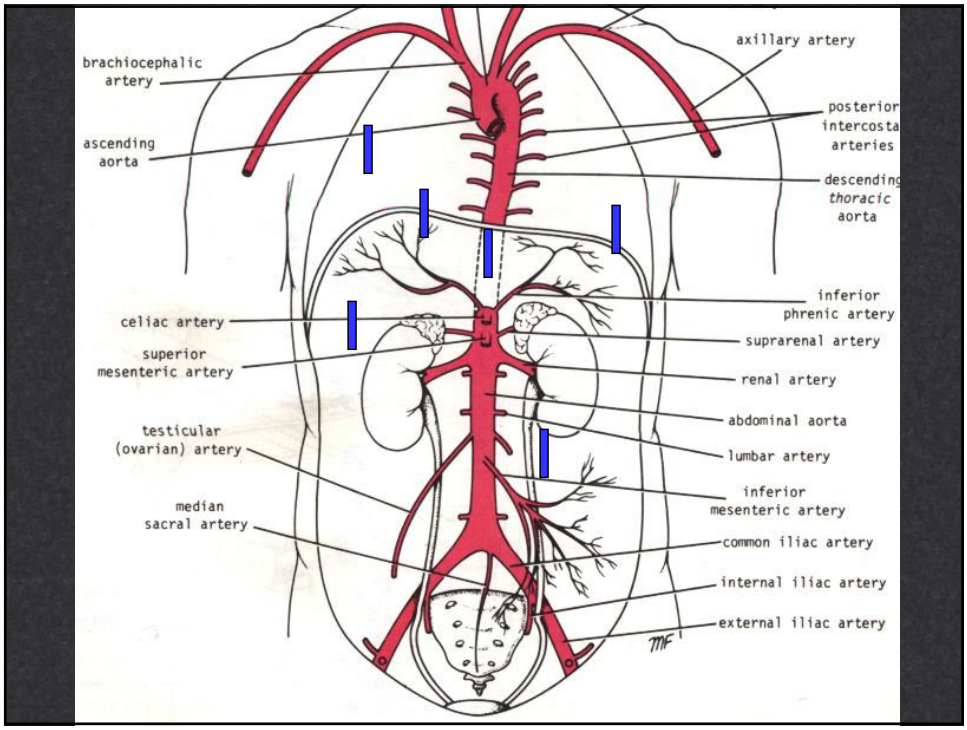


And the damage they do is largely confined to the profile of the blade.

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

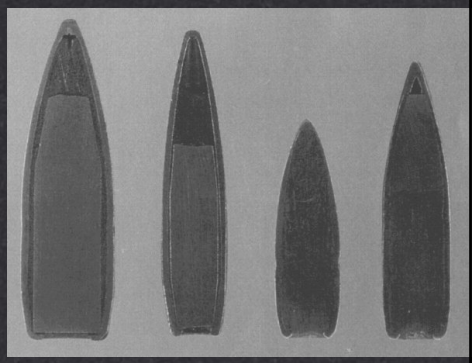
Both in terms of wounding potential and range.

The early firearms were smooth bore muskets

They could propel a soft lead ball (hence "Ballistics") hundreds of feet at a target.

But the range and the accuracy of these spherical projectiles was limited

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



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

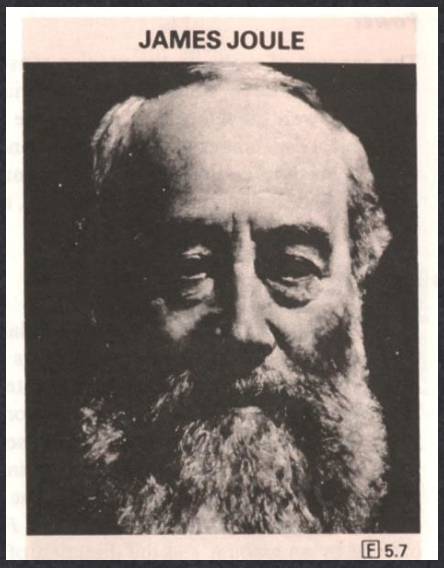
It is a small, blunt nosed, soft lead projectile.

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??

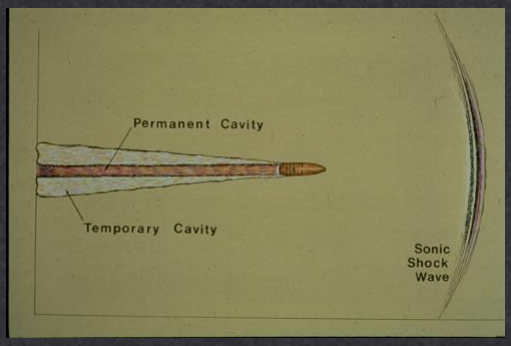


A precordial thump is ~ 50 J.

A solid punch is ~ 100 J.

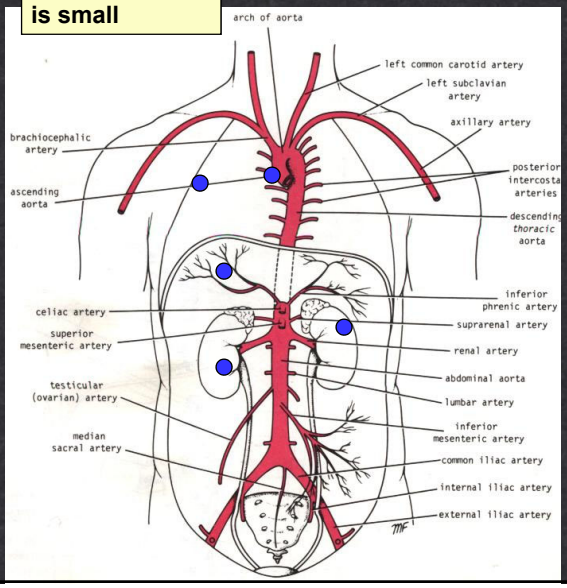
A typical defibrillation is 300 J.

A Low velocity (= 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.

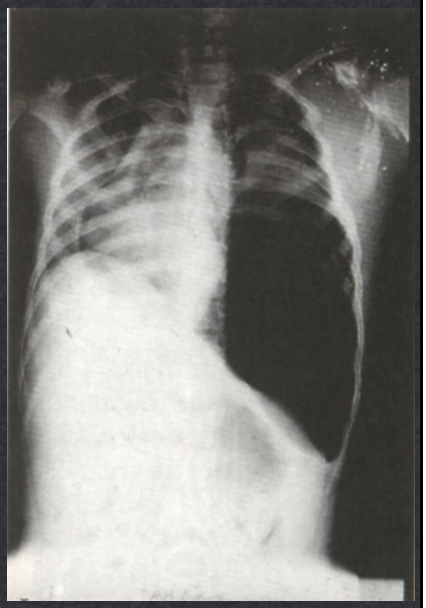
Like a knife wound, the chance of rapid incapacitation is small



A low energy projectile cannot be relied upon to immediately disable 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?

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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...

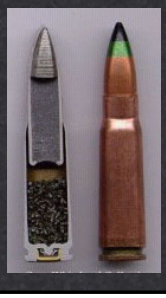
- has a kinetic energy of KE = 110J
- its 'one shot stop' rating* ~ 25%

*(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.

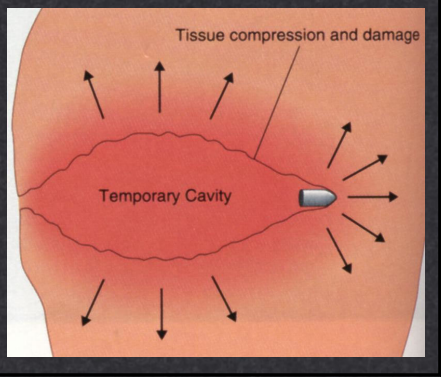
				
Caliber	9mm	45 auto	44 Magnum	308 Winchester
Weight (gm)	8	14.9	15.6	9.5
Muzzle Velocity (m/s)	350	260	440	830
Energy	490	505	1510	3270

Why would you need so much power?

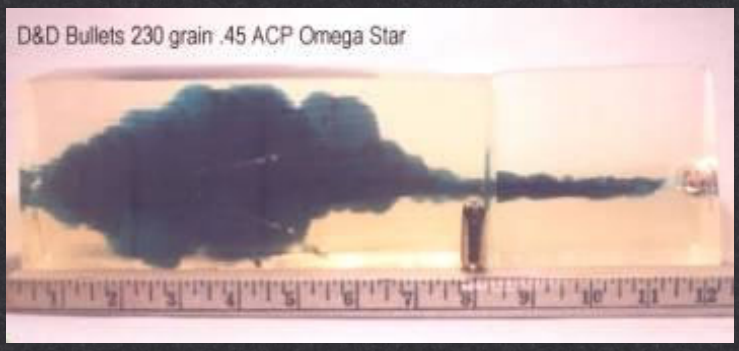
- to hit 'hardened targets'
- to maintain stopping power at a distance
  - a 1500Joule 5.56mm round has lost half its energy at 300m
  - a 525 Joule 9mm bullet has lost half its energy at 100m.

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.



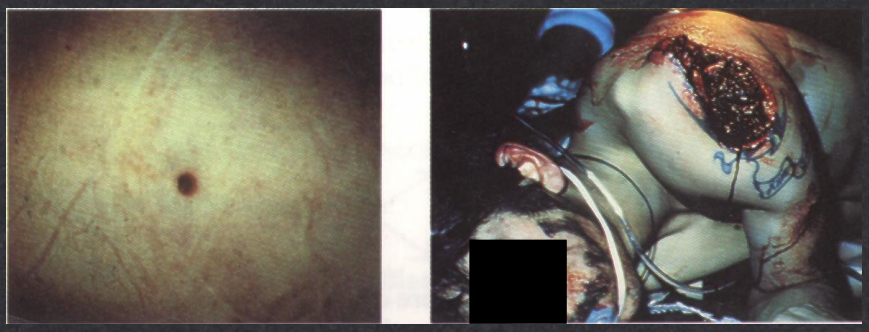
Temporary cavity of a bullet shown in ballistic gelatin.



9mm temporary cavity in a watermelon

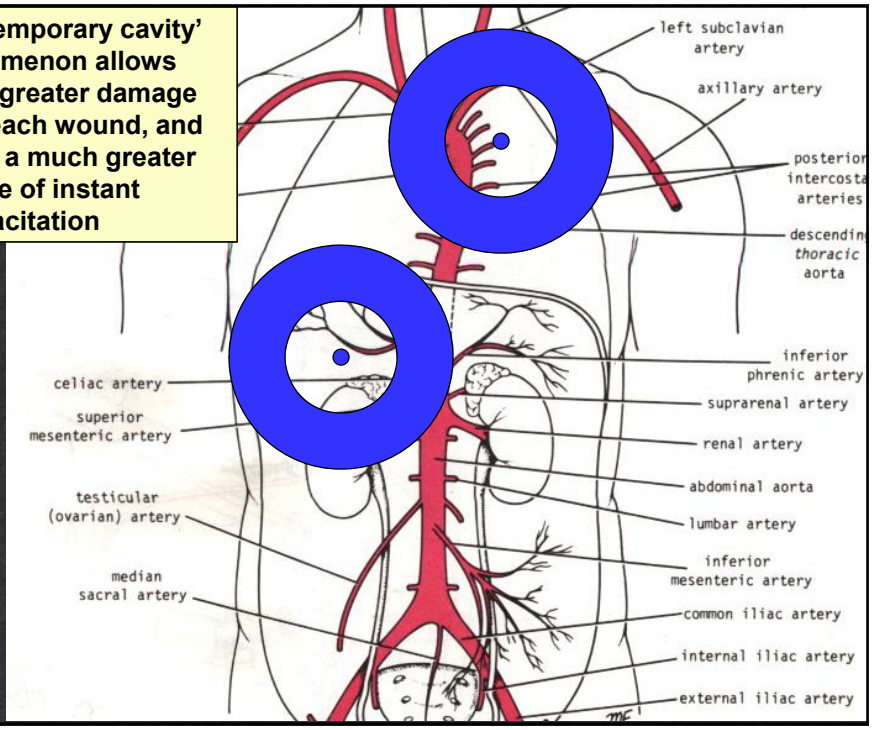
Femur fracture from 5.56mm M16 round

With high velocity projectiles,the size of the projectile or entry wound 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

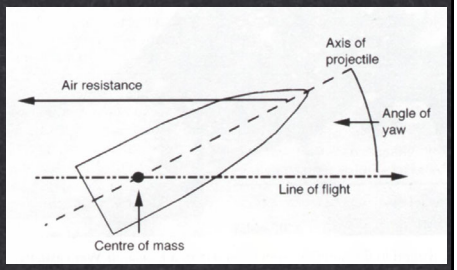


Extreme damage seen when a high velocity bullet hits the head.

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.

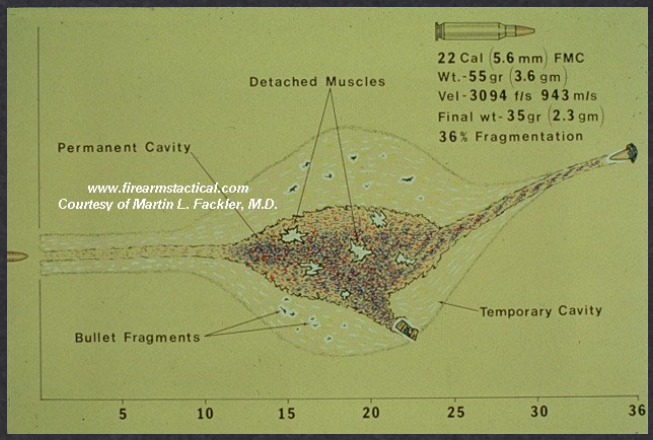
So military bullets are designed to tumble once they enter the body,



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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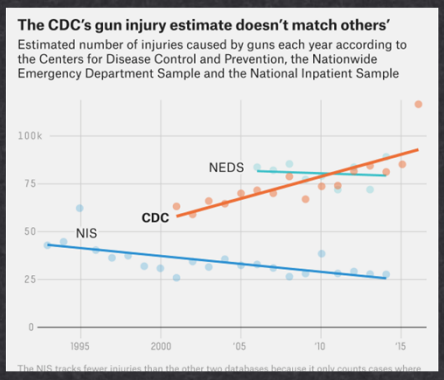
Multiple Fragment Wounds from an IED

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]

@gundeaths
www.gunviolencearchive.org
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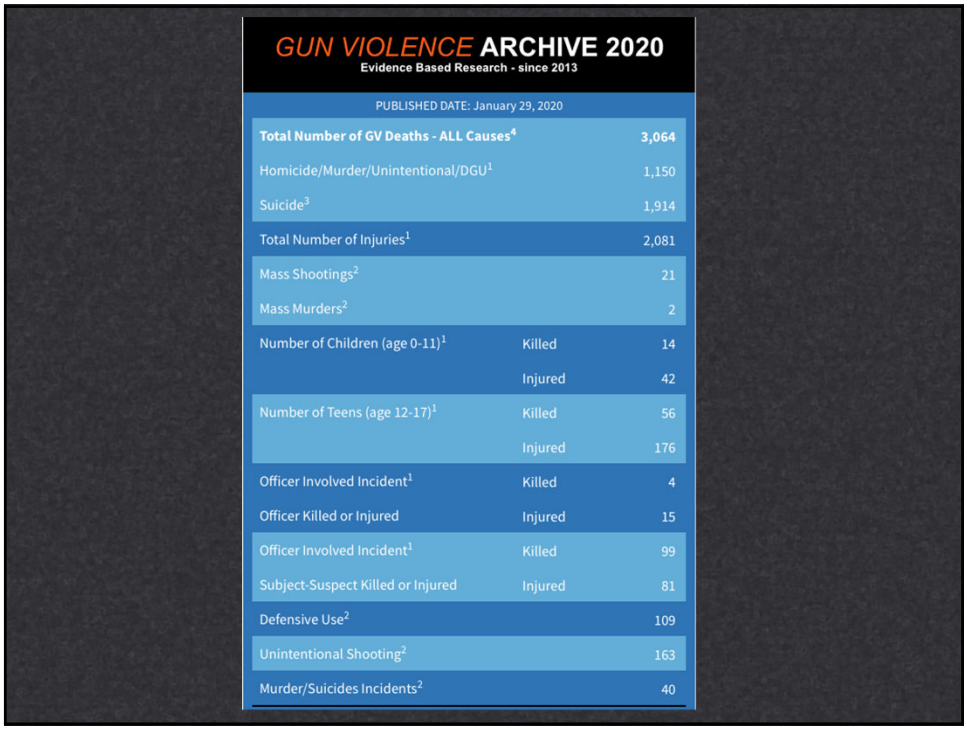
GVA



Gun Safety

- Remove guns from the home
- Rules for safe gun ownership
  - ALWAYS keep the gun pointed in a safe direction.
  - ALWAYS keep your finger off the trigger until ready to shoot.
  - ALWAYS 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