

Lecture Notes

Gunshot Wounds



Small arms: Handguns, Rifles, Shotguns, Submachine guns, Machine guns

Small arms ammunition: Cartridge, Primer, Propellant, Bullet

Ballistics, Gunshot Residues

Bullet wounds, Range of Fire

Shotgun wounds, Range of Fire:

Shotguns & Ammunition

Investigation of Gunshot Cases, X-rays, Suicide

SMALL ARMS

1. HANDGUNS

- a. Single shot pistols
- b. Derringers
- c. Revolvers**

Definition: A firearm designed to be fired from the hand and having a rifled barrel and a revolving cylinder containing several chambers each of which holds one cartridge.

1. Solid frame (Samuel Colt 1835)
2. "Swingout" type (USA)
3. "Breaktop" type (UK)

d) Auto-loading pistols ("automatics")

Definition: A firearm designed to be fired from the hand and having a rifled barrel and a removable magazine storing cartridges with a mechanism for auto-loading.

2. RIFLES

Definition: A firearm with a rifled barrel designed to be fired from the shoulder.

- a. Single shot
 - b. Lever action
 - c. Bolt action
 - d. Pump action
 - e. Auto-loading (erroneously called "automatic rifles")
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3. SHOTGUNS

Definition: A firearm with a smooth bored barrel designed to fire multiple pellets and to be fired

from the shoulder.

- a. Single shot
- b. Over and under
- c. Double barrel
- d. Bolt action
- e. Lever action
- f. Pump action
- g. Auto-loading

4. SUBMACHINE GUNS (Synonym "machine pistols", erroneously called "machine guns")

Definition: A firearm, with a rifled barrel firing pistol ammunition, designed to be fired from the shoulder or the hip and capable of fully automatic fire.

5. MACHINE GUNS

Definition: A firearm with a rifled barrel firing rifle ammunition and capable of fully automatic fire.

SMALL ARMS AMMUNITION

1. CARTRIDGE CASE

function: expands and seals chamber against rearward escape of gases.

composition: usually brass (70% copper 30% zinc); also plastic and paper in shotgun shell tubes.

shape: (a) straight ("always" pistol ammunition)

(b) bottleneck ("always" rifle ammunition)

(c) tapered ("obsolete").

extractor flange: configuration at base; rimmed, semi-rimmed, rimless, belted, rebated.

headstamp: manufacturers identification imprinted or embossed on cartridge case.

2. PRIMER

function: explodes on compression igniting the propellant.

composition: commonly lead styphnate, barium nitrate, antimony sulphide. Typically all 3 elements (lead, barium antimony) in centrefire ammunition but sometimes lead only or lead and barium in rimfire ammunition. Elemental trace tests used to determine if person fired a weapon.

location: (a) centrefire. Centrally placed primer assembly comprising primer cup (struck by firing pin), primer, anvil with flash holes. Boxer design (USA) or Berdan design (Europe).

(b) rimfire. No primer assembly. Primer spun into rim of cartridge case (rim struck

by firing pin) and in contact with propellant.

3. PROPELLANT

function: burns to produce large volumes of gases under pressure.

composition: black powder (charcoal, sulphur, potassium nitrate) now obsolete. Smokeless powder (nitrocellulose with/without nitroglycerine).

shape: sheets of smokeless powder cut into disc, flake or cylinder shapes. Alternatively produced as ball and flattened ball smokeless powder (Winchester) which may be coated with silver-black graphite.

4. BULLET

function: the part of the cartridge which exits the muzzle.

composition:

(a) lead alloyed with tin and/or antimony with/without copper or copper alloy "gilding" (less than 0.0002 inches thick).

(b) metal jacketed with lead or steel core and jacket of cupro-zinc, cupro-nickel or aluminium (0.0165 to 0.03 inches thick).

shape: (a) lead bullets - roundnose, wadcutter, semi-wadcutter, hollowpoint; generally all have cannelures or grooves. (b) metal-jacketed (i) full jacketing in military ammunition (ii) partial jacketing in hunting rifle and semi-automatic pistol ammunition: semi-jacketed soft point, semi-jacketed hollow point, Silver-tip (aluminium).

usage: (a) lead bullets - traditionally only for revolvers and .22 calibre rimfire ammunition; copper gilding in .22 calibre high-velocity rimfire ammunition. (b) metal-jacketed bullets - traditionally for semi-automatic pistols and high velocity rifles.

.22 RIMFIRE AMMUNITION

<u>Ammunition</u>	<u>Introduced</u>	<u>Characteristics</u>
.22 Short*	1857	29-gr solid or 27 to 29-gr 0.223 in. hollow point lead bullet with gilding in high velocity but not standard velocity cartridges.
.22 Long*	1871	29-gr. 0.223 in. bullet with gilding of copper or cupro-nickel (not Rifle popular, becoming obsolete).
.22 Long	1887	40-gr 0.223 in. solid lead or 36 to Rifle 40-gr hollow point bullet with gilding (most accurate and popular).

.22 Magnum	1959	40-gr jacketed hollow point or full metal-jacketed 0.224 in. bullet (least popular).
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*available in either standard or high velocity powder loadings, all with unjacketed bullets and all capable of firing from handguns and rifles.

Marlin produces Micro-Groove rifling for .22 rifles (but not handguns); 16 lands and grooves for .22 Short, Long and Long Rifle and 20 lands and grooves for .22 Magnum rifles.

Many manufacturers of .22 ammunition (indicated by head stamp).

.22 Frangible ammunition used in shooting galleries comprise bonded fragments of iron or lead unsuitable for ballistic comparison. They have caused deaths. Iron frangible bullets tend to break up into cylinders or discs in the body (can be collected with magnet).

Variants of .22 ammunition include 0.22 Long rifle shot cartridges containing No. 12 shot (deaths rare) as well as cartridges with differing bullet weights and powder loadings.

HIGH VELOCITY CENTREFIRE RIFLE CARTRIDGES

A high velocity centrefire cartridge is one with a centrally located primer assembly, intended to be fired in a rifle of calibre .17 or greater, with a muzzle velocity greater than 2,000 ft/sec.

High velocity centrefire rifle bullet construction:

- i. full metal jacketed - lead or steel core with copper alloy jacketing (military use);
- ii. soft point partial metal jacketed - lead core exposed at tip (pointed or rounded) facilitating distortion by expansion in target (hunting use);
- iii. hollow point partial metal jacketed - variant of soft point with cavity at tip to enhance distortion (hunting and competitive shooting use);
- iv. miscellaneous controlled expansion projectiles - e.g. thin aluminium jacket over lead tip, plastic tip

BALLISTICS

Rifles and handguns (but not shotguns) have rifled barrels. The rifling comprises spiral grooves cut the length of the interior or bore of the barrel. The raised metal between the grooves is the lands. Typically, calibre is measured from land to land but usage is inconsistent.

When a rifled weapon is discharged, the rifling produces marks on the bullet as it passes down the barrel. Some markings have "class characteristics" indicative of the make and model of the firearm. Other markings have "individual characteristics" which reflect imperfections peculiar to a particular firearm and may allow its specific identification.

Bullet class characteristics:

1. Number of lands and grooves (usually 4 to 6 but range from 2 to 22).
2. Diameter of lands and grooves.
3. Width of lands and grooves.
4. Depth of grooves.

5. Degree of twist (twist is the number of inches/cms of bore required for one complete rifling spiral).
6. Direction of rifling twist (commonly right/clockwise, less commonly left/counter- clockwise e.g. Colt).

Bullet individual characteristics:

1. Imperfections of grooves (most pronounced in lead bullets).
2. Imperfections of lands (most pronounced in jacketed bullets).

Markings having class and individual characteristics are also found on the cartridge case and primer. These characteristics include:

- (1) Type of breech block marking.
- (2) Size, shape and location of extractor marks.
- (3) Size, shape and location of ejector marks.
- (4) Size, shape and location of firing pin marks (the most important identifying marks in rimfire cartridge cases).

Fingerprints are rarely recovered from firearms but may be obtained from cartridge cases.

DETECTION OF GUNSHOT DISCHARGE RESIDUES

It is possible to detect on the back of the firing hand of individuals, who had discharged a weapon, traces of the metals barium, antimony and lead, originating from the primer of the cartridge. Cotton tipped swabs moistened with either 10% hydrochloric acid or 5% nitric acid are used to recover residues for analysis by flameless atomic absorption spectrometry (FAAS) and neutron activation analysis (NAA). Adhesive material is used to recover residues for analysis using scanning electron microscopy and EDAX.

Problems to be aware of:

- i. All three metals are not necessarily present in some rimfire primers.
- ii. Neutron activation only detects antimony and barium, and must be used in conjunction with FAAS to detect lead.
- iii. NAA and FAAS are both quantitative elemental analytical methods which do not distinguish the source of the metals. False positives are therefore theoretically possible.
- iv. Although SEM with EDAX can potentially absolutely identify gunshot residue, often the result is typical but not unique. In practice residues are detectable in 90% of persons who have fired handguns, but only 50% of persons who have fired rifles and shotguns.
- v. The quantity and distribution of the three metals can be described as consistent or not consistent with gunshot residue and thus with firing a weapon.
- vi. Residues on the palms of the hands may indicate a defence gesture, or alternatively the handling of a previously fired weapon.
- vii. In suicides residues are often detected on the non-firing hand used to steady the muzzle against the body.
- viii. Residues of barium alone may be the result of contamination with barium rich soil.

In the UK, firearms discharge residue kits are available from the Metropolitan Police Forensic Science Laboratory, the Home Office Forensic Science Service Laboratory at Chorley and the

Belfast Forensic Science Laboratory.

In taking the hand-wipings plastic gloves must be worn. The cotton swab is moistened with two or three drops of acid solution. About 20 seconds of swabbing is recommended and important per swab. Each area is swabbed twice. The four areas swabbed are the backs of both hands and the palms of both hands. On the back of the hand the radial aspect of the forefinger, the dorsal aspect of the thumb, and the skin web between is swabbed. On the palm of the hand the palmar aspect of the forefinger and thumb together with the base of the forefinger and thumb and the skin web between is swabbed. (In some jurisdictions the entire palm is included in the swabbing).

WOUND BALLISTICS

Definitions:

Ballistics is the science of the motion of projectiles.

Interior ballistics is the study of projectiles in weapons.

External ballistics is the study of projectiles in the air.

Terminal ballistics is the study of projectile penetration of solids.

Wound ballistics is the study of projectile penetration of tissues.

A moving projectile has kinetic energy proportional to its weight and velocity. $KE = WV^2/2g$.

The wounding effect of a projectile is produced by transfer of kinetic energy from the projectile to the tissues.

The greater the kinetic energy of a projectile, the greater the wounding potential. Kinetic energy increases in proportion to increases in the velocity squared; hence the great wounding potential of high velocity projectiles.

If a projectile does not exit the body, then all its kinetic energy has been transferred to the tissues. If the projectile exits the body, then only some of its kinetic energy has been transferred to the tissues.

The loss of kinetic energy by the projectile is influenced by a variety of factors:

1. The more unstable the flight of the projectile (the greater the angle of yaw) at the moment of impact with the body, then the greater the loss of KE. Subsequent wobble and tumbling of the bullet in the body increases KE loss.
2. The calibre and shape of the projectile influence the "drag effect" in tissues and thus the loss of KE. The structure of the bullet influences bullet deformation and break-up both of which result in greater loss of KE. High velocity projectiles are more likely to break up than low velocity projectiles.
3. The longer the wound track through the body, the greater the loss of stability and the greater the deformation of the projectile with resultant increased loss of KE (see above).
4. The denser the tissue through which the projectile passes, the greater the retardation of the projectile and thus the greater the loss of KE.

Projectiles disrupt tissues by two principal mechanisms:

1. Direct laceration of the tissues as occurs with any penetrating object ("drilling effect"). This is the main mechanism in low velocity gunshot wounds e.g. from a pistol, and in such cases

the permanent cavity seen at autopsy accurately reflects the tissue damage produced by the path of the bullet.

2. In high velocity rifle wounds, e.g. centrefire hunting rifles, there is an additional effect of temporary cavity formation. Produced by the large amount of kinetic energy transferred to the tissue, this cavity may be up to 30 times the diameter of the projectile, has a lifetime of 5 to 10 milli-seconds, produces pressures of 100 to 200 atmospheres and collapses in a pulsatile fashion. The diameter of the resultant permanent cavity is variable but usually larger than the diameter of the bullet. At autopsy, the evidence of temporary cavity formation may be a wide zone of haemorrhage around a small permanent cavity; this is deceptive as the tissue damage is greater than it appears to be. If the pressure of temporary cavity formation exceeds the elastic limit of the tissue, then the organ may be disrupted ("bursts") and a large permanent cavity seen at autopsy reflects the size of the temporary cavity. Organs which are dense (and thus cause greater loss of projectile KE) and relatively inelastic are most susceptible to this bursting effect e.g. liver. Organs with low density and high elasticity are relatively protected e.g. lung. Organs such as muscle and skin which have similar density to liver are relatively protected because of their elasticity. High velocity gunshot wounds of the head produce bursting injuries of the skull due to temporary cavity formation.

Other wounding mechanisms include:

1. Shockwaves receding from the projectile at the speed of sound. These may cause the rupture of gas-filled organs such as the bowel.
2. Secondary projectiles such as shattered bone fragments e.g. gunshot wounds to the head.
3. Discharge gases exiting the muzzle of the weapon pass into the wound track in hard contact wounds and produce tissue disruption e.g. contact shotgun wounds to the head.

High velocity centrefire rifle wounds

The full metal jacketing of military ammunition prevents deformation, thus velocity is the critical factor in the wounding effect. In partial metal jacketed hunting ammunition the bullet construction (which encourages deformation) plays as important a role as velocity in determining the wounding effect.

Military bullets pass through the body tending not to break up or shed lead fragments. By contrast hunting bullets expand or mushroom and tend to break up (although they too usually exit). The military 5.56mm (.223; standard US Army rifle calibre) M16 bullet is exceptional in tending to fragment. The fragmentation of hunting bullets and the 5.56mm bullet produces a "lead snowstorm" on X-ray ("diagnostic" but not ubiquitous feature of high velocity rifle hunting ammunition) characterised by scores of lead fragments along the wound track.

Comparative muzzle velocities and muzzle energies:

pre circa 1850:	rifles, smooth bore .69 to .75 calibre, firing soft lead spheres 484 to 580 gr. at muzzle velocities of 590 to 754 ft/sec
circa 1850:	introduction of conical soft lead bullets (Minie bullets) .67 to .69 calibre, from 556 to 686 gr at muzzle velocities of 931 to 1017 ft/sec.
circa 1900:	introduction of smokeless powder leading to general reduction of calibre (6.5 to 8mm for military weapons); approx. 220 gr. roundnosed full jacketed bullets with muzzle velocity around 2,000 ft/sec. Spitzer (pointed) bullets

	about 150 gr. with muzzle velocity about 2,700 ft/sec.
present:	centrefire muzzle velocities, 2,400 to 4,000 ft/sec with muzzle energies commonly about 2,000 ft-lb (range 1,000 to 5,000 ft-lb). By contrast .22 rimfire rifles and handguns have muzzle velocities of 650 to 1,400 ft/sec with muzzle energy less than 500 ft-lb (except .357 Magnum and .44 Magnum).

SKIN SURFACE CHARACTERISTICS OF GUNSHOT (BULLET) WOUNDS

<u>Term</u>	<u>Synonyms</u>	<u>Cause</u>
Skin defect	Permanent cavity	Passing of the projectile through the skin (a).
Abraded margin	Abrasion collar, Marginal abrasion, Contusion ring, Abrasion ring	Forward motion of bullet indenting the skin and abrading the margin of entry wound (b).
Micro-tears		High velocity centrefire rifle bullets tend to produce these rather than an abrasion ring.
Grey ring	Contact ring, Bullet wipe	Lubricant and debris on bullet surface wiped off onto the wound edge.
Smudging (c)	Fouling, Blackening	Deposition of soot from partially burnt gases.
Tattooing (c)	Involuntary tattooing, Stippling, Peppering	Unburned, partially burned and burning propellant grains abrading and embedding in skin (<u>sine qua non</u> of intermediate/close/near range).
Singeing (c)	Branding/Burning	Hot gases from muzzle at close range
Muzzle impression	Muzzle contusion, Muzzle imprint	Skin impact against muzzle produced by discharge gases or temporary cavity formation in contact and near contact wounds

(a) Exit wound is typically larger and more irregular than entry due to bullet tumbling and deformation.

(b) May be absent in the palm of sole, high velocity centrefire rifle wounds from jacketed or semi-jacketed handgun bullets (usually high velocity) and re-entry wounds of axilla and scrotum.

Typically absent from exit wounds, allowing their distinction from entry wounds. May be seen in "shored" exit wounds.

(c) The term "powder burns" is variably used to include one or more of these features.

<u>Term</u>	<u>Synonyms</u>	<u>Cause</u>
Pseudo-tattooing	Pseudo-powder tattooing	Skin marks mimicking tattooing produced by projectile fragments, intermediate target fragments, p-m insect bites, shotshell, packing, petechiae, suture marks etc
Pseudo-soot		Material deposited on the skin micking soot, e.g. fingerprint dusting powder, haemorrhage, dried out wound exudate.

RANGE OF FIRE OF GUNSHOT WOUNDS

<u>Range</u>	<u>Muzzle-target distance</u>	<u>Wound characteristics</u>
1. Contact (see below)	Muzzle in contact with body (or a very short distance - a few centimetres - from body)	Edges seared by gases and blackened by soot and propellant ("baked" into skin). With or without a concentric or eccentric seared blackened zone around wound. With or without soot deposition in a wider band around wound (can be wiped off). Soot, propellant, vapourised bullet, primer and cartridge case metals and CO in/along wound track.
2 Close range. (intermediate, near)	Muzzle to target distance within about arms length i.e. 3 feet	<u>sine qua non</u> is individual, red-brown to orange-red propellant grain tattooing; eccentric if muzzle at angle to skin; may be blocked by hair or clothing; post mortem is moist grey or yellow.
3. Distant	Muzzle to target distance greater than about 3 feet	produced by mechanical action of bullet penetration of skin only; ie. skin defect typically with abraded margin.

CONTACT GUNSHOT WOUNDS

<u>Range</u>	<u>Muzzle-target distance</u>	<u>Wound characteristics</u>
a) hard contact	Muzzle jammed "hard" against skin).	Edges seared by gases and blackened by soot ("baked" into skin)
b) loose contact	Muzzle in light but complete contact with skin	Soot deposition in band around wound (can be wiped off).
c) angled	Muzzle at acute angle to skin with only part of circumference in contact	Eccentric seared blackened zone contact around wound widest on side opposite muzzle; larger eccentric zone of soot deposition (can be wiped off).
d) incomplete	Muzzle in contact with contoured skin surface resulting in muzzle-skin gap(variant of angled contact)	Variably located seared blackened contact zone adjacent to wound
e) near contact	Muzzle a very short distance from skin (grey zone between contact and close range)	Wide blackened zone of soot baked into seared skin around wound (may not be distinguishable from loose contact).
f) angled near contact	as above but muzzle at acute angle to skin	Eccentric seared blackened zone and larger paler zone as in angled contact but widest on same side as muzzle (contrast angled contact).

SHOTGUN WOUNDS:

Pellets rarely exit therefore wounding effect = wounding potential;

$KE=WV^2/2g$ but weight falls off with range due to pellet dispersion with fewer striking target and velocity falls off rapidly due to poor pellet aerodynamics; therefore range has critical effect on injury severity;

12 gauge shotgun with nine 00 Buckshot pellets of muzzle velocity 1325 ft/sec has muzzle energy of 1899 ft-lb (211 ft-lb per pellet) which equals the energy of a 30-30 rifle bullet. (1902 ft-lb); a 12 gauge 402 gr. shotgun slug has a muzzle velocity of 1600 ft/sec and muzzle energy of 2485 ft-lb.

(1) contact wounds of the head are extremely mutilating due to (a) energy expended by shot and (b) large volume of gas produced. Typically the cerebral hemispheres are eviscerated and the great majority of wads and pellets will exit.

Entrance is easily identified by the large amount of surrounding soot; wound edges are seared and blackened with associated large lacerations; skull fragmented; exit is often not identifiable.

Intra-oral wounds show stretch lacerations in naso-labial folds and at margins of the mouth.

- (2) contact wounds of the trunk appear externally innocuous with a circular defect approximating the weapon bore; muzzle imprint is common; loose contact or interposed clothing produces surrounding soot smudging; CO produces cherry-red discoloration of underlying muscle.
- (3) close range tattooing begins at about 1 to 2 cm and is "always" lost by about 36 to 40 in.; it is less dense than with handguns.
- (4) distant range: birdshot from any gauge weapon except .410 produces a 3/4 to 1 in. round entrance at ranges from contact to 2ft.; a 7/8 to 1 1/4 in. entrance with scalloped margins by 3 ft.; a 1 to 1 3/4 in. entrance with scalloped margins and satellite pellet holes by 4 ft.; a definite cuff of satellite pellets by 6 to 7 ft.; beyond 10 ft. there is great variations in pellet pattern size depending upon ammunition type choke, the actual weapon and range (published formulae are unreliable); measurements of the pellet pattern should ignore "fliers". For buckshot at 3 ft a hole with scalloped margins, at 4 ft a few satellite pellet holes appear by, 9 ft there are generally individual pellet holes.
- (5) wad marks: the peeled back petals of power piston wadding may produce a patterned abrasion around the wound; four petals for 12, 16 and 20 gauge but 3 petals for .410; seen at ranges of 1 to 3 ft; at increasing range a focal marginal abrasion may be seen with the wad still entering the wound; at 5 to 8 ft range the wad(s) does not enter the wound but impacts the skin adjacent to the entrance (maximum range for wad abrasion is unknown - may be up to 20 ft); recovered wads indicate gauge of weapons and make of ammunition.
- (6) range of fire: precise estimates require comparison of wound pattern on skin/clothing with test patterns made by firing the same shotgun with the same ammunition.
- (7) intermediate targets: increase the dispersions of pellets on the victim making range assessment liable to error; applies to any intermediate object no matter how thin e.g. pane of glass, wire door screen.
- (8) "billiard ball" effect: pellets bunch up and bounce off each other on entering the body; range cannot be estimated from pellet dispersion in the body (eg in X-rays of decomposed bodies).
- (9) exit wounds: exceptional in trunk unless tangential wound, contact in a thin person or contact/close range with buckshot; typical in contact wound of head and neck.
- (10) other injuries: do not overlook injuries unrelated to the shotgun wound, e.g. evidence of a fist fight.

SHOTGUNS

Shotguns: have a smooth bore; fire multiple pellets (can fire single slug).

Construction:

- a. chamber - encloses shotgun shell.
- b. forcing cone - constricts the charge of pellets entering the bore
- c. the bore .

Gauge: measure of calibre of shotgun; number of lead balls of the given bore diameter required to

make up one pound weight.

Choke: partial constriction of the bore at the muzzle; constricts diameter and increases length of shot column; degree measured as percentage of pellets falling within 30 in. circle at 40 yard range (except .410 which is assessed with 20 in. circle at 25 yards); full choke on 12 gauge reduces muzzle bore from .729 in. to .694 in.; weapons of different gauge but the same choke produce (at the same range) shot patterns of similar size (diameter) but different density; variable choke adapters allow the shooter to vary the degree of choke.

Shot pattern size (diameter) varies with barrel length, choke, pellet size and range.

Shells (ammunition):

(a) **tube** - paper pre-1960 with mouth closed by "rolled crimp"; plastic body or hull with mouth closed by "pie crimp" or "star crimp", eliminating need for overshot wad.

(b) **head** - brass/brass-coated steel; low brass or high-brass types depending on length.

(c) **primer** - see above.

(d) **powder** - see above.

(e) **wads** - four, viz: base (underpowder), overpowder, filler (both between propellant and shot acting as gas seal), overshot; Remington plastic "power piston" (1963) with four "petals" replaced traditional felt or cardboard disc wads, other manufacturers have similar designs; must be recovered at autopsy since they indicate gauge of weapon and bear manufacturers' marks; felt wads may swell when wet, therefore measure after drying.

(f) **lead shot** - three types, viz. drop/soft shot (pure lead), chilled/hard shot (lead hardened by antimony), plated shot (coated with cupronickel), steel shot.

Two categories, viz. **birdshot** (for birds and small game), **buckshot** (for large game).

slugs (for deer and bear in heavily populated areas).

Some become partially melted and fused by discharge gases and rapid acceleration of pellets at bottom of the charge, others flattened by contact with barrel; these distorted pellets

become "fliers" straying from the main pattern, veering off at varying angles.

white granulated polyethylene/polypropylene filler used in some loads (produces pseudo-tattooing).

Sawn-off ballistic comparisons using "power piston" wad or sabot from slug shotguns possible if sawed off barrel end has not been smoothed off.

		<u>Shotshell length (in.)</u>	
<u>Shotgun gauge</u>	<u>Bore diameter (in.)</u>	<u>Standard</u>	<u>Magnum (b)</u>

.410 ("four ten)	.410	2 1/2 or 3	N/A
28	.550	2 3/4	N/A
20	.615	2 3/4	2 3/4 or 3
16	.662	2 3/4	2 3/4
12(a)	.729	2 3/4	2 3/4 or 3
10	.775	2 7/8	3 1/2

(a) most popular.

(b) do not produce higher velocities but contain more shot delivered at standard velocity.

<u>Choke</u>	<u>% shot in 30 in. circle at 40 yard range*</u>
cylinder (no choke)	25-35
improved cylinder	35-45
modified choke	45-55
full choke	65-75

* not .410 gauge shotguns

<u>Approximate* spread of shot (in inches) at various ranges (in yards)</u>				
	5 yards	10 yards	15 yards	20 yards
Cylinder	8	20	26	30
Full choke	3	9	12	15

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*shot pattern size (diameter) varies with barrel length, choke, pellet size and range.

SHOTGUN AMMUNITION

		Average weight of pellets (c)		
<u>No.</u>	<u>Diameter (in.)</u>	<u>Grains (a)</u>	<u>Milligrams</u>	<u>Approximate Number. per oz (b)</u>
<u>Birdshot</u>				
12	.05	.18	11	2385
11	.06	.25	19	1750
9	.08	.75	49	585
8 1/2	.085	.88	57	485
8	.09	1.07	69	410
7 1/2	.095	1.25	81	350
6	.11	1.95	126	225
5	.12	2.58	167	170
4	.13	3.24	210	135
2	.15	4.86	315	90
BB	.18	8.75	567	50

<u>Buckshot</u> :				
4	.24	20.6	1330	
3	.25	23.4	1520	
2	.27	29.4	1910	
1	.30	40.0	2590	
0	.32	48.3	3130	
00	.33	53.8	3490	
000	.36	68.0	4410	

- (a) the smallest British weight; the average weight of a seed of corn; 1/7,000th of a pound avoirdupois (the system of weights in which one pound equals 16 ounces; Old French *avoir de pes*, to have weight).
- (b) load for birdshot is stated in ounces, but for buckshot is stated in numbers of pellets per shell.
- (c) figures for chilled/hard shot; weights of drop/soft shot are several percent greater.

Note: at autopsy a representative sample of shot (about 25) should be recovered to allow an estimate of average size and weight.

<u>Slugs (d)</u>		
Brenneke	Germany 1898	pointed nose and wads screwed to base, approx. 12 angled ribs on sides.
Foster	American	round nose with deep, concave base and 12 to 15 angled ribs on side (variants - hollow point; plastic insert in base) (e)
Sabot	American	hour-glass with hollow base and plastic insert; slug surrounded by polyethylene plastic sabot in two halves which fall away.

"Homemade"		birdshot shell circumferentially grooved with knife just above metal head.
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- (d) produce massive internal injuries analagous to high velocity centrefire rifle wounds.
- (e) tends not to exit body; at autopsy X-ray shows a "pancake" or "disc" with 2 to 4 associated comma-like fragments (no "lead snowstorm").

INVESTIGATING GUNSHOT DEATHS

Scene:

1. Handle the body as little as possible thus avoiding artefacts and loss of trace evidence.
2. Paper bag the hands to preserve trace evidence
3. Transport the body in clear plastic sheeting or a body bag to preserve trace evidence and avoid contamination.

Autopsy:

1. X-ray prior to removing clothing.
2. Recover primer residues from hands by acid (10% nitric) moistened swab or adhesive tape.
3. Examine hands for trace evidence, soot and propellant grains, and blood spatter.
4. Examine and remove the clothing without cutting.
5. Examine the body, photograph wounds if appropriate, correlate with clothing.
6. Use dissecting microscope to examine clothing defects and wounds for soot and propellant.
7. Clean the body, photograph and describe the wounds.
8. Trace the wound tracks and recover the projectiles.
9. Complete the dissection.

Description of Wounds:

1. Describe each wound in turn completely ie. including the internal wound track revealed by dissection.
2. Describe wound location relative to (a) local landmarks, (b) the midline and heel (or top of head).
3. Describe wound appearance by size, shape, abrasion ring (width and symmetry), soot and propellant (presence, distribution and dimensions) and wound entry searing. Describe shotgun pellet pattern.

4. Describe muzzle imprint and compare with alleged weapon.
5. Describe lodged projectile or exit relative to entrance; describe general direction of wound track.
6. Describe any recovered projectile or fragments.

Recover:

1. Propellant grains from skin surface or wound track.
 2. Projectile, taking care not to scratch the surface by contact with a metal instrument.
 3. A representative sample of shotgun pellets and all wadding.
 4. Blood for grouping and blood and tissue for toxicology.
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X-RAYS IN GUNSHOT WOUNDS

In gunshot wound cases x-rays should "always" be performed.

To answer the questions:

1. Is the projectile present?
 2. If present, where is the projectile located?
 3. If the projectile exited, are projectile fragments present and where are they located?
 4. What type of ammunition or weapon was used?
 5. What was the path of the projectile?
-

Problems to be aware of:

1. The last few inches of a .22 rimfire ammunition wound track may have no associated haemorrhage.
2. In a partial exit wound and occasionally in a "shored" exit wound the projectile is in the body despite the presence of an exit wound.
3. With partial metal jacketed bullets the lead core may exit leaving the jacket (with its ballistically important rifling marks) in the body. Sometimes the opposite occurs. Alternatively the jacket and core may separate in the body and neither exit. Projectiles may be retained in clothing.
4. Components of some projectiles are poorly radiopaque on routine X-ray eg. aluminium jacket, plastic tip, plastic shotshell wadding.
5. Projectiles may embolize.
6. Projectiles may ricochet within the body off bones, most commonly the inner table of

the skull.

7. The spread of shotgun pellets in the body seen on X-ray cannot be used to determine range of fire because of the billiard-ball effect.
8. In contact shotgun wounds to the head, all but a few pellets may exit.
9. Exact projectile calibre cannot be determined due to X-ray magnification effects.

Diagnostic tips:

1. "Lead snowstorm" characterises high velocity centrefire rifle ammunition. Ruled out are full metal-jacketed bullets and lead slugs.
2. C-shaped or comma-shaped subgaleal lead fragment in head wounds characterises .32 or occasionally .38 calibre revolver bullets.
3. A "pancake" or "disc" with 2 to 4 associated comma-like fragments (no "lead snowstorm") characterises the Foster shotgun slug.
4. The presence of the base screw characterises the Brenneke shotgun slug.

GUNSHOT SUICIDE

The majority of suicides (including gunshot suicides) do not leave notes.

A contact wound creates a presumption of suicide rather than accident.

With rifle and shotgun wounds to the trunk the trajectory may corroborate suicide. With the weapon butt on the ground and the body hunched over it the trajectory is downwards (not upwards). Reaching for the trigger with the right hand rotates the body so that the trajectory is right to left (vice versa if reaching with the left hand).

Suicide handgun wounds occur primarily to the head (80%), the chest (15%) and abdomen (<5%) being less common. Within the head the common sites, in decreasing order of frequency, are temple, mouth, undersurface of chin and forehead. An unusual location raises a presumption of homicide.

Suicidal shotgun wounds show the same site preference as handguns. Rifle wounds show a distribution of head 50%, chest 35%, abdomen 15%.

Suicide by multiple gunshot is uncommon but not rare.

A suicide victim may "test fire" the weapon before inflicting the fatal shot.

In about 20% of suicides the weapon is found clutched in the hand. Rarely an orange-brown discolouration of the palm due to iron deposition from the barrel may be seen; the stain cannot be wiped away.

Occasionally high velocity impact blood spatter will be deposited on the back of the hand steadying the muzzle and the back of the firing hand.

The hand holding the muzzle may show soot deposition on the radial margin of the forefinger and

the adjacent surface of the thumb and the radial half of the palm due to muzzle blast. With revolvers the cylinder blast may cause soot deposition on the ulnar half of the palm.

Contact wounds to cotton or cotton mixture cloth from medium and large calibre weapons typically produces cruciform tearings; with synthetic materials there are burn holes with scalloped melted margins. Tearing is less prominent with the smaller amounts of gas from .22 rimfire ammunition. A grey to black rim of "bullet wipe" may be present around the entrance hole.

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