MINISTRY OF HEALTH PROTECTION OF UKRAINE
ODESSA NATIONAL
MEDICAL UNIVERSITY
DEPARTMENT OF GENERAL SURGERY

APPROVE
Vice-rector for scientific and pedagogical work
Svitlana KOTYZHINSKA

Methodical recommendations for classes of 3rd year students

Academic discipline: «General surgery »
Topic: «Fire injuries of soft tissues »
Level of higher education: second (master's)
Field of knowledge: 22 "Health care"
Specialty: 222 "Medicine"
Educational and professional program: Medicine

Approved at a meeting of
the Department of General
and Military Surgery
Protocol № 9 of 20.12.22

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Odessa 2022

The methodological recommendations were compiled on the basis of the educational and professional program "Medicine" for the training of specialists of the second (master's) level of higher education in the specialty 222 "Medicine" of the field of knowledge 22 "Health care", approved by the Scientific Council of ONMedU (№ _ of "___" _____ 20__ y.).

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The program was discussed at the meeting of the department of general and military surgery

Protocol № _ of "___" _____ 20__ y.

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Protocol № _ of "___" _____ 20__ y.

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Reviewed and approved at the department meeting_____

Protocol № _ of "___" _____ 20__ y.

Head of Department _____ _____

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Content module 1-4:

Fire ballistics of wounds. The concept of wounds, including gunshot wounds.

Emergency care for gunshot wounds. Surgical treatment of the wound.

Plan

Content module 1.	**Modern pathomorphological feature of a gunshot wound.**
Content module 2.	**The concept of wounds, including gunshot wounds.**
Content module 3.	**Emergency care for gunshot wounds.**
Content module 4.	**Surgical treatment of the wound.**

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Topic content

Modern pathomorphological feature of a gunshot wound. The concept of wounds, including gunshot wounds. Features of gunshot wounds.
Tactical and ballistic characteristics of firearms. Stages of the wound process. Areas of blood circulation disorders. Structure of a gunshot wound.

Wound ballistics – studies how the bullet moves in the human or animal body.

Wound ballistics – a branch of terminal ballistics that studies the behavior of ballistic projectiles (bullets, arrows etc.) when they get into the tissues of biological objects, investigates their impressive effects and features of the formation of gunshot wounds based on medical and physical and technical laws. Forensic medical experts and surgeons are involved in the research. A **wound** is a special case of damage, as a result of which the integrity of the covering tissues is violated.

Wound — a separate type of trauma, that is, the result of the interaction of the human body with striking agents, the morphological equivalent of which is a wound.

Fire wound — this is damage to tissues and organs with a violation of the integrity of their covering (skin, mucous or serous membrane), caused by a firearm.

Features of gunshot wounds:

- The presence of a zone of necrotic tissue around the wound canal
- Formation of new (additional) foci of necrosis in the next hours and days after the injury
- Uneven extension and tissue death outside the wound canal due to the weakness of its architectonics
- Various disorders in the tissues surrounding the wound canal, foreign bodies.

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Factors of formation of a gunshot wound:

1) main shock wave — action of direct impact and compressed air;

2) lateral shock wave — temporary pulsating cavity;

3) direct action of the projectile;

4) vortex trail — the flow of air and tissue particles behind the projectile.

Phases of the temporary pulsating cavity. A) formation of a temporary pulsating cavity; B) temporary pulsating cavity; C) residual cavity.

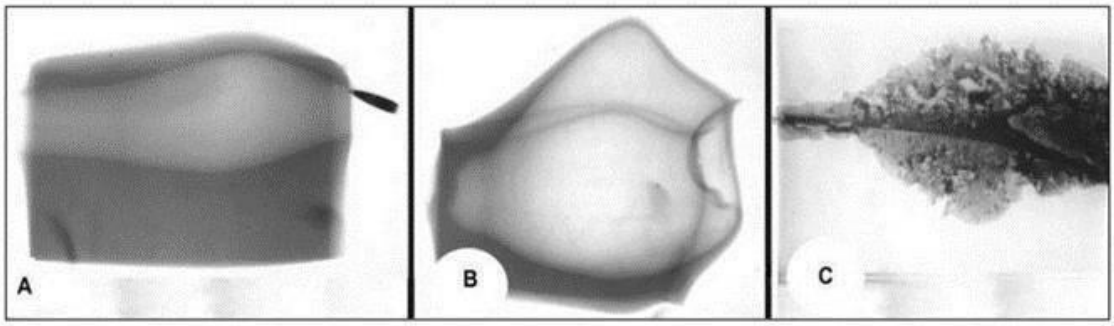

Рис. 1. Фази формування тимчасової пульсуючої порожнини за даними імпульсної рентгенографії.

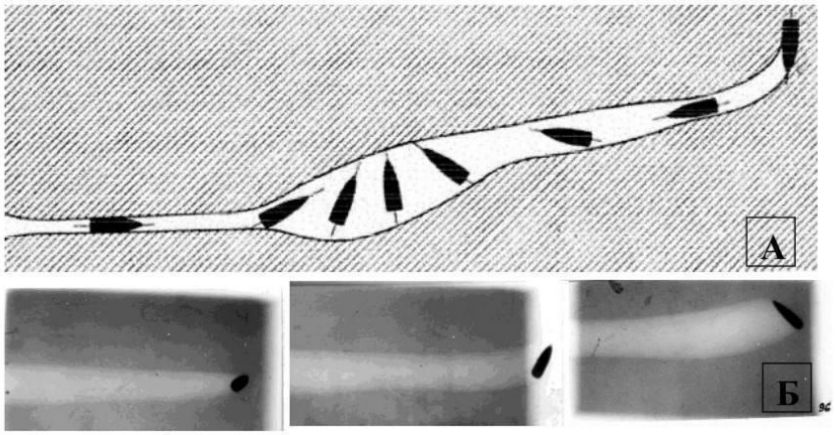

Рис. 2. Феномен „кувиркання" кулі:
А — схематичне зображення „кувиркання" кулі в рановому каналі;
Б — феномен „кувиркання" кулі за даними імпульсної рентгенографії.

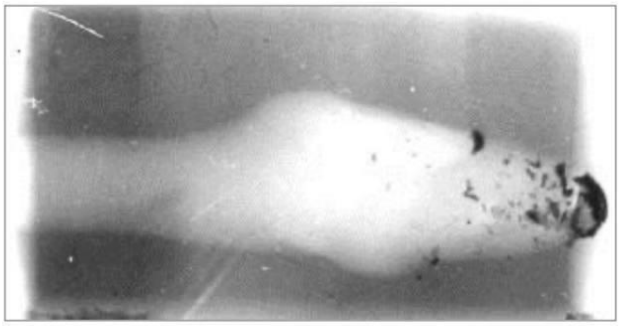

Рис. 3. Момент фрагментації ранячого снаряду за даними імпульсної рентгенографії.

Design features and ballistic properties of modern wound shells.

1) The phenomenon of "tumbling" of a bullet — axial displacements of bullets of modern wounding projectiles when passing through living tissues significantly change both the shape and direction of the wound channel.

2) Fragmentation of the wounding projectile — significantly changes the shape of the temporary pulsating cavity and the shape of the wound canal, creates a large number of small fragments.

Morphology of a gunshot wound.

1) primary wound channel — is formed under the action of the main shock wave and the direct impact of the projectile;

2) zone of primary necrosis (contusion)— occurs under the influence of all factors of formation of a gunshot wound: main shock wave, side shock wave, direct impact of a projectile, vortex wake;

3) zone of secondary necrosis (shock) — formed under the action of a lateral shock wave.

Currently, the theory of direct and side impact is generally accepted. The action of a direct impact is carried out on the tissues in the area where the wounding projectile comes into direct contact with them. The force of the side impact acts on tissues outside the wound canal. Using modern registration equipment (impulse photography, high-speed cinematography, tensometry, etc.), it was possible to decipher the mechanism of direct and side impact. It was established that an air flow in the form of a wedge is formed around the bullet. The direction of this flow parallel and radial to the bullet's trajectory.

The compressed air that goes ahead of the bullet - the main shock wave - is one of the factors that damage tissues. It is followed by the bullet itself, which mainly deals mechanical damage and depending on the energy it possesses, causes different damage. A bullet with a high kinetic energy has a piercing effect when the skin is damaged, that is, it creates a hole devoid of skin. When hit by a bullet with an unstable flight trajectory, it tumbles in the tissues. This gives rise to two main features. Firstly, the movement of the bullet is not linear, and secondly, more massive tissue damage occurs. The direct action of the projectile causes ruptures, splitting, crushing of tissues. The degree of destruction of tissues depends on their structure, as well as the speed, caliber and shape of the projectile.

The flow of air moving radially along the bullet's flight path forms a temporary pulsating cavity, which can exceed the diameter of the projectile by 30-50 times.

Having reached the maximum size, it begins to fall, its "collapse" occurs. The time of existence of the temporary pulsating cavity significantly exceeds the time of passage of the bullet in the tissues. Differences in positive and negative pressure in it reaches 50 atm. This contributes to widespread tissue damage, entry of microbes and foreign bodies to a considerable distance from the wound canal. The formation of a pulsating cavity is associated with the main characteristics of a gunshot wound, especially the severity of damage to organs and tissues far beyond the wound canal. This is due to the fact that the temporary pulsating cavity occurs mainly due to the force of the side impact of the energy of the bullet directed away from the wound canal.

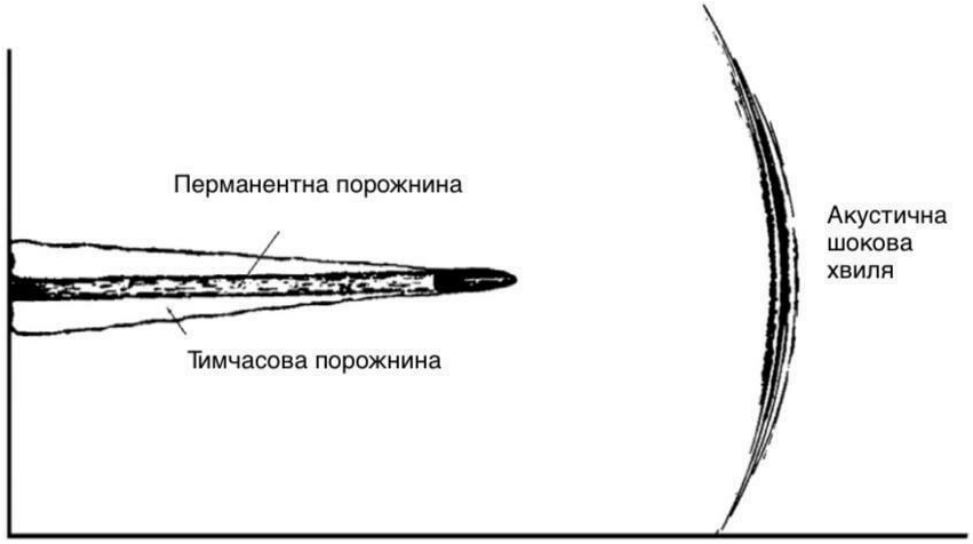

Рис. 1-2. Зображення взаємодії куля-тканина, на якому продемонстровано компоненти пошкодження тканини

The dimensions of the temporarily pulsating cavity significantly exceed the caliber of the wounding projectile, and the duration of its existence is 500 times longer than the time of passage of the projectile through the wounded object. The width of tissue damage around the circumference of the wound canal is directly dependent on the size of the temporary cavity and the duration of its existence. In turn, the parameters of the temporary pulsating cavity depend on the ballistic characteristics of the wounding projectile (flight speed, kinetic energy before wounding, the share of energy absorbed by the tissues during the passage of the projectile, the distribution of

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energy in the tissues along the direction of the projectile and away from the wound canal). The greater the kinetic energy of the bullet, the more pronounced the pulsation of the temporary cavity and the longer its existence. It is these factors that explain the extensive tissue damage along the wound canal and the formation of intra-tissue hematomas, damage to blood vessels, nerves, and even bones far from the wound canal. The dimensions of the temporary cavity and the extent of tissue damage also depend on the anatomical and physiological characteristics of the tissues and organs through which the bullet or fragment passes. So, for example, when the projectile passes through the brain, which has a soft consistency, in the process of forming a temporary pulsating cavity, it shifts away from the wound canal. This is prevented by the bones of the vault and the base of the skull, which causes hemorrhages in the tissue of the brain and its ventricles at a considerable distance from the wound canal. Thus, the severity of injury to the skull and brain depends not only on the direct damage to the brain tissue by the projectile, but also on the general deformation of the brain in the process of forming a temporary pulsating cavity. When the projectile passes through the lungs, a small temporary cavity appears, and hence the damage is small compared to other organs and tissues. This is due to the lightness of the lung tissue and the presence of a large number of elastic fibers in it. When the projectile passes through the hollow organs of the abdomen, which are filled with liquid contents or gas, the pulsation of the temporary cavity leads to significant ruptures of the walls in the direction of the periphery from the wound canal. Such damage occurs as a result of the transfer of projectile energy to the walls of organs through their contents. This explains the small size of the necrosis zone (up to 0.2-0.3 cm) in the area of large breaks in the walls of organs, which must be taken into account during surgical treatment of gunshot wounds of the abdomen.

When parenchymal organs are damaged, the energy of the projectile is transferred directly to the tissue. Here, there is no intermediate link in the form of liquid or gas on the way to the emergence of a temporary pulsating cavity, which is why the destruction of these organs with the separation of cracks in different directions is

observed. The degree of damage to parenchymal organs depends on the ballistic properties of the injuring projectiles.

At a high speed of flight of projectiles, strong shock waves can occur. These waves do not cause severe mechanical damage, but affect intracellular processes that lead to the destruction of cellular structures. Under the influence of shock waves, changes in blood coagulation and protein coagulation occur.

A bullet with high kinetic energy, hitting a hollow organ with liquid contents or a blood-filled parenchymal organ, will cause a hydrodynamic effect, and after hitting a bone, it will destroy it, showing a crushing effect. The bullet, which has little energy before contact with the body, will be able to exert only a wedge-shaped effect, which will be manifested by the displacement of tissues or their slaughter, the consequences of which may be limited hemorrhages, hematomas, or superficial closed wounds. Fragments of an exploded fire projectile also have a mainly mechanical effect, the consequences of which will be directly related to their kinetic energy.

The properties of the bullet that affect the nature of the wound are its mass, caliber, shape, and design features. These bullet characteristics are interrelated. That is why it is customary to consider the impressive properties of the bullet in relation to its individual constructive types. Bullets with greater mass, length and caliber have the greatest stability in flight and when hitting a biological target. Blunt-ended bullets quickly transfer energy to tissues and lead to the so-called stopping effect. Sharp elongated shell bullets often give tissues only 1/10 of their kinetic energy. The most significant damage occurs during the formation of a supersonic flow in tissues during energy transfer.

Sharp bullets form such a flow at a speed of interaction with the target of about 1300 m/s, bullets with a rounded main part - at 800 m/s.

Soft bullets without a shell have high plasticity and when they come into contact with soft biological tissues, they spend part of their energy on their own deformation, thereby increasing the impact time and impact power.

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The size of the entrance and exit holes of the wound channel can determine the type of projectile:

1) for wounds with rapid-fire small-caliber bullets - the exit hole is larger than the entrance one.

2) in case of wounds with arrow-shaped bullets, the entrance hole corresponds to the size of the exit hole;

3) in case of wounds with fragments and rubber balls, the entrance wound is larger than the exit wound.

Характеристика ранячого снаряду	Морфологічні особливості рани
Швидкість кулі 100-200 м/с (гумові кулі)	Сліпі поранення з діаметром вхідного отвору до 10 мм (рис. 6)
Швидкість кулі 300-400 м/с (пістолетні кулі)	Діаметр вихідного отвору в 2 рази перевищує діаметр вхідного отвору
Швидкість кулі 650 м/с (калібр кулі 7,62 мм)	Діаметр вихідного отвору в 3-4 рази перевищує діаметр вхідного отвору
Швидкість кулі 750-1000 м/с (калібр кулі 5,45 мм)	Діаметр вихідного отвору в 8-12 разів перевищує діаметр вхідного отвору
Швидкість кулі 1100-1500 м/с	Діаметр вихідного отвору в 6-8 разів перевищує діаметр вхідного отвору
Швидкість кулі 3000-8000 м/с	Діаметр вихідного отвору в 8-10 разів перевищує діаметр вхідного отвору

The main ballistic parameters that affect the volume of damage:

1) mass of the hitting projectile:

2) the speed of the projectile;

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3) shape of the projectile; 4) design features of the projectile.

The main myths about gunshot wounds:

Непорозуміння	Реальність
Швидкість кулі є найважливішою детермінантою пошкодження тканини.	Швидкість кулі є лише одним із чинників, які треба брати до уваги при пораненні. Зростання швидкості кулі не збільшує об'єм пошкодженої тканини. Пошкоджені тканини, які оточують перші 12 см ранового каналу, створеного кулею від гвинтівки М-16 А1, характеризуються порівняно невеликою кількістю розривів м'яких тканин, подібно до ранового каналу від кулі, яка випущена з гвинтівки калібру 0,22 і має майже удвічі меншу швидкість.
Під час свого польоту кулі відхиляються від курсу, внаслідок чого можуть виникати рани неправильної форми.	Крім тих випадків, коли куля вдаряється у проміжну перепону, величина відхиляння кулі в польоті є незначною.
Вихідні рани є завжди більшими, ніж вхідні рани.	Це неправильно і ця теза не має жодного впливу на хірургічну тактику при пораненні.
Кулі з цільнометалевою оболонкою не фрагментуються, за винятком незвичних обставин.	Куля М-193 від гвинтівки М-16 А1 практично завжди фрагментується на рівні жолобка після того, як вона пройшла приблизно 12 см лише м'яких тканин.
Усі кульові канали мають повністю висікатися внаслідок ефектів тимчасової порожнини.	Усі рани мають промиватись із необхідною хірургічною обробкою, яка полягає у видаленні чужорідних матеріалів і лише некротичної тканини. Рани часто потребують повторного дослідження в динаміці та повторної хірургічної обробки внаслідок того, що в них залишилися нежиттєздатні тканини.

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Tactical, technical and ballistic characteristics of service firearms.

Name of the weapon	TTH
Fort-17 pistol 	**Caliber: 9mm** **Weight without ammunition: 0.68 kg** **Length: 179 mm** **Barrel length: 97 mm** **Magazine capacity: 15 rounds** **Initial speed of the bullet: 320 m/s**
AK-74 	**Caliber: 5.45mm** **Weight without ammunition: 3.07 kg** **Length: 940 mm** **Barrel length: 415 mm** **Magazine capacity: 30 rounds** **Initial bullet velocity: 910 m/s**
MP-5 submachine gun 	**Caliber: 9mm** **Weight without ammo: 2.7 kg** **Length:** **680 mm** **Barrel length: 225 mm** **Magazine capacity: 15/30 rounds** **Initial bullet velocity: 400 m/s**

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Makarov pistol 	**Caliber: 9mm** **Weight without ammunition: 0.73 kg** **Length: 161 mm** **Barrel length: 93 mm** **Magazine capacity: 8 rounds** **Initial speed of the bullet: 315 m/s**

Тактико-технічні та балістичні характеристики спеціальних видів вогнепального озброєння.

Назва зброї	**ТТХ**
 **Штурмова гвинтівка «Форт-224»**	**Калібр: 5.45 мм** **Вага без набоїв: 3.9 кг** **Довжина:** **645 мм** **Довжина ствола: 380 мм** **Місткість магазину: 30 наб** **Початкова швидкість кулі:** **600910 м/с**
Снайперська гвинтівка Sig-Sauer SSG 3000 	**Калібр: 7.62 мм** **Вага без набоїв: 5.44 кг** **Довжина: 1180 мм** **Довжина ствола: 600 мм**

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	Місткість магазину: 5 наб **Початкова швидкість кулі:** **800830 м/с**
РПК-74 	**Калібр: 5.45 мм** **Вага без набоїв: 5.0 кг** **Довжина: 1060 мм** **Довжина ствола: 590 мм** **Місткість магазину: 45 набоїв Початкова швидкість кулі: 960 м/с**
Спеціальний пістолет підводний **СПП-1** 	**Калібр: 4.5 мм** **Вага без набоїв: 0.95 кг** **Довжина: 244 мм** **Довжина ствола: 195 мм** **Місткість магазину: 16 набоїв** **Початкова швидкість кулі: 250 м/с**

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Types of mine-blast injuries:

Категорія	Характеристики	Частина тіла	Типи поранень
Первинні	Унікальні для вибухових середників високого порядку; виникають унаслідок удару, спричиненого вибуховою хвилею	Найбільш вразливими є наповнені газом структури: легені, ШКТ, середнє вухо	Травмована вибухом легеня (легенева баротравма) (нечасто) Розрив барабанної перетинки і пошкодження середнього вуха (розповсюджені) Перфорація абдомінальних порожнистих органів і кровотеча (рідко) Розрив очного яблука (рідко)
Вторинні	Виникають унаслідок розлітання різноманітних уламків, фрагментів оболонки снаряда і його вмісту	Будь-яка частина тіла	Проникні поранення фрагментами чи тупі травми Проникне поранення ока (може бути прихованим)
Третинні	Виникають, коли тіло постраждалого відкидається вибуховою хвилею	Будь-яка частина тіла	Перелом і травматична ампутація Закрите і відкрите пошкодження мозку
Четвертинні	Усі пов'язані з вибухом поранення, патологічні процеси чи захворювання, які не є наслідком первинного, вторинного чи третинного механізмів; включають загострення чи ускладнення існуючих станів	Будь-яка частина тіла	Опіки (поверхневий, не на всю товщину і на всю товщину шкіри) Краш-синдром (обвал будинку) Астма, ХОЗЛ чи інші проблеми з боку органів дихання, які були спричинені пилом, димом чи токсичними випарами Стенокардія Гіперглікемія, гіпертензія

ХОЗЛ: хронічне обструктивне захворювання легень; ШКТ: шлунково-кишковий тракт.

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Stages of the wound process:

1) inflammation:

- inflammation phase;

- period of wound cleansing from necrotic tissues:

1) - primary cleansing - occurs due to traumatic edema, which contributes to the displacement of wound detritus, clots, foreign bodies; - secondary cleansing - occurs due to suppuration of the wound;

2) regeneration; 3) scar reorganization and epithelization.

Zones of circulatory disorders:

- Zone of total stop of microcirculation with the development of primary tissue necrosis.
- Zone of subtotal stop 75% with further stop of blood circulation with the formation of secondary tissue necrosis on the 3rd day
- Zone of focal changes with a decrease in blood circulation by 55% with subsequent recovery on the 14th day, and in case of complicated course - the formation of areas of secondary necrosis.
- Zone of functional disorders with 23% decrease in blood flow with subsequent normalization of blood circulation on the 7th day

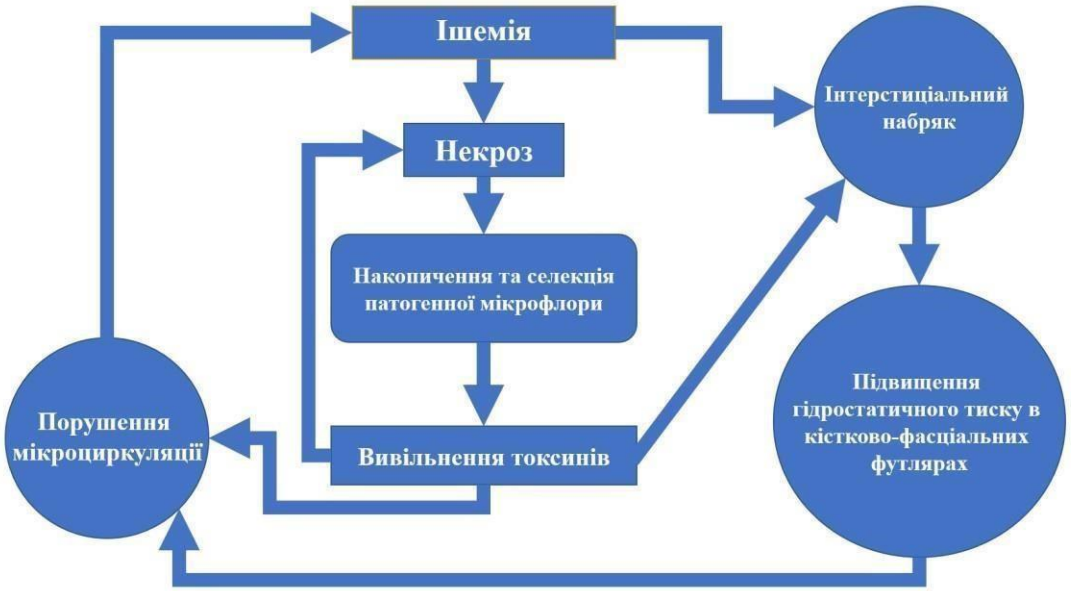
Areas of microcirculation disorders in the wound channel.

- zone of total microcirculation disorder - gives rise to the zone of primary necrosis;

2) zone of subtotal microcirculation disorder - turns into a zone of secondary necrosis on the 3rd day;

3) zone of focal microcirculation disorders - in case of uncomplicated course of wound process restores its function in 14 days; in case of complicated course of wound process it turns into the area of secondary necrosis;

4) zone of functional microcirculation disorders - is restored on the 7th day.



Morphological and functional changes.

Pathomorphological characterization of mine-blast injuries is especially important in case of limb severance. The polymorphism of injuries is determined not only by the variety of explosive devices, but also by different variants of the location of the victims' body in relation to the device at the time of the explosion.

All injuries in the affected limb during an explosion are conditionally divided into four zones, which differ in qualitative structural characteristics:

The first zone is the zone of limb segment detachment.

The second zone is the zone of tissue contusion of the preserved part of the affected segment.

The third zone is the zone of tissue contusion of the adjacent limb segment.

The fourth zone is the zone of general vibration damage (by analogy with molecular concussion).

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Changes in the first zone are reduced to the separation or complete destruction of the anatomical structures of the limb by the traction mechanism, which is combined with bruising and crushing of tissues. Due to the different mechanical strength of tissues, their damage occurs at different levels. Skin, bones, tendons, major vessels and nerves are destroyed much less - tissues are preserved more distally. Fatty tissue, muscles, connective tissue - is destroyed much more - tissues are viable at a distance - proximally. Ascending pneumatization of subcutaneous adipose tissue and loose connective tissue structures is also characteristic. There is significant contamination of the wound surface and deep impregnation of tissues with explosion products. The main role in the genesis of tissue damage is played by shock waves and ultra-high pressure of jets of hot explosive gases. The morphological changes in the second zone are based on multiple focal micro ruptures of muscles and walls of large and small vessels, resulting in the emergence of drainage and local hemorrhages.

The third zone is characterized by distinct microcirculatory disorders, mainly in small arteries and veins, reactive changes in the axons of peripheral nerves, especially within the fiber of the main vascular nerve bundle. When the body is exposed to the damaging factors of mine-blast trauma, primary injuries of internal organs (the fourth zone) occur: bruises, concussions, lacerations, which are observed in 96.4% of victims.

Gunshot wounds of the facial area are characterized by the fact that they are almost always accompanied by significant swelling, hemorrhage and bleeding, and have a tendency to suppuration.

Анатомічна локалізація	Частота	Відсоток
Множинне ушкодження	761	49,7
Нижня кінцівка	248	16,2
Верхня кінцівка	223	14,6
Голова/обличчя	174	11,4
Грудна клітка/спина	48	3,1
Шия	20	1,3
Немає	20	1,3
Черевна порожнина	16	1,0
Невідомо	9	0,6
Сідниці	6	0,4
Не застосовується	3	0,2
Геніталії	1	0,1
М'які тканини	1	0,1
РАЗОМ	**1530**	**100**

Factors contributing to the development of infection.

The gunshot wound is primarily microbially contaminated, not primarily infected.

Factors contributing to the development of infection:

1) closed cavities --- no air penetration --- development of anaerobes;

2) necrotic tissue --- a breeding ground for microorganisms;

3) wound channel surrounded by tissues with altered reactivity; 4) massive blood loss, protein and electrolyte imbalance, vitamin deficiency, immunodeficiency; Theory of gunpowder poisoning.

It was assumed that in gunshot wounds, along with the wounding projectile, gunpowder particles are introduced into the wound, which "poison" the tissues in the wound channel. The doctrine of the gunshot wound, set out in the book of I. Braunschweig (1497), is imbued with the belief that all gunshot wounds are "poisoned" by gunpowder, and accordingly, the author recommended peculiar methods of treatment: "If anyone is wounded with a gun, and the wound is poisoned with gunpowder, then take a rope of hair and push it through the hole shot, and pull it back and forth in all directions, and

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then you will achieve the exit of gunpowder from the wound; then the wound will fester." Fear of contamination of wounds with gunpowder forced surgeons to fight against this contamination, for which they burned wounds with hot iron or poured them with boiling oil.

The fallacy of this theory was proved by the French surgeon A. Paré in the XVI century, who formulated the requirement that "the surgeon should immediately expand the wound, if only the area of its spread allows it". He proved that the peculiarities of gunshot wounds depend not on gunpowder poisoning, but on tissue crushing.

Burn theory.

It explains the peculiarities of the course of a gunshot wound by the fact that the bullet, when passing through tissues, as a result of the conversion of mechanical energy into thermal energy, heats up and causes tissue burns. Subsequently, many authors in the experiment proved that the temperature of the bullet when passing through the tissue increases very slightly and can not cause burns of the tissues surrounding the wound channel.

The theory of hydraulic action.

The founder of it was Bush, but in its final form it was formulated by Kocher, Reger and Bruns. According to this theory, when a wounding projectile penetrates into tissues, conditions arise in them as in a hydraulic press, where a moving piston creates pressure in the liquid, and this pressure is transmitted to the walls of the cylinder according to Pascal's law, in all directions with equal force. The supporters of this theory explained by the hydraulic effect extremely large destruction of internal organs in cavity wounds. In convincing experiments, E.V. Pavlov, V.A. Thiele showed the failure of this theory and proved that the destruction of tissues as the projectile advances becomes more and more extensive, while according to the laws of hydraulic theory it should spread evenly.

Structure of a gunshot wound.

Within the wound channel there are three zones:

The first zone - the wound channel itself may contain a bullet. Foreign objects. pieces (flaps) of necrotic tissues, blood clots, bacteria); The second zone is the zone of direct traumatic injury (occurs under the influence of kinetic energy transferred from the bullet to the tissues. contains non-viable tissues soaked in blood);

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The third zone is the zone of molecular concussion (the area with damaged cellular structures and tissue metabolism, which necroticizes with decreased perfusion and oxygenation of tissues);

The fourth zone is the zone of distal vibration shocks.

The presence of the first two zones is present in each wound, including gunshot wounds, and determines rather its quantitative differences from other wounds. The last two zones are present only in the gunshot wound and arise as a result of lateral action of the wounding

projectile in the process of creating a temporary pulsating cavity. The "zone of molecular shock" includes almost the entire body of the wounded and

is determined not only by the "molecular concussion", but also by the vibration effect on the body tissues.

Primary wound channel.

Depends on the properties of the projectile itself: speed, mass, caliber, energy, bullet design. Heavy bullets of large caliber form a deep wound channel with a large energy transfer along its entire length, so they are preferable for hunting. Light and low velocity bullets usually act as an awl (narrow straight channel), can pierce the body overhang, or stop in it without causing significant damage. High speed bullets (5.56x45) can literally explode inside the body forming a pile of fragments and wound channels, and the hydrodynamic impact will significantly expand the wound channel area. It also depends on the structure of organs and tissues. The most difficult to determine the wound channel in muscles, fatty tissue, as they are abundantly saturated with blood. In parenchymal organs, the wound channel increases sharply, ruptures may occur, up to the destruction of the organ. In hollow organs, when a bullet passes through, point entry and significant exit holes are formed. In flat bones, perforated fractures are formed and the wound channel may look like a crater or a truncated cone expanding in the direction of the bullet's flight. In tubular bones fragmentary or fragment-hole fractures are formed.

Contusion zone.

The contusion zone (zone of direct traumatic, primary necrosis) occurs in the area of contact of the projectile with tissues. This zone includes tissues located in the immediate vicinity of the wound canal and subject to necrosis at the time of injury or the next few hours after it as a result of physical impact on the tissues of the wounding projectile. The depth of tissue necrosis in the walls of the primary wound channel is different in its different parts, in different organs and tissues. The size of the primary necrosis zone

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depends on the ballistic characteristics of the projectile, structural and functional features of tissues, in particular on their ability to tolerate traumatic injuries and hypoxic conditions. The connective tissue stroma is the best preserved in the contusion zone, which sometimes remains with the complete death of other surrounding tissues, which is especially evident in the walls of wound channels in the tissue and muscles. The more energy transferred

tissues by a wounding projectile, the larger the area of the contusion zone and primary necrotic tissue.

Visually, the contusion zone is a relatively thin layer of dark red tissue of soft consistency without capillary bleeding (if it is muscle tissue, then there is no contraction of muscle fibers when cut or pinched). It is important to keep in mind that the configuration of the primary necrosis zone can be different, which makes it very difficult to carry out exhaustive primary surgical treatment of wounds.

Zone of concussion.

The zone of concussion (molecular concussion, secondary necrosis) is a zone of lateral impact, directly adjacent to the tissues that have completely lost their viability at the time of injury or in the hours immediately after it. In the mechanism of formation of this zone, the main role is played by the formation of a temporary pulsating cavity of the wound channel and the propagation of shock waves, especially pressure waves. In the concussion zone, tissues are exposed to indirect impact of the projectile. Tissues located near the contusion zone, the inner layer of the concussion zone, are subjected to massive shock, which causes their sharp displacement as a result of the formation of a temporary pulsating cavity. In tissues located at a greater distance from the axis of the gunshot canal, i.e. in the outer layer of the concussion zone (the zone of "molecular concussion", according to N.I. Pirogov), the concussion is less pronounced. The amount of tissue damage in the concussion zone (commotion zone) varies widely and depends on the tissue structure. Thus, in organs characterized by a small compression ratio (brain, liver, spleen, bone), the effects of rupture or splitting into parts usually prevail. In tissues containing a large amount of collagen and elastic fibers, the damage is less significant. It should be noted that the inner layer of the commissure zone is characterized by very low cell viability due to profound metabolic disorders mainly at the molecular level. Initially, changes in the outer layer

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of the commissure zone are mainly functional in nature (disorders of blood circulation and tissue nutrition of varying severity). Microcirculatory disorders and the accompanying phenomena of pronounced edema, lymphostasis contribute to the development of acidosis and hypoxia, which has a harmful effect on the tissues in this area. A vicious circle arises: swelling of the muscles in the fascial cases leads to their compression, further deterioration of blood supply and edema growth.

Thus, dystrophic and necrobiotic processes can progress in the commissure zone against the background of increased microcirculation disorders, contributing to the development of secondary necrosis, which occurs in the commissure zone at a considerable distance from the primary wound channel. With a favorable course of the wound process, due to the appropriate adequate local effect on the wound and the general treatment of the wounded, the reverse development of structural and functional changes in the outer layer of the commissure zone can occur, resulting in a significant reduction in the amount of secondary tissue necrosis. Phases of the wound process.

In the course of the wound process, destructive processes are replaced by reparative ones. It can be represented in the form of several phases that successively replace each other.

Classical is the proposal of I.G. Rufanov to distinguish two phases: - 1. hydration (swelling and clearing of the wound from dead tissue);

- 2. dehydration (reparation and granulation).

But most authors distinguish three phases.

Автори	I фаза	II фаза	III фаза

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Б.М. Даценко, 1985	гнійнонекротична	грануляцій	епітелізація
М.І. Кузін і Б.М. Костюченок, 1980	запалення	регенерація (проліферація)	реорганізація рубці

Characteristics of gunshot wounds.

1) 1) By type of wounding projectile:

2) - bullet; - fragmentation:

3) - standard fragmentation elements; - irregularly shaped fragments;

4) - non-table projectiles:

5) - ball;

6) - arrow-shaped;

7) - secondary projectiles (stone, glass, ice, brick, etc.);

8) - mine-explosive.

9) 2) By the nature of the wound channel:

10)- blind:

11)- incomplete - the arrow-shaped element penetrates into the cavity to the stabilizer;

12)- complete - completely;

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13)- through;

14)- tangential - the wound channel does not have one of the walls;

15)- ricochet:

16)- external ricochet; - internal ricochet.

17)3) By the volume of the lesion: o isolated - one anatomical area:

18)- head; - neck;

19)- spine;

20)- chest;

21)- abdomen;

22)- pelvis;

23)- limbs; o combined - two or more anatomical areas with one projectile; o combined - the effect of a projectile combined with mechanical, thermal, radiation or chemical damage.

24)4) By the number of projectiles:

25)- single injuries - one projectile; - multiple injuries - two or more

26)projectiles.

27)5) By penetration into body cavities:

28)- penetrating;

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29)- non-penetrating.

30)6) By the nature of damage:

31)- only soft tissues;

32)- internal organs;

33)- vessels;

34)- nerves;

35)- bones; - nerve plexuses.

36)7) By burdensome consequences:

37)- massive bleeding (including damage to large vessels);

38)- acute regional tissue ischemia;

39)- damage to vital organs, anatomical structures;

40)- damage to bones and joints;

41)- traumatic shock.

42)2) By the clinical course of the wound process:

43)- complicated;

44)- uncomplicated

45)

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46)Complications of gunshot wounds:

47)-massive bleeding (including damage to large vessels);

48)-acute regional tissue ischemia;

49)-damage to vital organs, anatomical structures; - damage to bones and joints; - traumatic shock.

Рис. 4.6. Схема патогенезу травматичного шоку

General principles of wound infection prevention.

General principles of wound infection prevention.

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At the stages of medical evacuation, wound infection prevention includes the following measures.

When providing first aid: 1) correctly apply the primary aseptic dressing; 2) perform transport immobilization; 3) give tablet antibiotics.

Pre-hospital care includes: 1) correcting dressings; 2) improving transport immobilization; 3) giving antibiotics (oral or parenteral).

First medical aid includes: 1) administration of large doses of antibiotics; 2) improvement of aseptic dressings; 3) transport immobilization with service equipment; 4) administration of tetanus toxoid; 5) novocaine blockade; 6) anti-shock measures.

When providing qualified surgical care, it is necessary to perform: 1) early and radical debridement of the wound; 2) adequate antibiotic therapy and timely correction of blood loss.

Desmurgy. Individual dressing package. Bleeding.

Hemotransfusion. Asepsis and antisepsis.

Desmurgia

A dressing is a dressing material applied and fixed on a particular part of the body.

The dressing consists of two parts:

a) primary dressing applied directly to the wound (it must be sterile);

b) secondary dressing, with which the primary dressing is fixed. B) Dressing change - a successive change of the dressing with the treatment of the skin around the wound and manipulation of the wound.

Classification of dressings

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A) By purpose, dressings are divided into:

- fixing, which hold the dressing materials on the wound or any part of the body;

- immobilizing (which provide immobility of a particular part of the body); - dressings with traction; - compression dressings. B) By appearance and shape of the material:

- bandage;

- kerchief;

- sling-like;

- contour;

- T-shaped;

- orthopedic.

B) By the method of fixing the dressing material: - adhesive plasters;

- bandage.

D) By consistency:

- soft;

- hard (tires, plaster, plastic, etc.).

Covering (protective, aseptic) dressings are used to prevent re-infection of wounds, stop capillary bleeding and protect against adverse environmental influences. Before bandaging, disinfected (sterile) napkins are applied to the wound, and a layer of white cotton wool is placed on top. In such cases, elevation of the injured limb and a properly applied bandage can stop capillary bleeding.

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The covering dressing can be additionally protected with a plastic film or oilcloth impermeable to liquids. This type includes dressings using adhesive plasters, antimicrobial (bactericidal) plasters that disinfect the wound surface.

An occlusive dressing, which hermetically closes a penetrating chest wound complicated by pneumothorax, from air intake, is also protective. For the same purpose, you can use a piece of plastic film glued with strips of adhesive tape on three or four sides.

In a medicated bandage, which is applied to a wound or other pathological focus, a medicinal substance is used in the form of a solution, powder, ointment or gel. It is moistened or applied to a gauze napkin, directly applied to the wound surface; the napkin is covered with an aseptic dressing on top.

Compression (hemostatic) bandages are applied in case of vein injuries that cause quite severe bleeding. Pressure at the site of the vein injury is created by an additional cotton gauze roller, which is placed between the layers of the bandage. In addition, it is advisable to lift the injured limb and put a bubble (bottle) with ice or cold water over the bandage.

For transportation / transfer of a victim with limb fractures, transport immobilization is carried out.

To treat bone fractures, plaster casts are used to immobilize the limbs.

Bandages for support and immobilization of the shoulder and forearm

Supportive bandages, the most common of which is the ovoid bandage, are used for nose injuries, fractures of the lower jaw or lacerations of the back of the head. For the same

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purpose, bandages are applied in the case of clavicle fractures to spread the upper arm with a medical scarf and fractures of the bones of the shoulder or forearm if the means shown in the photo are available.

Individual dressing package (abbreviation IPP) is a means of providing first aid for wounds and burns.

In a combat situation, PPI is on the equipment of every serviceman. In wartime and peacetime, a stock of first aid kits should be kept in sanitary bags, at posts and medical aid stations. The contents of the PPI are sterile, consisting of a bandage (10 cm × 5 m) and two cotton gauze compresses-pads, one 18 cm × 16 cm in size, which is sewn to the bandage near its free end, the other can be moved along the bandage, has dimensions of 16 cm × 16 cm. The bandage is compactly folded and wrapped in parchment paper, in the fold of which a safety pin is placed on the outside. The bundle is enclosed in an outer shell with

In Ukraine, there are PPI of own production. The simplest of them is packed in paper packaging, with a thread for quick opening. In the middle is a gauze bandage of the size to which a cotton pillow is sewn. There are also options with two pillows, both of which are fixedly sewn. There are also modern Ukrainian developments that are available on

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the market, such as the IPPK (Individual Hemostatic Dressing Package), which has a pressure applicator like the "Israeli" bandage.

Bleeding

Bleeding (haemorrhagia) is the leakage of blood from blood vessels into the external environment, hollow organ or body cavity as a result of damage to the vessel wall or impaired permeability.

Classification of bleeding:

A) By the nature of bleeding:

a) arterial bleeding:

- leakage of blood under pressure with a pulsating or flowing jet of bright red color;

- the pulsation of the jet is synchronous with the pulse, clamping the vessel proximal to the site of injury stops the bleeding;

- arterial bleeding is characterized by a high rate of blood loss, which depends on the diameter of the damaged vessel. b) venous bleeding:

- constant leakage of blood of dark cherry color;

- when bleeding from the large veins of the upper half of the body, blood may flow intermittently, but synchronously with respiratory movements, not with the pulse;

- compression of the vessel proximal to the site of injury increases bleeding.

c) capillary bleeding:

- bleeding of mixed nature (from small venules, arterioles and capillaries) with uniform outflow of blood from the entire wound surface by the type of "dew drops". d) parenchymal bleeding:

- bleeding from parenchymal organs (liver, spleen, kidneys);

- the blood vessels of these organs are intimately connected with the parenchyma and therefore bleeding is profuse, prolonged, and stops with great effort. B) Regarding the external environment:

a) external bleeding - leakage of blood from the wound into the external environment;

b) internal bleeding - leakage of blood into the lumen of hollow organs, tissue or body cavity.

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- Overt bleeding: after some time is accompanied by leakage of changed or unchanged blood through natural openings to the outside (vomiting blood or

vomiting of blood or "coffee grounds" type contents, stool, macrohematuria).

- Hidden bleeding: visually undetectable: leakage of blood into the pleural cavity - hemothorax, into the abdominal cavity - hemoperitoneum, into the pericardial cavity - hemopericardium, into the joint cavity - hemarthrosis; leakage of small amounts of blood into the gastrointestinal and urinary tracts, which are detected by laboratory methods of research. C) By the time of occurrence:

- primary bleeding - occurs immediately or in the first hours after

trauma;

- secondary bleeding - manifests itself up to 4-5 hours (early) or after 4-5 hours (late) from the moment of injury (their main causes are slipping of the ligature applied during the primary treatment of the wound, or washing out of the thrombus from the vessel with an increase in systemic blood pressure as a result of treatment). D) By clinical course:

a) acute bleeding:

- sudden leakage of blood in a short period of time (the cause is often traumatic injuries; a simultaneous loss of about 40% of the OCC is incompatible with life).

b) chronic bleeding:

- gradual constant or periodic leakage of blood in small portions over a period of time (peptic ulcer disease, malignant tumors, hemorrhoids

etc.);

- without a real threat to life, a more significant volume of blood is lost than in acute blood loss.

E) By the severity of blood loss (severity depends on the nature of the bleeding, the diameter of the bleeding vessel, the rate of blood loss). The American Association of Surgeons (P. L. Marino 1998) distinguishes 4 degrees of severity of blood loss:

- small volume blood loss - deficiency of OCC

0.5-10 % (up to 500 ml);

- blood loss of medium volume - deficit

OCC 11-20 % (500-1000 ml);

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$$\text{Шоковий індекс} = \frac{\text{ЧСС}}{\text{АТ с,}}$$

Де ЧСС - частота серцевих скорочень
АТ с – систолічний артеріальний тиск

• - large volume blood loss - BCC deficit 21-40 % (1000-2000 ml); - massive blood loss - OCC deficit 41-70 % (2000-3500 ml); Shock index

Algover's index

- Normally, the Algover index = 1.
- The value of the index can be used to draw conclusions about the amount of blood loss

Індекс Альговера	Об’єм крововтрати (у % від ОЦК)
0,8 та менше	10%
0,9-1,2	20%
1,3-1,4	30%
1,5 та більше	40%

Note: Algover index is not informative in patients with hypertension

$$КВ = ОЦК\ (н) \times (ГТ\ (н) - ГТ\ (ф)) / ГТ\ (н)$$

КВ- крововтрата
ОЦК (н) – нормальний ОЦК
ГТ (н) – гематокрит у нормі (у жінок-42)
ГТ (ф) – гематокрит фактичний, визначений після зупинки кровотечі та стабілізації гемодинаміки.

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Hematocrit method of Moore

For an approximate determination of the volume of blood loss, it is possible to use a modified Moore formula:

0.42 - Htf

SQ = M 75 -0.42

Where: BW - blood loss (ml); M - body weight (kg); Htf - actual hematocrit (l / l)

Temporary bleeding arrest:

A) Temporary stopping of arterial bleeding

a) application of a tourniquet, twist, tourniquet above the site of injury:

- indications: bleeding on the extremities;

- tourniquet application technique:

- before applying the tourniquet, the limb is elevated;

- the tourniquet is applied proximally and as close as possible to the wound site, placing a cloth under it, and clamped until the bleeding stops;

- put a note under the tourniquet indicating the date and exact time of its application (you can keep the tourniquet for 1.5-2 hours in warm weather and 1-1.5 hours in cold weather,

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in a longer case, the tourniquet is loosened every hour for 10-15 minutes, replacing it with finger pressure on the artery);

- Do not cover the tourniquet with clothing or bandages; - Victims with tourniquets are transported first;

typical places of tourniquet application:

1 - on the lower leg; 2 - on the thigh; 3 - on the forearm; 4 - on the shoulder; 5 - on the axillary artery; 6 - on the thigh in case of arterial damage in the upper third of the thigh;

- effectiveness of tourniquet application: determined by stopping bleeding, pallor of the limb and absence of pulse in the periphery (a loosely applied tourniquet only increases bleeding).

b) finger pressure of the bleeding vessel at the site of its injury or along its length:

- indications: bleeding on the head, neck, proximal parts of the limb, where tourniquet application is technically difficult (even a physically strong person is not able to press the vessel for more than 15-20 minutes). This technique is important to prepare for tourniquet application;

- - technique of finger pressing of arteries: points of finger pressing of arteries along the length (places where the arteries are as close as possible to the bone) (Table 2.1):

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Таблиця 2.1. Точки пальцьового притискання артерій

Назва артерії	Зовнішні орієнтири	Підлягаюча кістка
a. temporalis	2 см вгору і вперед від отвору зовнішнього слухового проходу	Скронева кістка
a. facialis	2 см вперед від кута нижньої щелепи	Нижня щелепа
a. carotis communis	Середина внутрішнього краю кивального м'яза	Сонний горбик поперечного відростка C_6
a. subclavia	За ключицею в середній третині	I ребро
a. axillaris	Передня межа росту волосся в пахвовій западині	Головка плечової кістки
a. brachialis	Медіальний край двоголового м'яза в середній третині	Внутрішня поверхня плечової кістки
a. femoralis	Середина пахової складки	Горизонтальна гілка лобкової кістки
a. poplitea	Вершина підколінної ямки	Задня поверхня великогомілкової кістки
Aorta abdominalis	Ділянка пупка (притискають кулаком)	Поперековий відділ хребта

в)

maximum flexion of the limb:

Indications:

- bleeding from the vessels of the thigh (maximum flexion in the hip joint);

- bleeding from the vessels of the lower leg and foot (maximum flexion in the knee joint);

bleeding from the vessels of the hand and forearm (maximum flexion in the elbow

joint);

d) applying a clamp to a bleeding vessel (more often used during

during surgery);

e) wound tamponade in case of bleeding from small arteries;

f) temporary bypass of large vessels: bleeding in case of damage

of the main large vessels (for example: femoral artery). If the surgeon does not know the technique of vascular suturing or the defect is very large and requires a shunt, the method of temporary bypass can be used. A PVC or glass tube is inserted into the damaged ends of the artery.

It is fixed with two ligatures.

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Such a temporary shunt can function for several hours. During this period, the patient must be taken to a specialized department for reconstructive surgery.

B) Temporary stopping of venous and capillary bleeding:

a) compressive dressing - an aseptic dressing is applied to the wound, and then a roller of several rolled sterile napkins and tightly bandaged; b) tamponade of the wound;

c) elevated position of the limb;

d) aseptic dressing (only in case of capillary bleeding).

Hemotransfusion

Indirect method of blood transfusion - transfusion of pre-prepared preserved components of donor blood:

- the main method of hemotransfusion, which is characterized by simplicity of execution and simple technical equipment;

makes it possible to use a sufficiently large amount of pre-prepared donor blood;

- prevents the possibility of donor infection.

Reverse method of blood transfusion (reinfusion) - blood reinfusion is a type of autohemotransfusion and is aimed at returning to the patient's vascular bed of washed red blood cells obtained from the patient's blood, which spilled into the serous cavities during injury or surgery.

A) Reinfusion is performed intraoperatively using a specially designed device "Cell Saver". Using the device, blood is collected from the cavities during surgery or trauma, filtered and washed red blood cells are returned to the patient's vascular bed. B) Indications for blood reinfusion:

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- closed chest injuries accompanied by massive internal bleeding;

- abdominal injuries with damage to parenchymal organs, blood vessels, diaphragm;

- disturbed ectopic pregnancy, ovarian apoplexy, accompanied by massive internal bleeding;

- emergency operations on extremities with massive bleeding. B)

Contraindications to blood reinfusion:

- presence of purulent or intestinal contents in the wound cavity;

- introduction into the wound cavity of drugs that cause hemolysis;

- local use of hemostatic drugs; the presence of severe hemolysis of erythrocytes, which is not eliminated by washing.

NB! Reinfusion of washed autoerythrocytes does not require compatibility testing.

Таблиця 9.1

Класи тяжкості крововтрати за системою ATLS

Показник	Клас крововтрати			
	I	II	III	IV
Величина крововтрати, мл	До 750	750–1500	1500–2000	Більше 2000
Величина втрати ОЦК, %	До 15	15–30	30–40	Більше 40
Частота пульсу, уд. за 1 хв	До 100	100–120	120–140	Більше 140
Артеріальний тиск	Нормальний	Нормальний	Зменшений	Зменшений
Пульсовий тиск, мм рт. ст.	Нормальний або зменшений	Зменшений	Зменшений	Зменшений
Частота дихання, за 1 хв	14–20	20–30	30–40	Більше 40
Діурез, мл/год	Більше 30	30–20	15–5	Анурія
Свідомість	Легка тривога	Помірна тривога	Тривога або сплутаність свідомості	Сплутаність або відсутність свідомості
Рекомендована ІТТ	Кристалоїди	Кристалоїди	Кристалоїди та кров	Кристалоїди та кров

Визначення величини крововтрати за характером і локалізацією ушкоджень

Характер і локалізація ушкоджень	Крововтрата, л	Дефіцит ОЦК, %
Відкрита травма черепа	1,0	20
Травма грудної клітки: закрита	1,0	20
відкрита	1,5	30
Травма живота: закрита	1,0–1,5	20–30
відкрита	1,5–2,0	30–40
Переломи: кісток таза стабільні	0,5–1,0	10–20
кісток таза нестабільні	2,5–3,0	50–60
стегнової кістки закриті	1,0	20
стегнової кістки відкриті	1,5	30
кісток гомілки закриті	0,5–1,0	10–20
кісток гомілки відкриті	1,0–1,5	20–30
Відриви: стегна	2,0	40
гомілки, плеча	1,5	30
передпліччя	1,0	20
Ушкодження магістральних судин	2,5–3,0	50–60

There is also a group of chemotherapeutic agents that are used to destroy pathogens in the pathological focus of the patient and are administered parenterally or enterally (nitrofurans, fluoroquinolones, sulfonamide drugs, nitroimidazole derivatives, quinoxaline, etc.) Chemotherapy and chemoprophylaxis are measures aimed at direct neutralization or suppression of pathogens in the internal environment of the macroorganism in order to treat (or prevent) infectious or parasitic diseases.

Biological antiseptics include means of :

– - action on the microorganism: antibiotics, enzymes, serums, antitoxins, gammaglobulins, hyperimmune plasma, serums, bacteriophages;

– - actions on the macroorganism: stimulators of specific immunity (vaccines, anatoxins) and nonspecific immunity - immunocorrectors and immunostimulants,

– interferons, thymaline, vitamins, pyrimidine bases

– (methyluracil).

– Mixed antisepsis involves the combined use of different methods, which is widely used in practice today.

– PXO. Indications, contraindications, types. Stages of PCO. Necrectomy. Features

– PCO for different organs. Treatment of purulent infection of gunshot wounds.

Principles of treatment of mine-blast injuries at the stages of medical evacuation.

– Primary surgical debridement (PSD) is the first surgical intervention performed according to the primary indications (for the wound) in order to remove non-viable tissues, prevent complications and create conditions for wound healing. Indications for PCO of gunshot wounds:

– 1) penetrating gunshot wounds of the skull, chest, abdomen, large joints, eyeball;

– 2) ongoing bleeding from the wound;

– 3) gunshot injuries of long tubular bones, large trunk vessels and nerve trunks;

– 4) wounds contaminated with poisonous, radioactive substances and soil; 5) wounds with massive soft tissue damage.

Contraindications to CWA of gunshot wounds:

– 1) tangential, "dotted", through and blind wounds of soft tissues with small diameter of entrance and exit holes;

– 2) wounds without damage to large vessels and nerves;

– 3) wounds that do not penetrate into body cavities;

– 4) wounds not accompanied by gunshot bone fractures (except for so-called perforated fractures);

– 5) wounds that are not accompanied by significant contamination of the wound.

Types of PXO of gunshot wounds:

– 1) early - up to 12 hours after injury (up to 24 hours with preliminary

– antibiotic prophylaxis);

– 2) delayed - from 12 to 24 hours after the wound (from 24 to 48 hours with preliminary antibiotic prophylaxis);

– 3) late - after 24 hours from the wound (after 48 hours from the wound with preliminary antibiotic prophylaxis).

Stages of antibiotic treatment of gunshot wounds: 1) dissection of the wound;

– 2) stopping the bleeding;

– 3) removal of foreign bodies, hematomas, free bone fragments;

– 4) conversion of a complex wound into a simple one; 5) excision of non-viable wound edges;

– 6) drainage: a. single-layer;

– b. layer-by-layer

– c. flowing;

– d. aspiration systems;

– 2) restorative and reconstructive element: a. nerve suture;

– b. suture or plastic of the vessel;

– c. suture or plastic of tendon;

– d. application of external fixation devices for gunshot wounds of the extremities; e. various types of skin plastics.

Wound drainage methods for gunshot wounds:

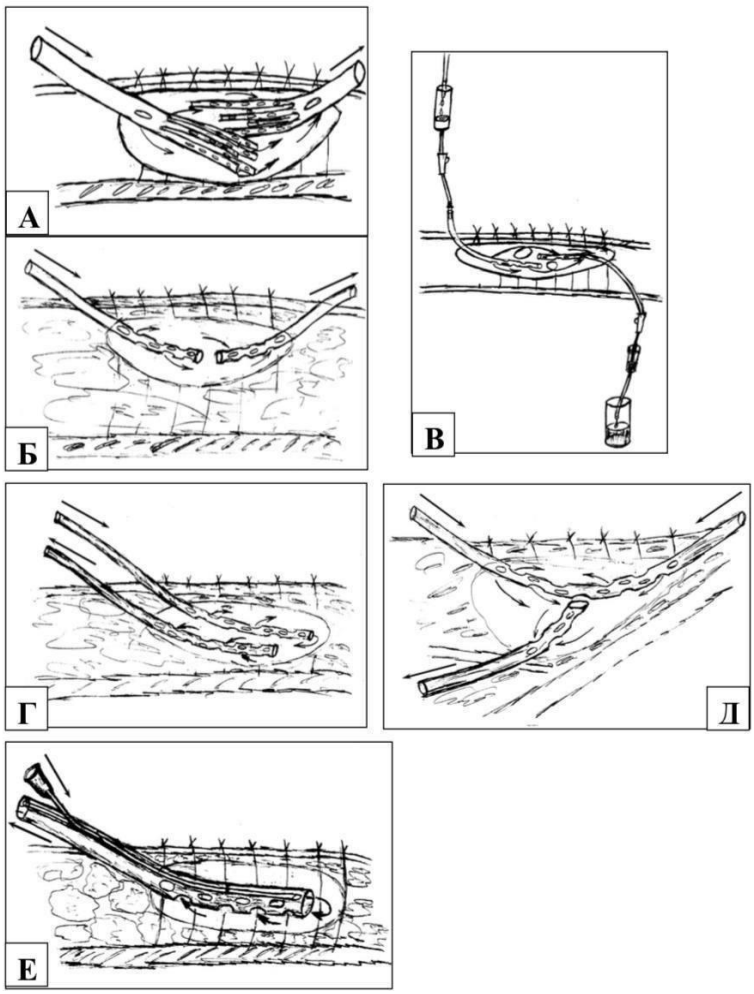
– 1) upper wound drainage (A);

– 2) through drainage of the wound cavity (B);

– 3) flow-flush drainage (C);

– 4) oppositional drainage (D);

– drainage of the wound with a T-shaped tube (E); 6) drainage of the wound cavity with two-lumen PVC drains (F).



Types of sutures at PCO of gunshot wounds:

1) primary - after PXO;

2) primary provisional sutures - are applied at the time of PXO, delayed for 4-5 days; 3) primary delayed sutures - are applied before the appearance of granulation (for 6-7 days);

4) secondary early - imposed after the appearance of granulations before the development of the scar (for 8-

15 days);

5) secondary late - applied after the development of the scar with excision of the scar and granulations (20-30 days).

Conditions for the application of primary sutures in the case of PCO of gunshot wounds:

1) there are no signs and threat of infectious complications;

2) the ability to observe the patient by the operating surgeon until the sutures are removed; 3) confidence in the completeness of the PFO + treatment in the hospital under the supervision of the operating surgeon + constant adequate drainage;

4) wounds of the face;

5) head wounds;

6) wounds of the external genital organs;

7) chest wounds with open pneumothorax. In other cases, a blind primary suture after the treatment of a gunshot wound is not imposed !!!

Necrectomy

Necrectomy is a surgical operation on soft tissues, the main task of which is to remove dead tissue that can become a source of infection or toxic complications. During the operation, the surgeon removes necrotic tissue with subsequent closure of the wound with skin plastics.

Given that necrotic tissues usually lack sensitivity, anesthesia is not required for surgery. To remove dead tissue, the doctor can choose one of the following methods:

Instrumental excision.

During this type of necrectomy, tissue dissection is carried out in such a way that the fluid can drain out, and the damaged tissue can dry and mummify with the appearance of a specific line of damage. During the operation, blood is not released from the wound. If drops of blood do appear, it means that the doctor has touched living tissue with a scalpel.

Laser excision.

During the intervention, the doctor also removes dead tissue. The only difference is that instead of a scalpel, the doctor uses a laser. This technique is more advanced and safer, as there is no risk of damage to healthy tissues.

Enzymatic therapy of necrosis.

For treatment using this technique, the doctor uses special proteolytic drugs, which include a complex of active enzymes. Under their influence, necrotic tissues are independently rejected over the entire wound surface. As a result, only healthy intact tissues remain. Before the operation, it is important to undergo a comprehensive diagnosis. Its main task is to determine the degree of tissue damage, the spread of necrosis and the boundaries of the damage.

Upon completion of necrectomy, the surgeon sutures. After that, a sterile dressing is applied or skin plasty is performed. Types of operations:

necrotomy - dissection of necrotic tissue to drain the tissue fluid and reduce swelling and progression of necrosis (e.g., circular burns of the extremities, chest); necrectomy - a single removal of dead tissue in delimited dry necrosis due to various injuries or in stages as signs of viability clearly appear (e.g., frostbite, burns);

- amputation of a limb or its segment - is performed in case of gangrene at the level of healthy tissues, the blood supply of which is sufficient for healing of the stump;

- resection or removal (extirpation) of the oragan is performed urgently in case of necrosis of the abdominal cavity organs; conservative local treatment in accordance with the principles of wound treatment according to

phases of the wound process;

improvement of tissue trophism to reduce the area of tissue death and improve wound healing (reduction of tissue oxygen demand - immobilization of the limb, antioxidants, improvement of microcirculation - antispasmodics, disaggregants, anticoagulants, hyperbaric oxygenation).

Wound treatment with fly larvae (also known as biological necrectomy), or "maggot therapy", is a type of biotherapy using intentionally introduced fly larvae into a human wound to selectively clear necrotic tissue and promote healing (currently not used).
Volumes of PCO for gunshot wounds:

1) limited volume:

a. wound infiltration with 0.25% novocaine solution with antibiotic;

b. corrective infusion therapy;

c. if indicated - wide subcutaneous fasciotomy;

if indicated - drainage of the deepest "pockets" of the wound with additional incisions;
2) full volume.

Indications for full PCA: a.

wounded with prolonged bleeding;

b. wounded with tourniquet applied;

c. wounded with severed limbs and large destruction of limbs;

d. wounded with signs of purulent or anaerobic infection.

Definition

Repeat surgical treatment is the second and subsequent surgical intervention, which is carried out in case of inadequacy of the first surgical treatment (or secondary surgical treatment of the wound), before the development of infectious complications.

Stages of repeated surgical treatment of wounds:

1) removal of foreign bodies;

2) necrectomy of non-viable tissues; 3) primary delayed wound suture.

Secondary surgical treatment is a surgical intervention that is performed for secondary indications for infectious complications.

Methods of closing large skin defects of granulating wounds in secondary surgical treatment of wounds:

1) autodermoplasty;

2) secondary sutures;

3) skin grafting with a displaced skin flap; 4) vintage method.

Secondary surgical treatment of wounds is performed in case of suppuration. In this case, the specialist examines all parts of the wound, pockets, purulent cavities. During the treatment, antibacterial agents and antiseptics are widely used, laser intervention is possible. Excision of non-viable tissues is performed as

carefully to preserve nerves and blood vessels. In most cases, the wound is drained to avoid repeated suppuration. With the help of drainage, the doctor ensures the outflow of purulent exudate during the entire recovery period. Secondary sutures are applied according to indications. If there is an anaerobic infection, the wound is left open.

Рідина/Початкова доза	Показання	Переваги	Застереження
Кристалоїди Фізіологічний розчин Розчин Рінгера лактатний	Гіповолемія, геморагічний синдром, шок, опіки	Зручні у зберіганні, недорогі, доведена ефективність, ізотонічність	Масова частка — вимагають 3:1 при втраті крові, розрідженні, набряках, коагулопатіях
Гіпертонічні розчини 3-5% 7,5%* Гіпертонічні колоїдні комбінації* Гіпертонічний декстран* Гіпертонічний Хетастарч	Геморагічний шок: 4 мл/кг або 250 мл болюсно, можна повторити один раз Опіки: лише одна доза на початку	Менша молекулярна маса Малий об'єм = більший ефект Збільшення скоротливої здатності серця Більша тривалість ефекту порівняно з простими гіпертонічними розчинами?	>500 мл — ризик гіпернатріємії, судом Не використовувати для дегідратації при блюваті, діареї чи пітливості, або теплових ушкодженнях Не повторювати без додавання інших рідин Повинні замінити зменшену кількість позасудинної рідини
Колоїди Альбумін Штучні колоїди Декстран 6% Хетастарч (Хекстенд, Хеспан) 10% Пентастарч* Колоїди на основі желатину*	Геморагічний шок (500-1000 мл болюсно) Опіки? 3-й день	Більша тривалість ефекту Заміщення крові 1:1 Підвищують онкотичний тиск плазми Залучають позасудинну рідину Співвідношення ваги та об'єму ліпше, ніж у кристалоїдів	Надмірна кількість може привести до "витоку" в тканини Зв'язує імуноглобуліни та Ca^{2+} Повинні замінити зменшену кількість позасудинної рідини Штучні колоїди: коагулопатії, алергічні реакції, осмотичний діурез, впливає на сумісність Хетастарч: ↑ фібриноліз, ↑ амілаза Максимальна доза: 20 мл/кг/добу (приблизно 1,5 л)

Principles of treatment of mine-blast injuries at the stages of medical evacuation:

1) First of all, emergency surgical interventions are performed - refusal to which leads to a lethal outcome. Preoperative preparation is carried out on Operation Table.

Оральні регідратаційні розчини	Дегідратаційно-контрольований геморагічний синдром Опіки	Розчини зручні у використанні Нестерильні інгредієнти: 4 чайні ложки цукру, 1 чайна ложка солі, 1 л води	Засіб для лікування поранень черевної порожнини та пацієнтів без свідомості, але використовують з осторогою Зберігання, група крові та сумісність
Кров	Геморагічний синдром — універсальний донор групи 0	Переносить кисень Автотрансфузія Мобільний банк крові	Трансфузійні реакції, інфекція, імуногенність
Штучна кров На основі гемоглобіну На основі фторвуглеводнів	Геморагічний синдром	Просте зберігання Немає груп крові та проблем із сумісністю	На експериментальному етапі, недоступна для використання Фторвуглеводні потребують додаткового кисню Засіб, що використовуватиметься в майбутньому?

2) Secondly, urgent operations are performed - the refusal of which leads to the development of severe complications that can lead to the death of the patient. When

performing urgent surgical interventions, there are 2-4 hours for preoperative preparation

In the third stage, delayed operations are performed - the refusal of which leads to the development of pulmonary and purulent-septic complications. Delayed surgical interventions are performed on 2-3 days after the injury.

Urgent and urgent operations are performed simultaneously or sequentially during one anesthesia.

Urgent and delayed operations are performed during one anesthesia, or at different times.

Treatment of purulent infection of gunshot wounds

The first principle is a comprehensive treatment of purulent wound infection; surgical and medical methods complement each other, but the main role belongs to the surgical method. In most cases, only it provides the necessary conditions for optimal healing, as it eliminates the focus of infection and creates favorable conditions for drainage of wound contents. Adequate surgical intervention creates the best conditions for the action of antibacterial agents. The principle of the main role of surgical intervention is fundamental in the treatment of any purulent wound.

Elimination of purulent focus, which is a purulent wound, can be achieved only in one way - by means of radical surgical treatment. Surgical treatment of purulent wound in accordance with its purpose is classified as secondary surgical treatment, as it is aimed at eliminating the wound infection that has already developed and preventing more formidable purulent-septic complications.

Features of PCO in the treatment of gunshot wounds of the soft tissues of the skull:

1) it is not recommended to excise the edges of the skin wound;

2) remove foreign bodies and blood clots, coagulate bleeding vessels;

3) wounds larger than 4 cm are subjected to irrigation drainage for 3 days; 4) nodal sutures are applied to the aponeurosis, without sutures on the skin.

Features of PCO in the treatment of non-penetrating gunshot wounds of the skull and brain:

1) the wound is dissected without excision of the edges;

2) a trepanation hole is made in the area of the damaged bone;

3) if the dura mater is not pulsating and the color is changed, it is opened;

4) hematoma is removed and foci of crushing are aspirated;

5) the dura mater is sutured with a continuous suture with atraumatic thread;

drainage is placed over the dura mater; 7) aponeurosis suture.

Peculiarities of SCA in the treatment of penetrating gunshot wounds of the skull and brain:

1) perform PCO of soft tissues;

2) perform resection trepanation of the skull;

3) excise damaged areas of the dura mater and make radial incisions (to access the brain wound);

4) large bone fragments are removed from the brain wound;

5) bone fragments usually do not go deeper than 5 cm into the brain tissue, so they can and should be completely removed;

6) metal fragments usually penetrate deep into the brain tissue, so their removal is dangerous, so only large fragments are removed using a pin magnet;

7) a stream of saline is used to wash out brain detritus and small surface bone fragments;

8) the brain wound is diluted with spatulas;

9) brain detritus is removed with suction;

10) stop cerebral bleeding;

11) the dura mater is carefully sutured (especially in case of ventricular injuries);

12) in case of a defect of the dura mater, its plastic is performed; 13) in case of blind sutures - tidal drainage for 2-6 days. Features of PCO of gunshot wounds of the chest:

1) layer-by-layer dissection of tissues;

2) economical removal of non-viable and contaminated soft tissues, foreign bodies;

3) hemostasis, removal of clots;

4) subcostal resection of the ends of the ribs, edges of the shoulder blades;

5) primary sutures are not applied;

Gunshot wounds of extremities

Features of mine-blast wounds of extremities:

1) significant mechanical damage to soft tissues;

2) burns of soft tissues of the limbs;

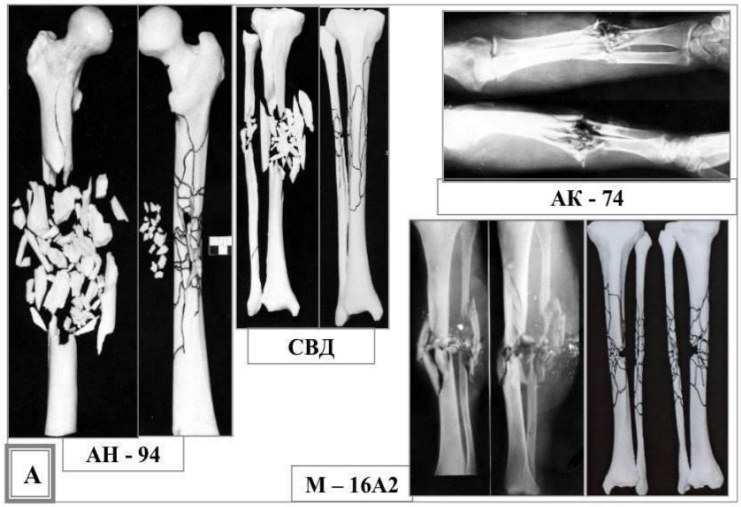
3) stratification of soft tissues by shock wave and gas along the tubular structures of the limbs (neurovascular bundles); 4) modern mines contain balls and needles that increase the volume of lesions.

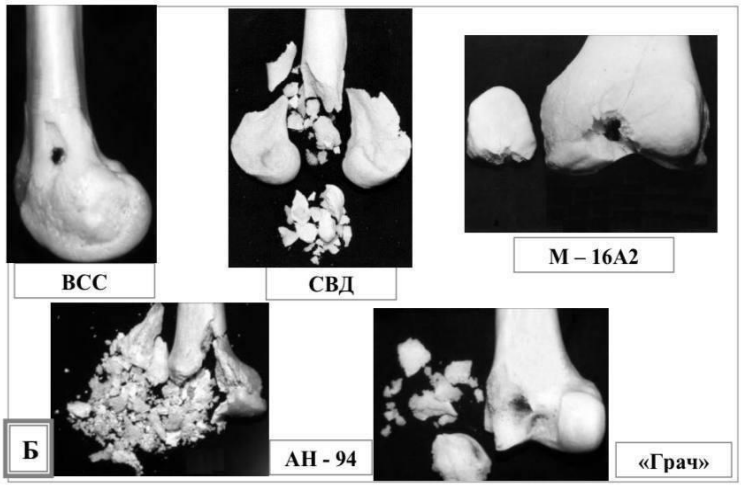
Characteristics of destruction of the diaphyseal zone of bones by modern wounding shells:

1) multiple fragment fractures with longitudinal bone splitting - 26%;

2) comminuted fractures - 69%;

3) comminuted fractures with the formation of primary bone defects -





5%.

Characteristics of diaphyseal (A) and epiphyseal (B) bone destruction by modern wounding projectiles.

Peculiarities of PCO in limb wounds

- wide dissection of the wound with sparing excision of the edges of the damaged skin; - decompression fasciotomy of the main bone and fascial cases throughout the damaged segment

- revision of the wound channel and all wound pockets with removal of blood clots, foreign inclusions, small bone fragments not associated with soft tissues;

- removal of destroyed and deprived of blood supply tissues (mainly subcutaneous adipose tissue and muscles), taking into account the topography of neurovascular formations;

- repeated irrigation of the surgical wound during the operation with isotonic sodium chloride solution, 3% hydrogen peroxide solution, antiseptic solutions with aspiration of the washing fluid;

- storage of all significant bone fragments, as well as small ones associated with periosteum and soft tissues;

- restoration of main blood flow in case of injuries of large arteries by their temporary prosthetics;

- full drainage of the wound by performing counterperforating incisions on the posterolateral surface of the segment with the introduction of drainage tubes with a diameter of at least 10 mm to create a natural outflow of wound contents;

- periwound infiltration and parenteral administration of broad-spectrum antibiotics

spectrum of action;

- loose tamponade with napkins moistened with antiseptic liquids and

sorbents of osmotic action;

- adequate immobilization of the injured segment of the limb with longitudinal plaster or circular plaster bandages, cut lengthwise, in the absence of such a possibility - with transport splints reinforced with plaster rings.

Features of gunshot injuries of abdominal organs:

1) internal organs can be damaged not only by the direct impact of the projectile, but also by the force of impact from the side;

2) it is not always possible to accurately determine the limits of viability of tissues of damaged organs due to the presence of a zone of repeated necrosis

(molecular concussion);

3) multiple ruptures and destruction of hollow organs under the influence of hydrodynamic impact are possible, especially in cases when these organs are filled with fluid

(bladder, stomach, intestines);

4) the number of injuries, the complexity of the trajectory of the wound channel, associated with the use of projectiles with a displaced center of gravity, cause the complexity of intraoperative diagnosis of gunshot injuries of internal organs

of the abdomen;

5) large areas of primary tissue necrosis and disturbance of regional blood flow and microcirculation in the wound area, which causes a large number of purulent-septic complications in the wounded;

6) 2/3 of the wounded have damage to 2 or more abdominal organs;

7) injuries of hollow organs are detected in 62% of the wounded, and a combination of injuries of hollow and parenchymal organs - in 14%;

8) 1/3 of the wounded in the abdomen have serious extra-abdominal injuries, most often gunshot fractures of the pelvis, limbs and spine;

9) 13% of abdominal wounded are diagnosed with thoracoabdominal wounds.

Medical triage. First aid measures. Pre-hospital care. Medical assistance. Vacuum therapy. Ultrasonic debridement.

Scope of medical care at the stages of medical evacuation First medical and premedical aid measures:

1. on the battlefield (in the lesion), a bandage is applied to the entrance and exit wound openings;

2. the entrails that have fallen out are not inserted, but covered with a bandage and taped to the wounded;

3. analgesics are administered;

1. rapid evacuation from the battlefield.

Рівень надання допомоги*	Категорія допомоги	Рекомендація
Етап 1 поле	Первинна допомога на полі бою	Накладіть на рану стерильну пов'язку (уникайте тиску на рани в ділянці ока) Стабілізуйте переломи Переведіть у хірургічний відділ якомога швидше
	Протимікробні препарати після поранення	Введіть одну дозу протимікробного препарату на місці поранення в разі дійсної або очікуваної затримки з евакуацією
Етап 1 лікувальний підрозділ/ Етап 2 без хірургічної підтримки	Протимікробні препарати після поранення	Введіть в/в протимікробні препарати якомога швидше (в межах 3 год.) Введіть правцевий токсоїд і імуноглобулін за потребою Не рекомендують посилювати грамнегативне покриття аміноглікозидом або фторхінолоном Не рекомендують додавати пеніцилін для запобігання клостридіальній гангрені або стрептококовій інфекції Повторіть дозу протимікробного препарату, якщо великий об'єм крові призводить до реанімації Застосовуйте при опіках лише протимікробні препарати місцевої дії
	Хірургічна обробка і промивання	Для видалення явного бруду промийте рану фізіологічним розчином, стерильною або питною водою під малим тиском (великим шприцом або подібним пристроєм) без додатків Не намагайтесь видалити залишені фагменти в глибині тканини за наявності критеріїв[1]; введіть цефазолін 2 г в/в × 1 доза
Етап 2 з хірургічною підтримкою і Етап 3	Протимікробні препарати після поранення	Введіть в/в протимікробні препарати якомога швидше (в межах 3 год.) Введіть правцевий токсоїд і імуноглобулін за потребою Не рекомендують посилювати грамнегативне покриття аміноглікозидом або фторхінолоном Не рекомендують додавати пеніцилін для запобігання клостридіальній гангрені або стрептококовій інфекції Повторіть дозу протимікробного препарату, якщо великий об'єм крові призводить до реанімації Застосовуйте при опіках лише протимікробні препарати місцевої дії

		Можна застосувати протимікробні кульки або мішечки При потребі здійсніть імунізацію після спленектомії за показаннями
	Хірургічне лікування рани	Хірургічна консультація якомога швидше Лише рани на твердій мозковій оболонці та обличчі можна зашивати відразу Можна застосувати терапію ран від'ємним тиском Зовнішня фіксація (тимчасове шинування) переломів стегна/гомілки Зовнішня фіксація (тимчасове шинування) або рейкова іммобілізація відкритих переломів плеча/передпліччя
Етап 4	Протимікробні препарати після поранення	Повний курс протимікробних препаратів після поранення Можна застосувати протимікробні кульки або мішечки При потребі здійсніть імунізацію після спленектомії за показаннями
	Хірургічна обробка і промивання	Промийте рани для видалення забруднень звичайним фізіологічним розчином або стерильною водою під малим тиском (5–10 фунт/кв. дюйм (0,34–0,68 ат); наприклад, з допомогою шприца або гравітаційного потоку без додатків (використовуйте 3 л для I типу, 6 л для II типу і 9 л для III типу переломів кінцівок) Не намагайтесь видалити фрагменти, залишені глибоко в м'яких тканинах, при досягненні критеріїв;[1] введіть цефазолін 2 г в/в × 1 дозу Не робіть посівів, якщо нема ознак інфекції Хірургічне лікування ран Рани не треба зашивати до 3–5 днів після поранення Лише рани на твердій мозковій оболонці та обличчі можна зашивати відразу Можна застосувати терапію ран від'ємним тиском Зовнішня фіксація (тимчасове шинування) переломів стегна/гомілки Зовнішня фіксація (тимчасове шинування) або рейкова іммобілізація відкритих переломів плеча/передпліччя

в/в — внутрішньовенно; ЛРНТ — лікування ран негативним тиском; ФКД — фунти на квадратний дюйм.

First aid measures:

1) temporary stopping of external bleeding;

2) finger pressure of the vessel in the wound;

3) finger pressure on the vessel in the wound;

4) flexion or extension of the limb in the joint;

5) pressure bandage;

6) tourniquet application, twisting;

7) applying a primary aseptic dressing that protects the wound from repeated microbial contamination, repeated minor injuries, drying, and provides rest;

8) administration of analgesic from a syringe-tube, which is in the individual first aid kit;

9) transport immobilization with improvised means; in their absence, the injured upper limb is tied to the body, the lower limb - to the undamaged lower limb;

10) ingestion of tablet antibiotics; 11) evacuation.

Pre-hospital care measures:

1) check the appropriateness of tourniquets and correct incorrectly applied tourniquets;

2) check the expediency of applying and correct incorrectly applied aseptic dressings, splints;
3) re-introduction of painkillers

means;

4) application of service transport splints (from the set B-2); 5) anti-shock therapy:

a. intravenous infusion therapy (400 ml of Ringer's solution or 400 ml of sorbilact or 400 ml of rheosorbilact);

b. administration of cardiac and respiratory analeptics according to indications;

c. inhalation of oxygen;

6) re-dispensing for oral administration of tableted antibiotics; 7) evacuation.

First aid

When providing first aid, 4 sorting and evacuation groups are distinguished:

1. seriously injured, who need first aid in the dressing room;

2. injured who do not need help at this stage and are sent to the evacuation ward;

3. lightly injured who are subject to outpatient treatment and return to the unit;

4. agonizing, who are provided with symptomatic care.

Scheme of triage and evacuation on the battlefield

First aid measures:

1) dressing correction (in case of evacuation, wetting the loops of prolapsed intestines and omentum with sterile petroleum jelly to prevent drying is indicated);

2) administration of tetanus toxoid;

3) administration of broad-spectrum antibiotics;

4) administration of analgesics, according to cardiac indications; if there are absolute signs of a penetrating abdominal wound, the use of narcotic analgesics is indicated;

5) in the cold season, the wounded should be warmed: covered with heating pads, wrapped in a blanket or sleeping bag;

6) infusion therapy is indicated for abdominal wounded with signs of prolonged bleeding, if it does not cause delays in evacuation;

in case of intra-abdominal prolonged bleeding, infusion therapy is ineffective, as the

rise in blood pressure increases internal bleeding ("sieve effect"); 8) immediate

evacuation.

Sorting and evacuation groups in providing qualified medical care to the wounded in

the abdomen:

1) wounded with signs of internal bleeding, who are immediately sent to the operating

room;

2) wounded in a state of shock of II-III degree and in a terminal condition are sent to

anti-shock wards to prepare for surgery;

3) all other wounded with penetrating wounds subject to surgery are sent to the

operating room in the first place, but after those who have signs of internal bleeding;

4) wounded without signs of shock and acute blood loss, who need additional diagnostic measures to confirm or exclude penetrating wounds or closed injuries of internal organs, depending on the condition, are sent to the operating room (dressing room) or to the hospital department (for observation, X-ray examination).

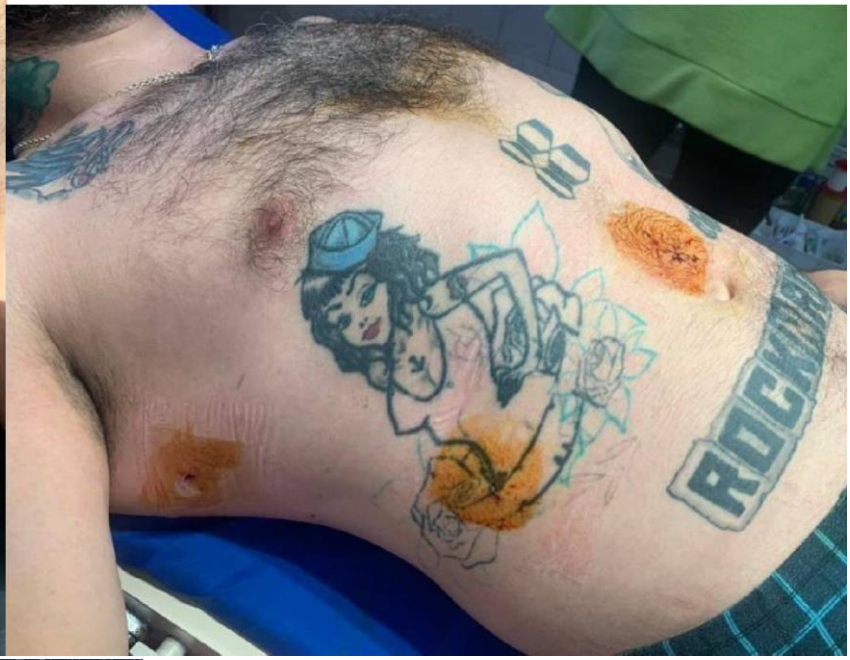
Wound treatment with negative pressure (also known as vacuum wound therapy), or "negative pressure wound therapy (NPWT)", is one of the types of local treatment used to improve the course of the wound process.

Nowadays, vacuum therapy has already received comprehensive scientific substantiation and recognition among specialists in the field of wound treatment. It is known that its application accelerates the course of all phases of the wound process. It is widely and successfully used in many clinics for the treatment of wounds of various etiologies: acute traumatic wounds, burns, bedsores, purulent wounds and trophic ulcers, diabetic foot syndrome, complications of cavitary operations and endoprosthetics, used in thoracic, reconstructive and plastic surgery, as well as in open abdominal trauma, peritonitis and unformed intestinal fistulas.

Ultrasonic wound debridement uses the effect of cavitation. The ultrasonic vibrations of the ultrasonic wound debridement tool (UAW) form cavitation bubbles in the irrigation solution. They explode under the influence of pressure changes. This results in strong currents, the so-called "microcurrents".

Thus, plaque is removed from the base of the wound and biofilms are opened. Healthy tissue, due to its higher elastin content, is almost not damaged, which ensures rapid progress in the healing process.

Photo to the topic: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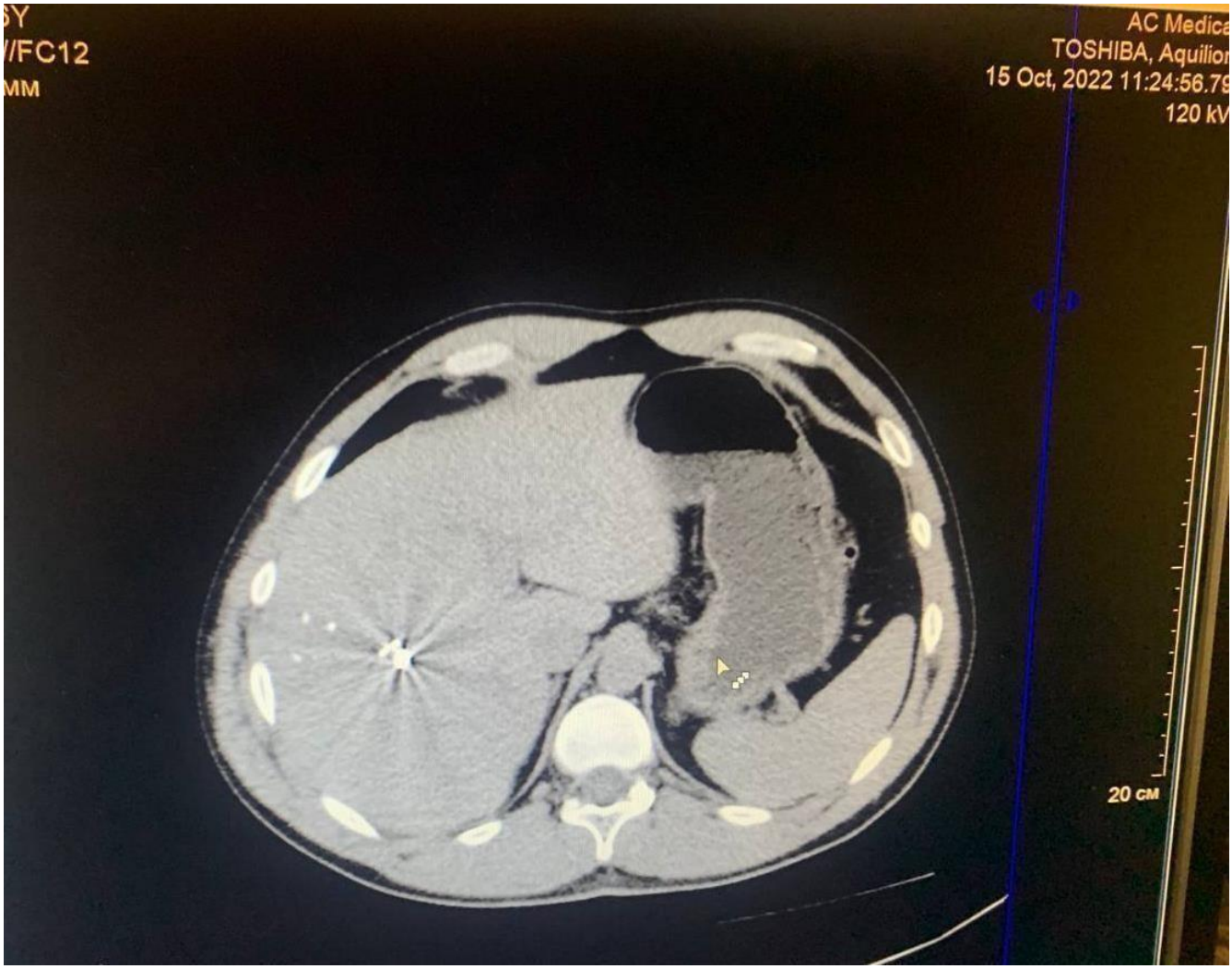
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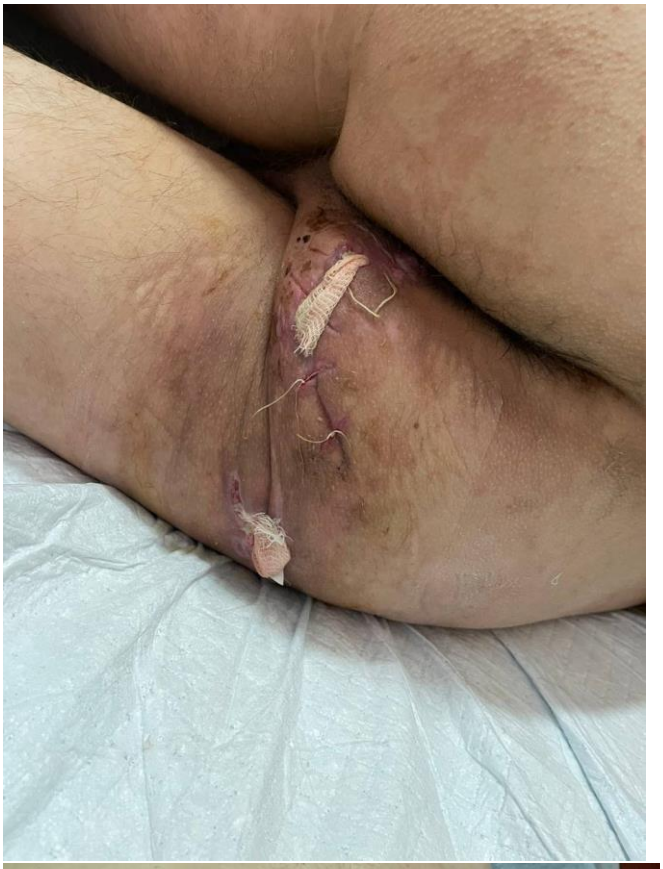


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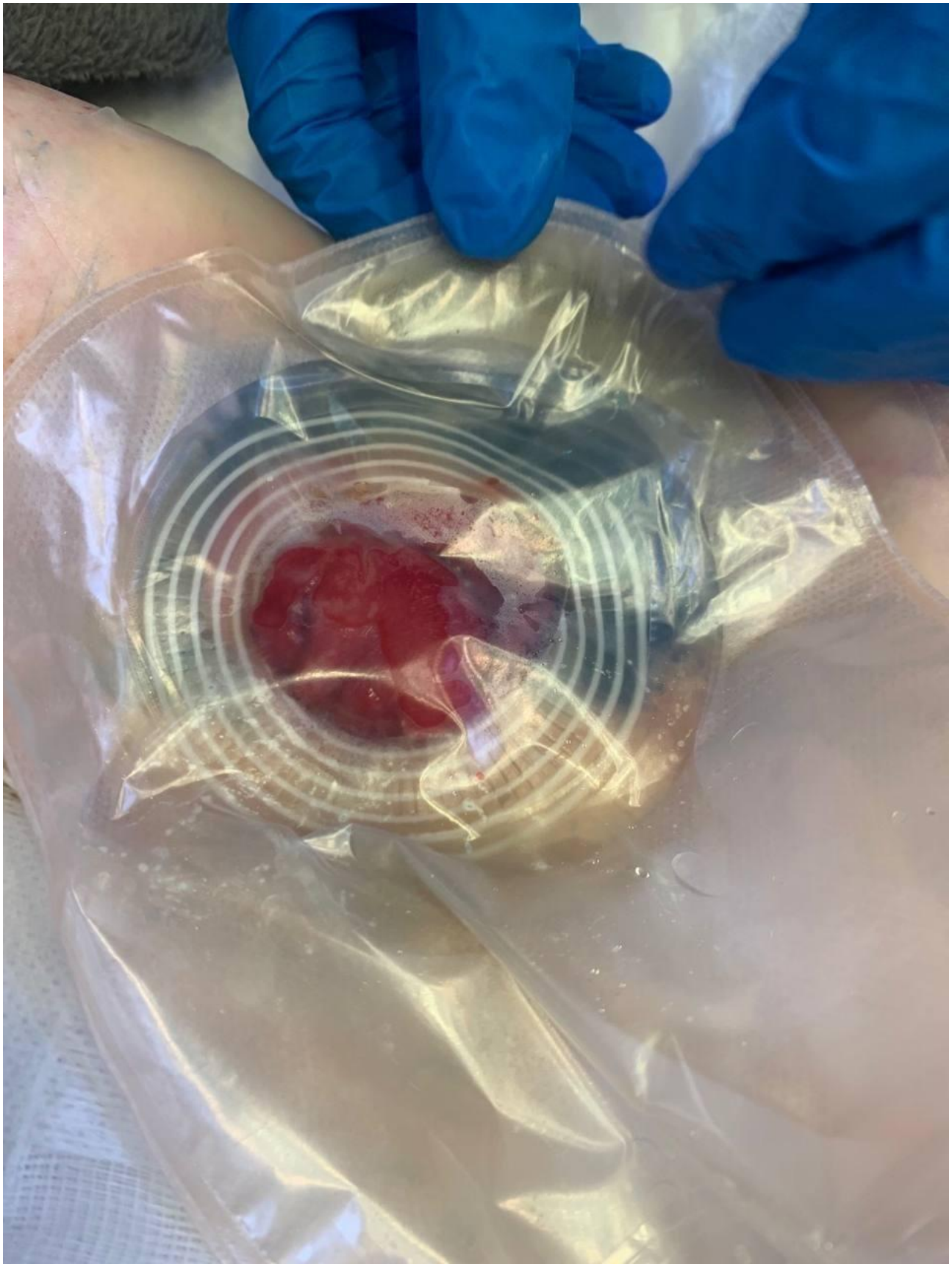

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