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Medicine of emergency situations

Study guide

Under edition of Yu. V. Shkatula

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This study guide is intended for the students of medical higher educational institutions of IV accreditation level, who study medicine of emergency situations in English.

Навчальний посібник рекомендований для студентів вищих медичних навчальних закладів IV рівня акредитації, які вивчають медицину надзвичайних ситуацій англійською мовою.

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INTRODUCTION

Scientific and technological progress not only improves the production, improvement of working conditions and the welfare of the population, but also increases the risk of accidents on facilities management. Huge regional burden of industrial and energy facilities increases the likelihood of accidents and disasters, losses from which can be compared with losses due to military conflicts.

Ensuring national security is an integral function of each state as a social formation, designed to ensure favorable conditions for life and work of its citizens. Assessment of the overall state of technogenic and ecological security is the foundation on which a strategy of state policy in the field of population and territories from emergency situations of Ukraine.

Problems of prevention and elimination of health effects of anthropogenic and natural origin in order to preserve life and health, is a component of national security.

The manual sets out the main characteristics emergency situations of natural, anthropogenic and socio-political character, their medical and sanitary consequences.

The manual presents information on the principles of emergency medical aid to the victims, modern standards cardiopulmonary and cerebral resuscitation.

We hope that this manual will help students, medical interns to study the topic of “Medicine of emergency situations” and will be useful in the work of medical practitioners.

1 EMERGENCY SITUATIONS OF NATURAL, ANTHROPOGENIC AND SOCIO-POLITICAL CHARACTER, THEIR MEDICAL AND SANITARY CONSEQUENCES. ECOLOGICAL SITUATION ON THE TERRITORY OF UKRAINE. TASKS AND ORGANIZATION OF URGENT MEDICARE FOR THE VICTIMS OF THE EMERGENCY SITUATIONS

Worsening of ecological situation, urbanization, scientific and technical progress, the increase of amount of transport vehicles, unstable political situation, military conflicts result in the increase of amount of accidents, catastrophes, natural disasters and other emergency situations. Every year from 44 to 70 thousand people perish from traumas, poisonings and accidents and this is a reproductive part of our population which is able to work.

There was a reactor accident on the Chornobyl nuclear power plant on April, 26, 1986. A few millions of cubic meters of radioactive gas got into the atmosphere as a result of the explosion of the fourth reactor. That was much more than from the emission after nuclear explosion above Hiroshima and Nagasaki.

On June, 3, 1989 there was the damage of the gas pipeline in Bashkiria (650).

On September, 28, 1994 a passenger ferry Estonia sank (912).

On September, 11, 2001 there was an attack on the World shopping center in the USA. Towers-twins were destroyed. 4834 people perished. In October, 2002 there was a tragedy in the theatrical Center in Dubrovka in Russia during the musical Nord-Ost. Officially 119 people perished from poisoning by gas.

January, 12, 2005 – mass death of pilgrims during the hajj in Saudi Arabia – 362 people.

Emergency situations in recent days and months include a war in Ossetia, explosions of ammunitions in Lozova, floods in Lvov and Ivano-Frankovsk regions. This is an incomplete list of the emergency events about which we hear from mass media practically every day.

Emergency situations on the territory of Ukraine

With the conflict in the east entering its ninth month, the situation is becoming extremely dire for the population, particularly older persons, children and people in institutional care, many of whom are on the brink of survival. Moreover, the impact of the conflict in the east on the rest of Ukraine is increasingly acute.

As the fighting intensified in the east, there have been increased reports of violations of international human rights law and international humanitarian law. This highlighted the need to ensure the protection of civilians. The use of indiscriminate shelling in residential areas has led to the killing of civilians, as well as the damage to property and infrastructure.

By 30 November 2015, the total number of casualties in the east had reached at least 4,364 killed and 10,064 wounded. Over 1,000 bodies delivered to morgues in the conflict zone remained unidentified, and many sites where hostilities had taken place not yet been searched to recover all remains.

With the onset of winter and no let-up in the hostilities, the situation of approximately 5.25 million people living in the conflict and post-conflict affected areas is further deteriorating due to significant damage of the infrastructure, the breakdown of economic activities, and the disruption of social and medical services and social welfare benefits.

Ecological situation on the territory of Ukraine

Five nuclear power plants have 15 operating power units each of which contains 75-100 tons of nuclear fuel. Nuclear high-power channel-type reactor operating on Chornobyl nuclear power plant is of an out-of-date construction, a sarcophagus which is above the fourth power unit, which was destroyed during the accident, does not provide reliable protection from the influence of radio-active gas.

On the territory of Ukraine there are more than 1500 industrial enterprises, which produce, keep and use more than 300 thousands of tons of poisonous substances. 20 million Ukrainians live in the area where these objects are located.

The cargoes of railway and auto transport consist of 15% of dangerously explosive, fire-hazardous and chemically poisoned substances.

A couple of oil and gas pipelines, ammonia line pass the territory of Ukraine, and also some new are built. On the rivers of Ukraine 2000 of storage pools are built.

Medicine of emergency situations is a science about the rendering medical help under the emergency conditions. The medicine of emergency situations studies and develops the methods of simultaneous rendering of help to plenty of victims in an optimum volume and in the shortest period of time.

Emergency situation is circumstances which were established on a separate territory as a result of an accident, catastrophe, dangerous natural phenomenon, natural or some other disasters that can lead or lead to human victims, to harm to the health of people or environment, material losses, worsening of conditions of life.

Area of the emergency situation is a territory in which the emergency situation is established.

We will try to formulate **general characteristics of the areas of emergency situations**:

– emergency situations are accompanied by a huge amount of sanitary losses, variable pathology of victims who need multi-faceted medical help;

– in the areas of emergency situation a lot of people with different neuropsychic abnormalities appear. it makes the rendering of first medical aid much more difficult. approximately 10% of victims need a sanitary treatment;

– in the situation when people are crowded and communal and sanitary buildings collapse, the bursts of infectious diseases are possible;

– in the result of emergency situations the appearance of repeated fire of chemical pollution is possible, for example, because of the damage of tanks with ammonia or chlorine on the production;

– during the emergency situations there is a big possibility of numeral sanitary and irreversible losses among medical workers and destruction of medical establishments. during the earthquake in armenia 70 % of the general amount of medical establishments were destroyed, 348 of medical workers perished.

On July, 15, 1998 by the Decision of Cabinet of Ministers of Ukraine № 1099 «About the order of classification of emergency situations» was stated «The regulation about the classification of emergency situations». According to this regulation depending on the territorial distribution, volumes of the caused or expected economic losses emergency situations are divide into a few levels:

– national;
– regional;
– local;
– object.

The emergency situation of the national level is an emergency situation which is developed on the territory of two and more regions (Autonomous Republic Crimea, places of Kiev and Sevastopil) or is a threat for transborder transference, and also in the case when for its liquidation the materials and technical resources in the volumes, which exceed the possibilities of separate region (Autonomous Republic Crimea, cities of Kiev and Sevastopil), but not less than one percent of volume of charges of the proper budget, are required.

The emergency situation of the regional level is an emergency situation, which is located on the territory of two or more administrative districts (places of regional value) of the Autonomous Republic Crimea, regions, places of Kiev and Sevastopil or is a threat of the transfere to the territory of contiguous region of Ukraine, and also in the case when for its liquidation material and technical resources in volumes, which exceed possibilities of a separate district, but not less than one percent of the volume of charges of the proper budget, are needed.

The emergency situation of the local level is an emergency situation, which goes out from the potentially-dangerous object, threatens by the distribution of situation or its second consequences on the environment, neighbouring settlements, engineering buildings, and also in the case when for its liquidation material and technical resources in volumes, which exceed the possibilities of potentially-dangerous object, but not less than one percent of the volume of charges of the proper budget are needed. The local level also includes all emergency situations which appear on the objects of housing and communal sphere and others which do not belong to the approved lists of potentially dangerous objects.

The emergency situation of the objective level is an emergency situation which does not fall under earlier mentioned determinations. It is opened out on the territory of object or on an object by itself and the consequences of which keep inside of an object or its sanitary-hygienic zone.

For the organization of an effective work for prevention of emergency situations, liquidation of their consequences, decline of scales of damage and losses is very important to know the reasons of their origin and the theory of the appearance of catastrophes.

The regulations about the **classification of emergency**

situations according to the character of the origin of events which predetermine the appearance of the emergency situations on the territory of Ukraine distinguishes four classes of emergency situations. They are the emergency situations of anthropogenic, natural, socio-political and military character. Every class of emergency situations is divided into groups which contain their concrete types.

The emergency situations of the anthropogenic character are transport accidents (catastrophes), fires, unprovoked explosions or their threat, accidents with the emission (the threat of emission) of dangerous chemical, radio-active, biological substances, sudden destruction of buildings, accidents on engineering networks and buildings of life-support, hydrodynamic accidents on the dikes, etc.

The emergency situations of the natural character are the dangerous geological, meteorological, hydrological marine and freshwater phenomena, degradation of soils of the earth, natural fires, change of the state of air pool, infectious morbidity of people, agricultural animals, mass defeat of agricultural plants by illnesses or pests, change of the state of water resources and biosphere, etc.

The emergency situations of socio-political character are the situations which are related to illegal actions of the terrorist and unconstitutional direction: realization or real threat of assassination (armed attack, fascination and detention of important objects, nuclear installations and materials, media and telecommunications, attack or an attempted murder at the crew of the air or marine ship), theft (attempt of theft) or elimination of ships, establishment of explosive devices in public places, theft or fascination of weapon, exposure of out-of-date ammunitions, etc.

The emergency situations of the military character are the situations connected with the consequences of application of the weapon of mass defeat or ordinary facilities of defeat, which cause the second factors of defeat of population as a result of destruction of the hydroelectric stations, depot of radioactive and toxic substances and wastes, oil products, explosive, drastic poisonous substances, transport and engineer communications, etc.

An accident is an emergency event on an industrial object or transport as a result of which the threat to life and health of people, the destruction of industrial premises and buildings, transport vehicles, mechanisms, products appeared.

A catastrophe is an accident that resulted in human victims and destructions in considerable sizes and also made a considerable harm to the environment.

A natural disaster is a natural phenomenon which appears suddenly and leads to the defeat and death of people, elimination of material values.

Main types of natural disaster:

Fire is an elemental distribution of fire which is out of the man’s control. Fires are classified into natural fires (forest, peat, steppe, field), and fires in settlements (separate, mass, continuous).

Drifts are moving masses of mountain breeds down the slope under the influence of attractive power. Under 90,0% of drifts are on the territories located on a height from 100 to 1700 meters above a sea level. They appear on the slopes which have a steepness above 20 degrees, mostly on the banks of the rivers in Carpathians and Crimea Mountains.

The floods are temporal submergences by water of considerable areas of locality as a result of raising of water level in the rivers and other reservoirs, damage of hydraulic work, etc.

Strong thundershowers, intensive melting of snow, annual floods can become the main reasons of beginning of flood. Especially dangerous submergences, which appear as a result of sudden breach of dikes of hydraulic works, changes or collapses of mountain breeds.

A mud flow is a variety of a flood. It is the stream of water, sand, clay suddenly arising up in the mouth of mountain rivers, wreckages of stones and boulders. The reason of mud flow streams can be thundershower rains, intensive melting of mountain snow and glaciers, earthquakes.

The earthquakes are earthquake shocks and vibrations of the earth surface, which appear as a result of the rupture in the earth's crust and are passed on to large distances as resilient vibrations. According to the data of the world statistics 15% of all natural catastrophes are connected with the earthquakes, but according to the character of human and material losses they take the first place . Intensity of earthquakes is estimated in the **points of the international Richter scale**.

Hurricane is a wind of a destructive power (more than 30 m /s) and a considerable duration. A storm and tornado are the varieties of hurricane.

Main striking factors during the emergency situations are:

– mechanic (blast wave, falling down, trauma because of damaged constructions);
– chemical (drastic toxic substance);
– radiative (ionizing radiation);
– thermal (high and low temperatures).
– biological (bacterial means, toxins).

These factors can operate simultaneously or consistently, predetermining numerous, combined defeats of a different degree of difficulty.

Main tasks of the urgent medicare in the area of emergency situation:

– the organization and timely rendering of all the kinds of medical care to injured people;

– the organization and rendering of medical care to the formations that participate in rescue works;

– implementation of medical and preventive measures, directed at decrease of negative influence of neuropsychic stresses;

– prevention of the origin and spreading of mass infectious diseases among the population.

Medical grading – is dividing victims into groups according to necessity of homogenous treatment-prophylaxis and evacuation measures in accordance with medical indications, the volume of rendered medical care at this stage of medical evacuation and order of evacuation.

The rest of victims can be divided into 4 groups:

To the first group we refer victims in very poor condition, with extremely serious injuries, victims who are between life and death (in agony).

To the second group we refer victims with serious injuries with significant functional disorders.

To the third group we refer victims with serious and moderately severe injuries with not significant functional disorders or without them.

To the fourth group we refer victims with light injuries.

Medical evacuation – taking victims out of the place of emergency situation to the hospital, where doctors render necessary medical care.

2 TERMINAL STATES. BASIC CARDIOPULMONARY RESUSCITATION. ELEMENTARY MAINTENANCE OF LIFE

Resuscitation (cardiopulmonary resuscitation) – complex of urgent actions using to help patient out from reversible stages of dying. The main measures at first stage of resuscitation are artificial lung ventilation and cardiac massage, at the second stage – selective drug and infusion therapy, at the third stage – strengthening of success achieved on the second stage, surgical procedures and correction of drug therapy.

Resuscitation or reanimation is to put out patients of the terminal state in sudden death.

Terminal conditions is a borderline between life and death, the stages of dying are: preagonal, agonal and clinical death.

Preagonal stage is characterized by general apathy, confusion which is growing progressively deeper. AP is not determined, no pulse at the peripheral arteries, tachy- or bradypnoe. pathological rhythms of respiration, cyanosis or pallor of the skin and mucosa.

Agony, death struggle – severe pain or extreme suffering; old term for the period just before death occurs; in the modern medicine this term means the terminal status of wounded or sick patient in which pulse and blood pressure are not determined, heart beat is weak, patient is in unconscious status, his breathing is superficial.

Apparent (clinical) death – final stage of terminal status which happens momentarily after stop of breathing and heart beat; if life signs are not recovered during 5-7 minutes, brain cells perish with the following biological death.

Biological death – the cessation of life beyond the possibility of resuscitation.

Breathing problems (breathing disturbance) – difficulty or stop of breathing resulting from wound, disease or obstruction of airway.

Cardiac arrest – sudden stoppage of the pumping function of the heart and collapse of arterial blood pressure to immeasurable level; it usually leads to death unless corrected, but may be temporary or paroxysmal.

When the heart stops, the absence of oxygenated blood can cause irreparable brain damage in only a few minutes. Time is critical when you're helping an unconscious person who isn't breathing.

Figure 1 – **Check pulse**

Cardiopulmonary resuscitation (CPR) is a lifesaving technique useful in many emergencies, including heart attack or near drowning, in which someone's breathing or heartbeat has stopped (figure 1). The American Heart Association recommends that everyone – untrained bystanders and medical personnel alike – begin CPR with chest compressions.

It's far better to do something than to do nothing at all if you're fearful that your knowledge or abilities aren't 100 percent complete. Remember, the difference between your doing something and doing nothing could be someone's life.

CPR can keep oxygenated blood flowing to the brain and other vital organs until more definitive medical treatment can restore a normal heart rhythm.

To learn CPR properly, take an accredited first-aid training course, including CPR and how to use an automated external defibrillator (AED). If you are untrained and have immediate access to a phone, call 103 before beginning CPR. The dispatcher can instruct you in the proper procedures until help arrives.

The scheme of patient examination by P. Safar

A. Air open.

B. Breating.

C. Circulation of blood.

Assess the situation before starting CPR:

Is the person conscious or unconscious?

If the person appears unconscious, tap or shake his or her shoulder and ask loudly, "Are you OK?" (figure 2).

If the person doesn't respond and two people are available, one should call 103 or the local emergency number and one should begin CPR. If you are alone and have immediate access to a telephone, call 103 before beginning CPR – unless you think the person has become unresponsive because of suffocation (such as from drowning). In this special case, begin CPR for one minute and then call 103 or the local emergency number.

Figure 2 – **Assess the situation before starting CPR**

The American Heart Association uses the acronym of ABC – airway, breathing, compressions — to help people remember the order to perform the steps of CPR.

Put the person on his or her back on a firm surface.

Kneel next to the person's neck and shoulders.

Open the person's airway using the head-tilt, chin-lift maneuver. Put your palm on the person's forehead and gently tilt the head back. Then with the other hand, gently lift the chin forward to open the airway.

Restoration of adequate ventilation – measure of the first aid directed to removing of mucus, blood and foreign bodies from airways to restore free breathing.

Check the airway – don’t move the person. Tilt their head back, open their mouth and look inside. If fluid and foreign matter is present, gently roll them onto their side. Tilt their head back, open their mouth and remove any foreign matter (for example, chewing gum, false teeth, vomit).

Check for normal breathing, taking no more than five or 10 seconds. Look for chest motion, listen for normal breath sounds, and feel for the person's breath on your cheek and ear (figure 3). Gasping is not considered to be normal breathing. If the person isn't breathing normally and you are trained in CPR, begin mouth-to-mouth breathing. If you believe the person is unconscious from a heart attack and you haven't been trained in emergency procedures, skip mouth-to-mouth breathing and continue chest compressions.

Figure 3 – **Check for normal breathing**

Artificial (controlled) respiration – any method of forcing air into and out of the lungs of a person who has stopped breathing; in emergency cases can be performed without equipment (mouth-to-mouth, mouth-to-nose, manual breathing) or with special apparatus (heart-lung machine) (figure 4).

Figure 4 – **Artificial ventilation with Ambu sack**

With the airway open (using the head-tilt, chin-lift maneuver), pinch the nostrils shut for mouth-to-mouth breathing and cover the person's mouth with yours, making a seal.

Prepare to give two rescue breaths. Give the first rescue breath – lasting one second – and watch to see if the chest rises. If it does rise, give the second breath. If the chest doesn't rise, repeat the head-tilt, chin-lift maneuver and then give the second breath. Thirty chest compressions followed by two rescue breaths is considered one cycle.

Use mouth-to-mouth – if the person is not breathing normally, make sure they are lying on their back and: Open the airway by tilting the head back and lifting their chin. Close their nostrils with your finger and thumb. Put your mouth over the person's and blow into their mouth. Give 2 full breaths to the person (this is called 'rescue breathing'). Make sure there is no air leak and the chest is rising and falling. If their chest does not rise and fall, check that you're pinching their nostrils tightly and sealing your mouth to theirs. If still no luck, check their airway again for any obstruction.

Precardial impact – single precardial impact (striken by a fist in a lower third of breastbone) can be performed by a professional if he was a witness of the death. In case of sudden blood circulation stoppage which lasted more than 30 seconds, precardial impact is not effective.

Closed chest cardiac resuscitation – restoration of cardiac output using manual closed chest compression.

Cardiac compressions – start chest compressions. Place the heel of one hand on the lower half of the person's breastbone. Place the other hand on top of the first hand and interlock your fingers. Press down firmly and smoothly (compressing to 1/3 of chest depth) 30 times. Administer 2 breaths. The ratio of 30 chest compressions followed by 2 breaths is the same, whether CPR is being performed alone or with the assistance of a second person. Aim for a compression rate of 100 per minute (figure 5).

Automatic external defibrillator (AED). The discharges should be repeated three times with energy 200 Joule, 200 Joule, 360 Joule. There are 2 ways of defibrillation:

1. Place one electrode under the right clavicle at the edge of the breast bone, and the other one – under the left nipple. Press electrodes tightly for reduction of electric resistance and for avoiding of burns grease them with gel.

2. Place one electrode under the left scapula, the other one – on the bottom of the heart. Right before the befibrillation all the people should leave the place and the patient should be switched off the equipment.

Figure 5 – **Massage of the heart and artificial ventilation performed by two person**

To perform CPR on a child: the procedure for giving CPR to a child age 1 through 8 is essentially the same as that for an adult.

The differences are as follows:

1. Use only one hand to perform chest compressions.
2. Breathe more gently.
3. Use the same compression-breath rate as is used for adults: 30 compressions followed by two breaths. This is one

cycle. Following the two breaths, immediately begin the next cycle of compressions and breaths.

4. After five cycles (about two minutes) of CPR, if there is no response and an AED is available, apply it and follow the prompts. Use pediatric pads if available, for children ages 1 through 8. If pediatric pads aren't available, use adult pads. Do not use an AED for children younger than age 1. Administer one shock, then resume CPR – starting with chest compressions – for two more minutes before administering a second shock.

Continue until the child moves or help arrives.

3 FIRST AID MEASURES WHILE BLEEDING. HEMORRHAGIC SHOCK: CLASSIFICATION BY SEVERITY, CLINIC AND EMERGENCY CARE

Bleeding, is the loss of blood out the circulatory system. Bleeding can occur internally, where blood leaks from blood vessels inside the body or externally, either through a natural opening such as the vagina, mouth or anus, or through a break in the skin. The complete loss of blood is referred to as exsanguination, and desanguination is a massive blood loss. Loss of 10-15% of total blood volume can be endured without clinical manifestation in a healthy person.

Traumatic bleeding is caused by some type of injury. There are different types of wounds which may cause traumatic bleeding. These include:

Abrasion – also called a graze, this is caused by transverse action of a foreign object against the skin, and usually does not penetrate below the epidermis/

Excoriation – in common with Abrasion, this is caused by mechanical destruction of the skin, although it usually has an underlying medical cause/

Hematoma – (also called a blood tumor) – caused by damage to a blood vessel that in turn causes blood to collect under the skin.

Laceration – irregular wound caused by blunt impact to soft tissue overlying hard tissue or tearing such as in childbirth. In some instances, this can also be used to describe an incision.

Incision – a cut into a body tissue or organ, such as by a scalpel, made during surgery.

Puncture wound – caused by an object that penetrated the skin and underlying layers, such as a nail, needle or knife.

Contusion – also known as a bruise, this is a blunt trauma damaging tissue under the surface of the skin.

Crushing injuries – caused by a great or extreme amount of force applied over a period of time. The extent of a crushing injury may not immediately present itself.

Ballistic trauma – caused by a projectile weapon, this may include two external wounds (entry and exit) and a contiguous wound between the two.

Hemorrhaging is broken down into 4 classes by the American College of Surgeons:

Class I Hemorrhage involves up to 15% of blood volume. There is typically no change in vital signs and fluid resuscitation is not usually necessary.

Class II Hemorrhage involves 15-30% of total blood volume. A patient is often tachycardic (rapid heart beat) with a narrowing of the difference between the systolic and diastolic blood pressures. The body attempts to compensate with peripheral vasoconstriction. Skin may start to look pale and be cool to the touch. The patient might start acting differently. Volume resuscitation with crystalloids (Saline solution or Lactated Ringer's solution) is all that is typically required. Blood transfusion is not typically required.

Class III Hemorrhage involves loss of 30-40% of circulating blood volume. The patient's blood pressure drops, the heart rate increases, peripheral perfusion, such as capillary refill worsens, and the mental status worsens. Fluid resuscitation with crystalloid and blood transfusion are usually necessary.

Class IV Hemorrhage involves loss of >40% of circulating blood volume. The limit of the body's compensation is reached and aggressive resuscitation is required to prevent death.

Types of bleedings:

– bleedings can be traumatic, operating and spontaneous;
– bleedings can be internal and external;
– bleedings can be arterial, venous and capilyar;
– bleedings can be primary or secondary;

– bleedings can be one-shot and repeated.

Classification of bleedings(A.G.Brussov,1998)

I. Type:

1. Traumatic (Injury).
2. Pathologic (Tumor and other diseases).
3. Artificial (Medical exfusion).

II. The speed of development:

1. Occure More than (7% VCB per hour).
2. Suboccure 5-7% VCB per hour.
3. Chronic Less than 5% VCB per hour.

III. Volume:

1. Small 0,5-10% VCB (0,5 l).
2. Medium 10-20% VCB(0,5 – 1,0 l).
3. Large 21 – 40 VCB(1,0 – 2,0 l).
4. Massive 41 – 70% VCB (2,0 – 3,5 l).
5. Lethal 41 – 70% VCB (2,0 – 3,5 l).

IV. Degree of hypovolemia:

1. Light (Deficit of VCB 10-20%, no shock).
2. Medium (Deficit of VCB 21-30%, shock develops in case of long hypovolemia).
3. Hard (Deficit of VCB 31-40%, shock is inevitable).
4. Extremely hard (Deficit of VCB 40%, shock, terminal condition).

Symptoms of bleeding:

– blood coming from an open wound;
– bruising;
– confusion or decreasing alertness;
– clammy skin;
– dizziness or light-headedness after an injury;
– low blood pressure;
– paleness (pallor);
– rapid pulse, increased heart rate;
– shortness of breath;
– weakness;

Symptoms of internal bleeding may also include:

- abdominal pain and swelling;
- chest pain;
- external bleeding through a natural opening;
- blood in the stool (appears black, maroon, or bright red);
- blood in the urine (appears red, pink, or tea-colored);
- blood in the vomit (looks bright red, or brown like coffee-grounds);
- vaginal bleeding (heavier than usual or after menopause);
- skin color changes that occur several days after an injury (skin may black, blue, purple, yellowish green).

Empiric volume of traumatic bleeding:

- haemothorax – 1,5 – 2l;
- fracture of one rib – 0,2 – 0,5l;
- trauma of the abdomen – to 2l;
- fracture of bones of the pelvic – 3,0 – 5,0l;
- fracture of the hip – 1,0 – 2,5l;
- fracture of the shoulder/shank – 0,5 – 1,5l;
- fracture of the forearm – 0,2 – 0,5l;
- fracture of the spine cord – 0,5 – 1,5l;
- scalped injury (palm size) – 0,5l.

First aid in case of bleeding:

I. Stopping of an external bleeding.
II. Immobilisation.
III. Aneasthesation.
IV. Infusion therapy.

Methods stopping of an external bleeding:

Elevation was commonly recommended for the control of haemorrhage. Some protocols continue to include it, but recent studies have failed to find any evidence of its effectiveness and it was removed from the PHTLS guidance in 2006.

Direct pressure. Placing pressure on the wound will constrict the blood vessels manually, helping to stem any blood flow. When applying pressure, the type and direction of the wound may have an effect, for instance, a cut lengthways on the hand would be opened up by closing the hand into a fist, whilst a cut across the hand would be sealed by making a fist. A patient can apply pressure directly to their own wound, if their consciousness level allows. Ideally a barrier, such as sterile, low-adherent gauze should be used between the pressure supplier and the wound, to help reduce chances of infection and help the wound to seal. Third parties assisting a patient are always advised to use protective latex or nitrile medical gloves to reduce risk of infection or contamination passing either way. Direct pressure can be used with some foreign objects protruding from a wound; padding is applied from each side of the object to push in and seal the wound - objects are never removed.

Pressure points. In situations where direct pressure and elevation are either not possible or proving ineffective, and there is a risk of exsanguination, some training protocols advocate the use of pressure points to constrict the major artery which feeds the point of the bleed. This is usually performed at a place where a pulse can be found, such as in the femoral artery. There are significant risks involved in performing pressure point constriction, including necrosis of the area below the constriction, and most protocols give a maximum time for constriction (often around 10 minutes). There is particularly high danger if constricting the carotid artery in the neck, as the brain is sensitive to hypoxia and brain damage can result within minutes of application of pressure. Pressure on the carotid artery can also cause vagal tone induced bradycardia, which can eventually stop the heart. Other dangers in use of a constricting method include rhabdomyolysis, which is a buildup of toxins below the pressure point, which if released back into the main bloodstream may cause renal failure.

Tourniquet. Another method of achieving constriction of the supplying artery is the use of a tourniquet - a tightly tied band which goes around a limb to restrict blood flow. Tourniquets are routinely used in order to bring veins to the surface for cannulation, although their use in emergency medicine is more limited. The use of the tourniquet is restricted in most countries to professionals such as physicians and paramedics, as this is often considered beyond the reach of first aid and those acting in good faith as a good samaritan. A key exception is the military, where many armies carry a tourniquet as part of their personal first aid kit.

Improvised tourniquets, in addition to creating potential problems for the ongoing medical management of the patient, usually fail to achieve force enough to adequately compress the arteries of the limb. As a result, they not only fail to stop arterial bleeding, but may actually increase bleeding by impairing venous bloodflow.

Hemostatic agent. Some protocols call for the use of clotting accelerating agents, which can be either externally applied as a powder or gel, or pre-dosed in a dressing or as an intravenous injection. These may be particularly useful in situations where the wound is not clotting, which can be due to external factors, such as size of wound, or medical factors such as haemophilia.

Recombinant factor VIIa (rFVIIa) is not, as of 2012, supported by the evidence for most cases of major bleeding. Its use brings a significant risk of arterial thrombosis, and therefore it should only be used in clinical trials or with patients with factor VIIe deficiency.

Circulatory shock, commonly known simply as **shock**, is a serious, life-threatening medical condition characterized by a decrease in tissue perfusion to a point at which it is inadequate to meet cellular metabolic needs.

Classification of shock by S. Sumin (2000):

I. Hypovolemic shock:

1) haemorragic;

2) burn;
3) traumatic.

II. Cardiogenic shock.

III. Vascular shock:
1) anaphylactic;
2) septic.

Sings of shock severity:

I. Grade 1

Up to about 15% loss of effective blood volume (~750ml in an average adult who is assumed to have a blood volume of 5 liters). This leads to a mild resting tachycardia and can be well tolerated in otherwise healthy individuals. In the elderly or those with underlying conditions such as ischaemic heart disease the additional myocardial oxygen demands may not be tolerated so well.

II. Grade 2

Between 15-30% loss of blood volume (750-1500 ml) will provoke a moderate tachycardia and begin to narrow the pulse pressure. The time taken for the capillaries to refill after 5 seconds of pressure (capillary refill time) will be extended.

III. Grade 3

At 30 - 40% loss of effective blood volume (1500 - 2000 ml) the compensatory mechanisms begin to fail and hypotension, tachycardia and low urine output (<0.5ml/kg/hr in adults) are seen.

IV. Grade 4

At 40-50% loss of blood volume (2000 -2500 ml) profound hypotension will develop and if prolonged will cause end-organ damage and death.

Symptoms of shock:

– anxiety, restlessness, altered mental state due to decreased cerebral perfusion and subsequent hypoxia;
– hypotension due to decrease in circulatory volume;

– a rapid, weak, thready pulse due to decreased blood flow combined with tachycardia;

– cool, clammy skin due to vasoconstriction and stimulation of vasoconstriction;

– rapid and shallow respirations due to sympathetic nervous system stimulation and acidosis;

– hypothermia due to decreased perfusion and evaporation of sweat;

– thirst and dry mouth, due to fluid depletion;

– fatigue due to inadequate oxygenation;

– cold and mottled skin (cutis marmorata), especially extremities, due to insufficient perfusion of the skin;

– distracted look in the eyes or staring into space, often with pupils dilated.

Shock index of Algover(1967):

Pulse/arterial pressure(60/120)=0,5(0,54)

I. If this index is 1 (100/100) than the volume of bleeding is 20% of VCB.

II. If this index is 1,5 (120/80) than the volume of bleeding is 30 – 40% of VCB.

III. If this index is 2 (120/60) than the volume of bleeding is 50% of VCB.

4 EMERGENCY MEDICAL ASSISTANCE IN EMERGENCY SITUATIONS. FIRST AID MEASURES IN CASE OF BURNS. BURN SHOCK

Burns are injuries of skin or other tissue caused by thermal, radiation, chemical, or electrical contact. Burns are classified by depth and percentage of total body surface area (TBSA) involved.

Burns can be highly variable in terms of the tissue affected, the severity, and resultant complications.

Muscle, bone, blood vessel, and epidermal tissue can all be damaged with subsequent pain due to profound injury to nerve endings.

Complications and associated problems include hypovolemic shock, inhalation injury, infection, scarring, and contractures. Patients with large burns (> 20% TBSA) require fluid resuscitation. Treatments for burn wounds includes topical antibacterials, regular cleaning, elevation, and sometimes skin grafting. Intensive rehabilitation, consisting of range-of-motion exercises and splinting, is often necessary.

Every year from 44 to 70 thousand people perish from traumas, burns, poisonings and accidents and this is a reproductive part of our population which is able to work. In case of undue first medical aid 20% of victims die.

Etiology

Thermal burns may result from any external heat source (flame, hot liquids, hot solid objects, or, occasionally, steam). Fires may also result in toxic smoke inhalation.

Radiation burns most commonly result from prolonged exposure to solar ultraviolet radiation (sunburn) but may result from prolonged or intense exposure to other sources of ultraviolet radiation (eg, tanning beds) or from exposure to sources of x-ray or other nonsolar radiation.

Chemical burns may result from strong acids, strong alkalis (eg, lye, cement), phenols, cresols, mustard gas, phosphorus, and certain petroleum products (eg, gasoline, paint thinner). Skin and deeper tissue necrosis caused by these agents may progress over several hours.

Electrical burns result from heat generation and electroporation of cell membranes associated with massive current of electrons. Electrical burns often cause extensive deep tissue damage to electrically conductive tissues, such as muscles, nerves, and blood vessels, despite minimal apparent cutaneous injury.

Pathophysiology

Burns cause protein denaturation and thus coagulative necrosis. Around the coagulated tissue, platelets aggregate, vessels constrict, and marginally perfused tissue (known as the zone of stasis) can extend around the injury. In the zone of stasis, tissue is hyperemic and inflamed.

Damage to the normal epidermal barrier allows bacterial invasion and external fluid loss; damaged tissues often become edematous, further enhancing volume loss. Heat loss can be significant because thermoregulation of the damaged dermis is absent, particularly in wounds that are exposed.

There are four degrees of estimating of the depth of burns exist in Ukraine:

I. Burn degree (combustis eritematosa).

II. Burn degree (combustis bullosa).

III. Burn degree (combustis eschaeretica) – it’s a necrosis form, which is divided into **IIIA and IIIB**:

In case of **IIIA** burn degree the whole depth of epidermis and papillaris layer are affected (mainly partial affection).

IIIB. Burn degree is characterized by necrosis of the whole derma with the apurtenances – sebaceous , sweat glands and hair follicles.

IV. Burn degree necrosis is extended on the whole depth of skin and tissues, internal organs, bones.

On the XXth convention of surgeons, passed in September of 2000 in Ternopol, prof. Fistal E.J. offered changes to the classification of the burns, which draws it nearer to the international one:

I. Degree –epidermis burns (according to I and II degrees).

II. Degree –dermis surface burns (according to IIIA degree).

III. Degree – dermis deep burns (IIIB degree).

IV. Degree – subfascialis burns (according to IV degree).

First-degree burns are usually limited to redness (erythema), a white plaque and minor pain at the site of injury. These burns involve the epidermis only (figure 6).

Figure 6 – **First-degree burn**

Second-degree burns manifest as erythema with superficial blistering of the skin, and can involve more or less pain depending on the degree of nerve involvement. Second-degree burns involve the superficial (papillary) dermis and may also involve the deep (reticular) dermis layer (figure 7).

Figure 7 – **Second-degree burn**

Third-degree burns occur when the epidermis is lost with damage to the hypodermis. Burn victims will exhibit charring and extreme damage of the dermis, and sometimes hard eschar will be present. Third-degree burns result in scarring and victims will also exhibit the loss of hair shafts and keratin. These burns may require grafting (figure 8).

Figure 8 – **Third-degree burn**

Forth-degree burns damage muscle, tendon, and ligament tissue, thus result in charring and catastrophic damage of the hypodermis. In some instances the hypodermis tissue may be partially or completely burned away as well as this may result in a condition called comparment syndrome, which threatens both the life and the limb and the patient. Grafting is required if the burn does not prove to be fatal (figure 9).

Figure 9 – **Forth-degree burn**

Symptoms and Signs

Wound symptoms and signs depend on burn depth:

First-degree burns: These burns are red, blanch markedly and widely with light pressure, and are painful and tender. Vesicles or bullae do not develop.

Superficial partial-thickness burns: These burns blanch with pressure and are painful and tender. Vesicles or bullae develop within 24 h. The bases of vesicles and bullae are pink and subsequently develop a fibrinous exudate.

Deep partial-thickness burns: These burns may be white, red, or mottled red and white. They do not blanch and are less painful and tender than more superficial burns. A pinprick is often interpreted as pressure rather than sharp. Vesicles or bullae may develop; these burns are usually dry.

Full-thickness burns: These burns may be white and pliable, black and charred, brown and leathery, or bright red because of fixed Hb in the subdermal region. Pale full-thickness burns may simulate normal skin except the skin does not blanch to pressure. Full-thickness burns are usually anesthetic or hypoesthetic. Hairs can be pulled easily from their follicles. Vesicles and bullae usually do not develop. Sometimes features that differentiate full-thickness from deep partial-thickness burns take a few days to develop.

Diagnosis

Location and depth of burned areas are recorded on a burn diagram. Burns with an appearance compatible with either deep partial-thickness or full-thickness are presumed to be full-thickness until differentiation is possible.

The percentage of TBSA involved is calculated; only partial-thickness and full-thickness burns are included in this calculation. For adults, the percentage TBSA for parts of the body is estimated by the rule of nines (figure 10); for smaller scattered burns, estimates can be based on the size of the patient's entire opened hand (not the palm only), which is about 1% of TBSA. Children have proportionally larger heads and smaller lower extremities, so the percentage TBSA is more accurately estimated using the Lund-Browder chart.

In hospitalized patients, Hb and Hct, serum electrolytes, BUN, creatinine, albumin, protein, phosphate, and ionized Ca should be measured. ECG, urinalysis for myoglobin, and a chest x-ray are also required. Myoglobinuria (suggesting hemolysis or rhabdomyolysis) is suggested by urine that is grossly dark or that tests positive for blood on dipstick in the absence of microscopic RBCs. These tests are repeated as needed. Muscle compartments are evaluated in patients with myoglobinuria.

Infection is suggested by wound exudate, impaired wound healing, or systemic evidence of infection (eg, feeding intolerance, decrease in platelet count, increase in serum glucose level). Fever and WBC count elevation are common in burns without infection, and therefore are unreliable signs of developing sepsis. If the diagnosis is unclear, infection can be confirmed by biopsy; cultures from the wound surface or exudate are unreliable.

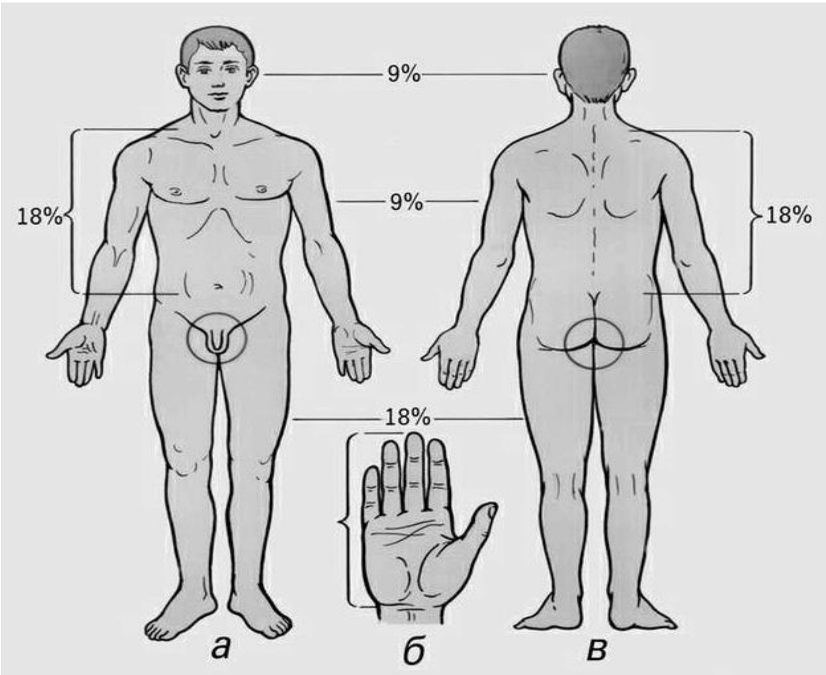

Figure 10 – **The rule "nines" by Wallace A.B.(1951), or by Berkow S.G. (1931)**

First Aid in case of burns:

– stop of the influence of trauming agent;
– durable cooling;
– aneasthesation;

– infusion therapy;
– preventive maintenance of infection;
– evacuation.

Initial treatment

Treatment begins in the prehospital setting. The first priorities are the same as for any injured patient: ABC (airway, breathing, and circulation). An airway is provided, ventilation is supported, and possible associated smoke inhalation is treated with 100% O_2. Ongoing burning is extinguished, and smoldering and hot material is removed. All clothing is removed. Chemicals, except powders, are flushed with water; powders should be brushed off before wetting. Burns caused by acids, alkalis, or organic compounds (eg, phenols, cresols, petrochemicals) are flushed with copious amounts of water continuing for at least 20 min after nothing of the original solution seems to remain.

Intravenous fluids

IV fluids are given to patients in shock or with burns > 10% TBSA. A 14- to 16-gauge venous cannula is placed in 1 or 2 peripheral veins through unburned skin if possible. Venous cutdown, which has a high risk of infection, is avoided.

Initial fluid volume is guided by treatment of clinically evident shock. If shock is absent, fluid administration aims to replace the predicted deficit and supply maintenance fluids.The Parkland formula (4 mL/kg/% TBSA burned) is used to estimate fluid volume needs in the first 24 h after the burn (not after presentation to the hospital) and determines the rate of IV fluid administration. Fluid is given as lactated Ringer solution because large amounts of normal saline could result in hyperchloremic acidosis.

For example, in a 100-kg man with a 50% TBSA burn, fluid volume by the Parkland formula would be:

4 ml of liquids x the mass of the body (kg) x area of the burnt surface (%)

Half of the volume, 10 L, is given in the first 8 h after injury as a constant infusion, and the remaining 10 L is given over the following 16 h. In practice, this formula is only a starting point, and infusion rates are adjusted based on clinical response. Urine output, typically measured with an indwelling catheter, is the usual indicator of clinical response; the goal is to maintain output between 30 and 50 mL/h in adults and between 0.5 and 1.0 mL/kg/h in children. When giving typical large volumes of fluid, it is also important to avoid fluid overload and consequent heart failure. Clinical parameters, including urine output and signs of shock or heart failure, are recorded at least hourly on a flow chart.

Some clinicians give colloid after 12 h to patients who have larger burns, are very young or very old, or have heart disease and require large fluid volumes.

If urine output is inadequate despite administration of a large volume of crystalloid, consultation with a burn center is necessary. Such patients may respond to an infusion of colloid or other measures. Patients with inadequate urine output despite administration of a large volume of crystalloid are at risk of resuscitation complications including compartment syndrome.

For patients of any age with rhabdomyolysis, fluid should be given to maintain urine output between 0.5 and 1 mL/kg/h. Some authorities recommend alkalinizing the urine by adding 50 mEq $NaHCO_3$ (one 50-mL ampule of 8.4% solution) to a liter of IV fluid.

Initial wound care

After adequate analgesia, the wound is cleaned with soap and water, and all loose debris is removed. Water should be room temperature or warmer to avoid inducing hypothermia. Ruptured blisters, except for small ones on palms, fingers, and soles, are debrided. Unruptured blisters can sometimes be left intact, but should be treated by application of a topical antimicrobial. In patients who are to be transferred to a burn center, clean dry dressings can be applied (burn creams may interfere with burn wound assessment at the receiving facility), and patients are kept warm and relatively comfortable with IV opioids.

After the wound is cleaned and is assessed by the final treatment provider, burns can be treated topically. For shallow partial-thickness burns, topical treatment alone is usually adequate. All deep partial-thickness burns and full-thickness burns should ultimately be treated with excision and grafting, but in the interim, topical treatments are appropriate.

Topical treatment may be with antimicrobial salves, commercial dressings incorporating silver (eg, sustained-release nanocrystalline silver dressings), or biosynthetic wound dressings (also called artificial skin products). Topical salves must be changed daily, and silver sulfadiazine may induce transient leukopenia. Some (but not all) silver-impregnated dressings must be kept moist but can be changed as infrequently as every 7 days (to minimize pain associated with repeated wound care). Artificial skin products are not changed routinely but can result in underlying purulence necessitating removal, particularly when wounds are deep. Burned extremities should be elevated.

Escharotomy (incision of the eschar) of constricting eschars may be necessary to allow adequate expansion of the thorax or perfusion of an extremity. However, constricting eschars rarely threaten extremity viability during the first few hours, so if transfer to a burn center can occur within that time, escharotomy can typically be deferred until then.

Supportive measures

Hypothermia is treated, and pain is relieved. Opioids (morphine) should always be given IV. Treatment of electrolyte deficits may require supplemental Ca, Mg, K, or phosphate (PO_4).

Hospitalization and referral

After initial treatment and stabilization, the need for hospitalization is assessed. Inpatient treatment, optimally at a burn center, is strongly suggested for:

– full-thickness burns > 1% TBSA;

– partial-thickness burns > 5% TBSA;

– burns of the hands, face, feet, or perineum (partial-thickness or deeper).

In addition, hospitalization may be necessary if

– patients are < 2 yr or > 60 yr.;

– adherence to home care measures is likely to be poor or difficult (eg, if continuous elevation of the hands or feet, usually difficult at home, is required).

Many experts recommend that all burns, except for 1st-degree burns < 1% TBSA, be treated by experienced physicians and that brief inpatient care be strongly considered for all burns > 2% TBSA. Maintaining adequate analgesia and exercise can be difficult for many patients and caregivers.

Infection

Prophylactic antibiotics are not given.

Initial empiric antibiotic treatment for apparent infection during the first 5 days should target staphylococci and streptococci. Infections that develop after 5 days are treated with broad-spectrum antibiotics that are effective against gram-positive and gram-negative bacteria. Antibiotic selection is subsequently adjusted based on culture and sensitivity results.

The stage of the burn disease:

– the burn shock;

– the acute burn toxemia (12-14 days) – reduction the volume of the plasma by forming of bladders,where necrotoxins are formed as the result of protein denaturation, coming into the total circulation of the blood. All these reasons cause the development of renal insufficiency;

– burn septicotoxemia (1-1,5 months).

– recovering period.

Burn shock – the shock with hypovolemia and primary loss plasma’s volume of the blood; the process which appears in organism under influence of the termal trauma with breach mechanism of autoregulation, which become unapt to support normal circulation of the blood in vitally important organ.

It’s possible to use the **rule Baux** for defining the index of burn shock (index Bo) (1962):

К = age + area of the burn surfaces, %.

Interpreting the index Baux:

– К > 100 – unfavorable result;
– К = 75 - 100 – death-rate about 50%;
– К < 75 – favourable result.

5 ACTIVITIES FIRST AID INJURIES, BONE FRACTURES. TRANSPORT IMMOBILIZATION

Musculoskeletal injuries include:
- fractures;
- joint dislocations;
- ligament sprains;
- muscle strains;
- tendon injuries.

These injuries are common and vary greatly in mechanism, severity, and treatment. The extremities, spine and pelvis can all be affected.

Some injuries are discussed elsewhere in The Manual: spinal trauma; metatarsal stress fractures; orbital fractures; rib fractures; fractures that occur during birth; spinal subluxation; and mandibular dislocation.

Musculoskeletal injuries may occur in isolation or as part of multisystem trauma. Most musculoskeletal injuries result from blunt trauma, but penetrating trauma can also damage musculoskeletal structures.

Fractures and dislocations may be open (in communication with the environment via a skin wound) or closed.

Fractures

Fracture is a complete breach of wholeness of a bone, caused by action of external forces. Most involve a single, significant force applied to normal bone.

In a closed fracture, the overlying skin is intact. In an open fracture, the overlying skin is disrupted and the broken bone is in communication with the environment.

Pathologic fractures occur when mild or minimal force fractures an area of bone weakened by a disorder (eg, osteoporosis, cancer, infection, bone cyst). When the disorder is osteoporosis, they are often called insufficiency or fragility fractures.

Stress fractures result from repetitive application of moderate force, as may occur in long-distance runners or in soldiers marching while carrying a heavy load. Normally, bone damaged by microtrauma from moderate force self-repairs during periods of rest, but repeated application of force to the same location predisposes to further injury and causes the microtrauma to propagate.

Dislocations

A dislocation is a complete separation of the 2 bones that form a joint. Subluxation is partial separation. Often, a dislocated joint remains dislocated until reduced (realigned) by a clinician, but sometimes it reduces spontaneously.

Sprains and strains

Ligaments connect one bone to another. Tears may occur in ligaments (sprains) or in muscles (strains).

Tears may be graded as

– 1st degree: Minimal (fibers are stretched but intact, or only a few fibers are torn);

– 2nd degree: Partial (some to almost all fibers are torn);

– 3rd degree: Complete (all fibers are torn).

Tendon injuries

Tendons connect muscles to bones. Tendon tears can also be partial or complete.

With **complete tears,** the motion produced by the detached muscle is usually lost.

Partial tears can result from a single traumatic event (eg, penetrating trauma) or repeated stress (chronically, causing tendinopathy). Motion is often intact, but partial tears may progress to complete tears, particularly when significant or repetitive force is applied.

Healing

Bone heals at various rates, depending on the patient's age and coexisting disorders. For example, children heal much faster than adults; disorders that impair peripheral circulation (eg, diabetes, peripheral vascular disease) slow healing.

Fractures heal in 3 overlapping stages:

– inflammatory;
– reparative;
– remodeling.

The **inflammatory phase** occurs first. A hematoma forms at the fracture site, and a small amount of bone in the distal fracture fragments is resorbed. If a fracture line is not evident initially (eg, in some nondisplaced fractures), one typically becomes evident about 1 wk after the injury as this small amount of bone is resorbed.

During the **reparative phase,** a callus is formed. New blood vessels develop, enabling cartilage to form across the fracture line. Immobilization (eg, casting) is needed during the first 2 stages to allow new blood vessels to grow. The reparative phase ends with clinical union of the fracture (ie, when there is no pain at fracture site, the injured extremity can be used without pain, and clinical examination detects no bone movement).

In the **remodeling stage,** the callus, which was originally cartilaginous, becomes ossified, and the bone is broken down and rebuilt (remodeled). During this stage, patients should be instructed to gradually resume moving the injured part normally, including putting load-bearing stress on it.

Most **joint dislocations** can be reduced (returned to the normal anatomic position) without surgery. Occasionally, dislocations cannot be reduced using closed manipulative techniques, and open surgery is required. Once a joint is reduced, additional surgery is often not necessary, However, surgery is sometimes required to manage associated fractures, debris in the joint, or residual instability.

Many **partial tears** to ligaments, tendons, or muscles heal spontaneously. Complete tears often require surgery to restore anatomy and function. Prognosis and treatment vary greatly depending on the location and severity of the injury.

Complications

Serious complications are unusual but may threaten life or limb viability or cause permanent limb dysfunction. Risk of complications is high with open injuries (which predispose to infection) and with injuries that disrupt blood vessels, tissue perfusion, and/or nerves. Dislocations, particularly if not rapidly reduced, tend to have a higher risk of vascular and nerve injuries than do fractures. Closed injuries that do not involve blood vessels or nerves, particularly those that are quickly reduced, are least likely to result in serious complications.

Acute complications (associated injuries) include the following:

I. Bleeding: Bleeding accompanies all fractures and soft-tissue injuries. Rarely, internal or external bleeding is severe enough to cause hemorrhagic shock (eg, in pelvic, femoral, and some open fractures).

II. Vascular injuries: Some open fractures disrupt blood vessels. Some closed injuries, particularly knee or hip dislocations and posteriorly displaced supracondylar humeral fractures, disrupt the vascular supply sufficiently to cause distal limb ischemia; this vascular disruption may be clinically occult for hours after the injury.

III. Nerve injuries: Nerves may be injured when stretched by displaced pieces of a fractured bone or by a dislocated joint, when bruised by a blunt blow, when crushed in a severe crush injury, or when torn by sharp bone fragments. When nerves are bruised (called neurapraxia), nerve conduction is blocked, but the nerve is not torn. Neurapraxia causes temporary motor and/or sensory deficits; neurologic function returns completely in about 6 to 8 wk. When nerves are crushed (called axonotmesis), the axon is injured, but the myelin sheath is not.

This injury is more severe than neurapraxia. Depending on the extent of the damage, the nerve can regenerate over weeks to years. Usually, nerves are torn (called neurotmesis) in open injuries. Torn nerves do not heal spontaneously and may have to be repaired surgically.

IV. Fat embolism: Fractures of long bones may release fat (and other marrow contents) that embolizes to the lungs and causes respiratory complications.

V. Compartment syndrome: Tissue pressure increases in a closed fascial space, disrupting the vascular supply and reducing tissue perfusion. Crush injuries or markedly comminuted fractures are a common cause, increasing tissue pressure as edema develops. Risk is high with forearm fractures that involve both the radius and ulna, tibial plateau fractures (proximal tibial fractures that extend into the joint space), or tibial shaft fractures. Untreated compartment syndrome can lead to rhabdomyolysis, hyperkalemia, and infection. It can also cause contractures, sensory deficits, and paralysis. Compartment syndrome threatens limb viability (possibly requiring amputation) and survival.

VI. Infection: Any injury can become infected, but risk is highest with those that are open or surgically treated. Acute infection can lead to osteomyelitis, which can be difficult to cure.

Evaluation

– evaluation for serious injuries;
– history and physical examination;
– x-rays to identify fractures;
– sometimes MRI or CT.

In the emergency department, if the mechanism suggests potentially severe or multiple injuries (as in a high-speed motor vehicle crash or fall from a height), patients are first evaluated from head to toe for serious injuries to all organ systems and, if needed, are resuscitated. Patients, especially those with pelvic or femoral fractures, are evaluated for hemorrhagic shock due to occult blood loss. If a limb is injured, it is immediately evaluated for open wounds and symptoms or signs of neurovascular injury (numbness, paresis, poor perfusion) and compartment syndrome (eg, pain out of proportion to injuries, pallor, paresthesias, coolness, pulselessness).

Patients should be checked for ligament, tendon, and muscle injuries as well as fractures; sometimes parts of this evaluation are deferred until fracture is excluded. The joint above and below the injured joint should also be examined.

History

The mechanism (eg, the direction and magnitude of force) may suggest the type of injury. However, many patients do not remember or cannot describe the exact mechanism.

Physical examination

Examination includes:

– vascular and neurologic assessment;

– inspection for deformity, swelling, ecchymoses, open wounds, and decreased or abnormal motio;

– palpation for tenderness, crepitation, and gross defects in bone or tendon;

– examination of the joints above and below the injured area;

– after fracture and dislocation are excluded (clinically or by imaging), stress testing of the affected joints for pain and instability.

If muscle spasm and pain limit physical examination (particularly stress testing), examination is sometimes easier after the patient is given a systemic analgesic or local anesthetic. Or the injury can be immobilized until muscle spasm subsides, usually for a few days, and then the patient can be reexamined.

Deformity suggests dislocation, subluxation (partial separation of bones in a joint), or fracture.

If a **wound** is near a dislocation or fracture, the injury is assumed to be open.

Swelling commonly indicates a significant musculoskeletal injury but may require several hours to develop. If no swelling occurs within this time, fracture or severe ligament disruption is unlikely. With some fractures (eg, buckle fractures, small fractures without displacement), swelling may be subtle but is rarely absent.

Tenderness accompanies nearly all injuries, and for many patients, palpation anywhere around the injured area causes discomfort. However, a noticeable increase in tenderness in one localized area (point tenderness) suggests a fracture or sprain. Localized ligamentous tenderness and pain when the joint is stressed are consistent with sprain. With some fractures and complete muscle or tendon tears, a defect may be palpable in the affected structure.

Crepitus (a characteristic palpable and/or audible grinding produced when the joint is moved) may be a sign of fracture.

Gross joint instability suggests dislocation or severe ligamentous disruption.

Some **partial tendon tears** escape initial clinical detection because function appears intact. Any of the following suggests partial tendon tears:

– tendon tenderness;
– pain when the joint is moved through its range of motion;
– dysfunction;
– weakness;
– palpable defects.

Partial tendon tears may progress to complete tears if patients continue to use the injured part. If the mechanism of injury or examination suggests a partial tendon injury or if the examination is inconclusive, a splint should be applied to limit motion and thus the potential for further injury. Subsequent examination, occasionally supplemented with MRI, may further delineate the extent of injury.

Imaging

Not all limb injuries require imaging. Some fractures are minor and are treated similarly to soft-tissue injuries. For example, most injuries of toes 2 through 5 and many fingertip injuries are treated symptomatically whether a fracture is present or not; thus, x-rays are not needed. Many ankle sprains do not require x-rays during the initial evaluation because the probability of finding a fracture that would require a change in treatment is acceptably low; for ankle sprains, explicit, generally accepted criteria for obtaining x-rays can help limit x-rays to patients that are more likely to have a fracture requiring specific treatment.

Plain x-rays are done first; they show primarily bone (and joint effusion secondary to bleeding or occult fracture) and thus are useful for diagnosing dislocations and fractures rather than sprains. They should include at least 2 views taken in different planes (usually anteroposterior and lateral views).

Additional views (eg, oblique) may be done when:

– the evaluation suggests fracture and 2 projections are negative;

– they are routine for certain joints (eg, a mortise view for evaluating an ankle, an oblique view for evaluating a foot);

– certain abnormalities are suspected (eg, Y view of the shoulder when posterior dislocation is suspected);

For lateral views of digits, the digit of interest should be separated from the others.

MRI or **CT** can be used if a fracture is not visible on plain x-rays but is strongly suspected clinically (common with scaphoid fractures and impacted femoral neck (subcapital) hip fractures) or if more detail is needed to guide treatment (eg, for scapular fractures, pelvic fractures, or intraarticular fractures). For example, if findings after a fall suggest hip fracture but x-rays are normal, MRI should be done to check for an occult hip fracture. MRI can also be done to identify soft-tissue injuries, including ligament, tendon, cartilage, and muscle injuries.

Fracture description

A fracture’s appearance on x-rays can be described relatively precisely using the following terms:

– type of fracture line;
– location of fracture line;
– displacement;
– open or closed.

Classification by the type of fracture line:

– longitudinal;
– oblique;
– transverse;
– spiral;
– T – shaped;
– V – shaped.

Terms for location include:

– dorsal or volar;
– epiphysis (sometimes involving the articular surface), which can refer to the proximal end of the bone or the distal end;
– metaphysis (neck—the part of a long bone between the epiphysis and diaphysis);
– diaphysis (shaft, divided into the proximal, middle, or distal third).

Distraction, displacement, angulation, or shortening (overriding) may occur.

Distraction is separation in the longitudinal axis.

Displacement is the degree to which the fractured ends are out of alignment with each other; it is described in millimeters or bone width percentage.

Angulation is the angle of the distal fragment measured from the proximal fragment.

Displacement and angulation may occur in the ventral-dorsal plane, lateral-medial plane, or both.

Open fracture (compound) – the fractured bone has broken the skin.

Closed fracture (simple) – the fractured bone has not broken the skin.

Treatment

- treatment of associated injuries;
- reduction as indicated, splinting, and analgesia;
- RICE (rest, ice, compression, and elevation) or PRICE (including protection) as indicated;
- usually immobilization;
- sometimes surgery.

Initial treatment

Hemorrhagic shock is treated immediately. Injuries to arteries are surgically repaired unless they affect only small arteries with good collateral circulation. Severed nerves are surgically repaired; for neuropraxia and axonotmesis, initial treatment is usually observation, supportive measures, and sometimes physical therapy. Suspected open fractures or dislocations require sterile wound dressings, tetanus prophylaxis, broad-spectrum antibiotics (eg, a 2nd-generation cephalosporin plus an aminoglycoside), and surgery to irrigate and debride them (and thus prevent infection).

Most moderate and severe injuries, particularly grossly unstable ones, are immobilized immediately by splinting (immobilization with a nonrigid or noncircumferential device) to decrease pain and to prevent further injury to soft tissues by unstable injuries. In patients with long-bone fractures, splinting may prevent fat embolism.

Pain is treated as soon as possible, typically with opioids.

After initial treatment, injuries are reduced, immobilized, and treated symptomatically as indicated.

Many 3rd-degree sprains and tendon tears and some dislocations in which structures supporting the joint are damaged require surgical repair.

Reduction

Rotational malalignment or significant angulation or displacement of fractures is typically treated with reduction (realignment of bones or bone fragments by manipulation), which usually requires analgesia and/or sedation. Exceptions include some fractures in children in which remodeling over time can correct significant deformities.

PRICE

Patients who have soft-tissue injuries, with or without other musculoskeletal injuries, may benefit from PRICE (protection, rest, ice, compression, elevation), although this practice is not supported by strong evidence.

Protection helps prevent further injury. It may involve limiting the use of an injured part, applying a splint or cast, or using crutches.

Rest may prevent further injury and speed healing.

Ice and **compression** may minimize swelling and pain. Ice is enclosed in a plastic bag or towel and applied intermittently during the first 24 to 48 h (for 15 to 20 min, as often as possible). Injuries can be compressed by a splint, an elastic bandage, or, for certain injuries likely to cause severe swelling, a Jones compression dressing. The Jones dressing is 4 layers; layers 1 (the innermost) and 3 are cotton batting, and layers 2 and 4 are elastic bandages.

Elevating the injured limb above the heart for the first 2 days in a position that provides an uninterrupted downward path; such a position allows gravity to help drain edema fluid and minimize swelling.

After 48 h, periodic application of warmth (eg, a heating pad) for 15 to 20 min may relieve pain and speed healing.

Immobilization

Immobilization decreases pain and facilitates healing by preventing further injury and keeping the fracture ends in alignment. Joints proximal and distal to the injury should be immobilized.

Most fractures are immobilized for weeks in a cast (a rigid, circumferential device). A few rapidly healing, stable fractures (eg, buckle wrist fractures in children) are not casted; early mobilization has the best results.

First-degree sprains are immobilized briefly if at all; early mobilization is best. Mild 2nd-degree sprains are often immobilized with a sling or splint for a few days. Severe 2nd-degree and some 3rd-degree sprains and tendon tears are immobilized for days or weeks, sometimes with a cast. Many 3rd-degree sprains require surgery; usually, immobilization is only adjunctive therapy.

A **cast** is usually used for fractures or other injuries that require weeks of immobilization. Rarely, swelling under a cast is severe enough to contribute to compartment syndrome. If clinicians suspect severe swelling under a cast, the cast (and all padding) is cut open from end to end medially and laterally (bivalved).

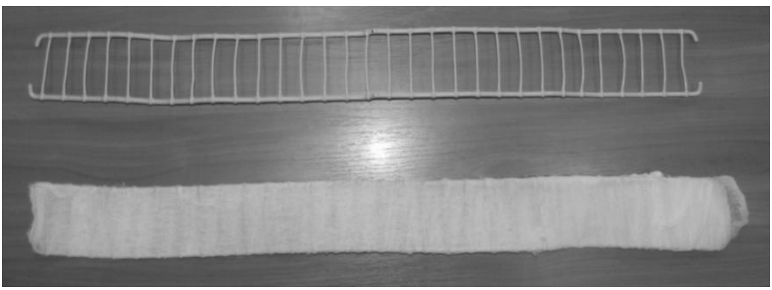

Figure 11 – **The splint of Cramer**

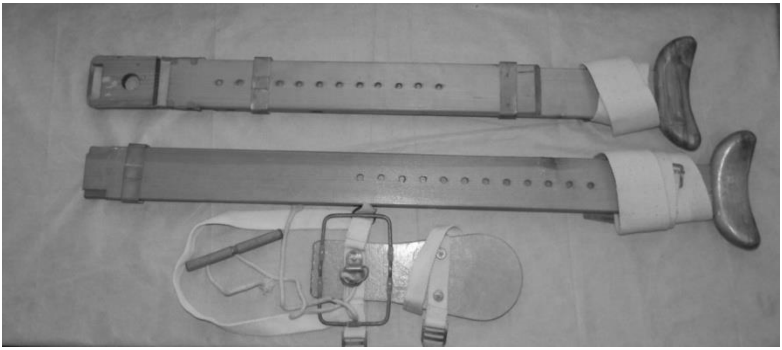

Figure 12 – **The splint of Diterikhs**

A **splint** can be used to immobilize some stable injuries, including some suspected but unproven fractures, rapidly healing fractures, sprains, and other injuries that require immobilization for several days or less (figure 11, 12). A splint is noncircumferential; thus, it enables patients to apply ice and to move more than a cast does. Also, it allows for some swelling, so it does not contribute to compartment syndrome. Some injuries that ultimately require casting are immobilized initially with a splint until most of the swelling resolves (figure 12).

A **sling** provides some degree of support and limits mobility; it can be useful for injuries that are adversely affected by complete immobilization (eg, for shoulder injuries, which, if completely immobilized, can rapidly lead to adhesive capsulitis [frozen shoulder]).

A **swathe** (a piece of cloth or a strap) may be used with a sling to prevent the arm from swinging outward, especially at night. The swathe is wrapped around the back and over the injured part.

Figure 13 – **Fixation via Diterikhs splint in hip fractures**

6 THE DEFEAT OF POISONOUS SUBSTANCES. EMERGENCY CARE IN POISONING

Poisoning is contact with a substance that results in toxicity. Symptoms vary, but certain common syndromes may suggest particular classes of poisons. Diagnosis is primarily clinical, but for some poisonings, blood and urine tests can help. Treatment is supportive for most poisonings; specific antidotes are necessary for a few. Prevention includes labeling drug containers clearly and keeping poisons out of the reach of children**.**

In Ukraine in 2005 as a result of accidental alcohol poisoning killed 9614 people, other poisoning – 3684. In 2005 as a result of accidental alcohol poisoning killed 8119 people. In Ukraine number of deaths per 100 thousand people from alcohol poisoning is 20,4 persons. In Sumy region number of deaths per 100 thousand people from alcohol poisoning is 45,6 persons

Most poisonings are dose-related. Dose is determined by concentration over time. Toxicity may result from exposure to excess amounts of normally nontoxic substances. Some poisonings result from exposure to substances that are poisonous at all doses. Poisoning is distinguished from hypersensitivity and idiosyncratic reactions, which are unpredictable and not dose-related, and from intolerance, which is a toxic reaction to a usually nontoxic dose of a substance.

Poisoning is commonly due to ingestion but can result from injection, inhalation, or exposure of body surfaces (eg, skin, eye, mucous membranes). Many commonly ingested nonfood substances are generally nontoxic; however, almost any substance can be toxic if ingested in excessive amounts.

Accidental poisoning is common among young children, who are curious and ingest items indiscriminately despite noxious tastes and odors; usually, only a single substance is involved. Poisoning is also common among older children, adolescents, and adults attempting suicide; multiple drugs, including alcohol, acetaminophen, and other OTC drugs, may be involved. Accidental poisoning may occur in the elderly because of confusion, poor eyesight, mental impairment, or multiple prescriptions of the same drug by different physicians.

Occasionally, people are poisoned by someone who intends to kill or disable them (eg, to rape or rob them). Drugs used to disable (eg, scopolamine, benzodiazepines, γ-hydroxybutyrate) tend to have sedative or amnestic properties or both. Rarely, parents, who may have some medical knowledge, poison their children because of unclear psychiatric reasons or a desire to cause illness and thus gain medical attention (a disorder called factitious disorder imposed on another [formerly called Munchausen syndrome by proxy]).

After exposure or ingestion and absorption, most poisons are metabolized, pass through the GI tract, or are excreted. Occasionally, tablets (eg, aspirin, iron, enteric-coated drugs) form large concretions (bezoars) in the GI tract, where they tend to remain, continuing to be absorbed and causing toxicity.

Way penetration poison:

1. Through the mouth.
2. By inhalation.
3. Through skin.
4. Parenteral.
5. The introduction of various cavity (rectum, vaginal, ear canal).
6. In the wound (bites of poisonous animals, plants, spider).

Classification of poisons by origin:

1. Industrial poisons.
2. Agricultural poison (pesticides, insecticides, herbicides).
3. Household poisons.
4. Drugs.

5. Warfare agents (sarin, Zaman, W gas, phosgene, lewisite).
6. Biological poisons (animals and plants).

Classification of the clinical course of poisoning:

I. Acute (rapid onset).
II. Subacute poisoning.
III. Chronic poisoning (alcoholism).

Symptoms and signs

Symptoms and signs of poisoning vary depending on the substance. Also, different patients poisoned with the same substance may present with very different symptoms. However, 6 clusters of symptoms (toxic syndromes, or toxidromes) occur commonly and may suggest particular classes of. Patients who ingest multiple substances are less likely to have symptoms characteristic of a single substance.

Symptoms:

– headach;
– dizziness;
– nausea;
– vomiting;
– chest pain;
– confusion;
– irritability;
– loss of consciousness;
– fever;
– cramps;
– shortness of breath;
– kidney insufficiency;
– liver insufficiency.

Treatment:

– supportive care;
– activated charcoal for serious oral poisonings;
– occasional use of specific antidotes or dialysis;
– only rare use of gastric emptying.

Seriously poisoned patients may require assisted ventilation or treatment of cardiovascular collapse. Patients with impaired consciousness may require continuous monitoring or restraints. The discussion of treatment for specific poisonings, below and in see, is general and does not include specific complexities and details. Consultation with a poison control center is recommended for any poisonings except the mildest and most routine.

Initial stabilization:

– maintain airway, breathing, and circulation;
– IV naloxone;
– IV dextrose and thiamine;
– IV fluids, sometimes vasopressors.

Airway, breathing, and circulation must be maintained in patients suspected of a systemic poisoning. Patients without a pulse or BP require emergency cardiopulmonary resuscitation.

If patients have apnea or compromised airways (eg, foreign material in the oropharynx, decreased gag reflex), an endotracheal tube should be inserted. If patients have respiratory depression or hypoxia, supplemental O_2 or mechanical ventilation should be provided as needed.

IV naloxone (2 mg in adults; 0.1 mg/kg in children) should be tried in patients with apnea or severe respiratory depression while maintaining airway support. In opioid addicts, naloxonemay precipitate withdrawal, but withdrawal is preferable to severe respiratory depression. If respiratory depression persists despite use of naloxone, endotracheal intubation and continuous mechanical ventilation are required. If naloxone relieves respiratory depression, patients are monitored; if respiratory depression recurs, patients should be treated with another bolus of IV naloxone or endotracheal intubation and mechanical ventilation. Using a low-dose continuous naloxone infusion to maintain respiratory drive without precipitating withdrawal has been suggested but in reality can be very difficult to accomplish.

IV dextrose (50 mL of a 50% solution for adults; 2 to 4 mL/kg of a 25% solution for children) should be given to patients with altered consciousness or CNS depression, unless hypoglycemia has been ruled out by immediate bedside determination of blood glucose.

Thiamine (100 mg IV) is given with or before glucose to adults with suspected thiamine deficiency (eg, alcoholics, undernourished patients).

IV fluids are given for hypotension. If fluids are ineffective, invasive hemodynamic monitoring may be necessary to guide fluid and vasopressor therapy. The first-choice vasopressor for most poison-induced hypotension is norepinephrine 0.5 to 1 mg/min IV infusion, but treatment should not be delayed if another vasopressor is more immediately available.

Topical decontamination

Any body surface (including the eyes) exposed to a toxin is flushed with large amounts of water or saline. Contaminated clothing, including shoes and socks, and jewelry should be removed. Topical patches and transdermal delivery systems are removed.

Activated charcoal

Charcoal is usually given, particularly when multiple or unknown substances have been ingested. Use of charcoal adds little risk (unless patients are at risk of vomiting and aspiration) but has not been proved to reduce overall morbidity or mortality. When used, charcoal is given as soon as possible. Activated charcoal adsorbs most toxins because of its molecular configuration and large surface area. Multiple doses of activated charcoal may be effective for substances that undergo enterohepatic recirculation (eg, phenobarbital, theophylline) and for sustained-release preparations. Charcoal may be given at 4- to 6-h intervals for serious poisoning with such substances unless bowel sounds are hypoactive. Charcoal is ineffective for caustics, alcohols, and simple ions (eg, cyanide, iron, other metals, lithium).

The recommended dose is 5 to 10 times that of the suspected toxin ingested. However, because the amount of toxin ingested is usually unknown, the usual dose is 1 to 2 g/kg, which is about 10 to 25 g for children < 5 yr and 50 to 100 g for older children and adults. Charcoal is given as a slurry in water or soft drinks. It may be unpalatable and results in vomiting in 30% of patients. Administration via a gastric tube may be considered, but caution should be used to prevent trauma caused by tube insertion or aspiration of charcoal; potential benefits must outweigh risks. Activated charcoal should probably be used without sorbitol or other cathartics, which have no clear benefit and can cause dehydration and electrolyte abnormalities.

Gastric emptying

Gastric emptying, which used to be well-accepted and seems intuitively beneficial, should not be routinely done. It does not clearly reduce overall morbidity or mortality and has risks. Gastric emptying is considered if it can be done within 1 h of a life-threatening ingestion. However, many poisonings manifest too late, and whether a poisoning is life threatening is not always clear. Thus, gastric emptying is seldom indicated and, if a caustic substance has been ingested, is contraindicated.

If gastric emptying is used, gastric lavage is the preferred method. Gastric lavage may cause complications such as epistaxis, aspiration, or, rarely, oropharyngeal or esophageal injury. Syrup of ipecac has unpredictable effects, often causes prolonged vomiting, and may not remove substantial amounts of poison from the stomach. Syrup of ipecac may be warranted if the ingested agent is highly toxic and transport time to the emergency department is unusually long, but this is uncommon in the US.

For gastric lavage, tap water is instilled and withdrawn from the stomach via a tube. The largest tube possible is used so that tablet fragments can be retrieved. If patients have altered consciousness or a weak gag reflex, endotracheal intubation should be done before lavage to prevent aspiration. Patients are placed in the left lateral decubitus position to prevent aspiration, and the tube is inserted orally. Because lavage sometimes forces substances farther into the GI tract, stomach contents should be aspirated and a 25-g dose of charcoal should be instilled through the tube immediately after insertion. Then aliquots (about 3 mL/kg) of tap water are instilled, and the gastric contents are withdrawn by gravity or syringe. Lavage continues until the withdrawn fluids appear free of the substance; usually, 500 to 3000 mL of fluid must be instilled. After lavage, a 2nd 25-g dose of charcoal is instilled.

Whole-bowel irrigation

This procedure flushes the GI tract and theoretically decreases GI transit time for pills and tablets. Irrigation has not been proved to reduce morbidity or mortality. Irrigation is indicated for any of the following:

– some serious poisonings due to sustained-release preparations or substances that are not adsorbed by charcoal (eg, heavy metals);
– drug packets (eg, latex-coated packets of heroin or cocaine ingested by body packers);
– a suspected bezoar.

A commercially prepared solution of polyethylene glycol (which is nonabsorbable) and electrolytes is given at a rate of 1 to 2 L/h for adults or at 25 to 40 mL/kg/h for children until the rectal effluent is clear; this process may require many hours or even days. The solution is usually given via a gastric tube, although some motivated patients can drink these large volumes.

Alkaline diuresis

Alkaline diuresis enhances elimination of weak acids (eg, salicylates, phenobarbital). A solution made by combining 1 L of 5% D/W with 3 50-mEq ampules of $NaHCO_3$ and 20 to 40 mEq of K can be given at a rate of 250 mL/h in adults and 2 to 3 mL/kg/h in children. Urine pH is kept at >8, and K must be repleted. Hypernatremia, alkalemia, and fluid overload may occur but are usually not serious. However, alkaline diuresis is contraindicated in patients with renal insufficiency.

Dialysis

Common toxins that may require dialysis or hemoperfusion include:

– ethylene glycol;
– lithium;
– methanol;
– salicylates;
– theophylline.

These therapies are less useful if the poison is a large or charged (polar) molecule, has a large volume of distribution (ie, if it is stored in fatty tissue), or is extensively bound to tissue protein (as with digoxin, phencyclidine, phenothiazines, or tricyclic antidepressants). The need for dialysis is usually determined by both laboratory values and clinical status. Methods of dialysis include hemodialysis, peritoneal dialysis, and lipid dialysis (which removes lipid-soluble substances from the blood), as well as hemoperfusion.

Specific antidotes

Chelating drugs are used for poisoning with heavy metals and occasionally with other drugs. Fat emulsions in 10% and 20% concentrations and high-dose insulin therapy have been used to successfully treat several different cardiac toxins (eg, bupivacaine, verapamil).

Ongoing supportive measures

Most symptoms (eg, agitation, sedation, coma, cerebral edema, hypertension, arrhythmias, renal failure, hypoglycemia) are treated with the usual supportive measures.

Drug-induced hypotension and arrhythmias may not respond to the usual drug treatments. For refractory hypotension, dopamine, epinephrine, other vasopressors, an intra-aortic balloon pump, or even extracorporeal circulatory support may be considered.

For refractory arrhythmias, cardiac pacing may be necessary. Often, torsades de pointes can be treated with Mg sulfate 2 to 4 g IV, overdrive pacing, or a titrated isoproterenol infusion.

Seizures are first treated with benzodiazepines. Phenobarbital or phenytoin can also be used. Severe agitation must be controlled; benzodiazepines in large doses, other potent sedatives (eg,propofol), or, in extreme cases, induction of paralysis and mechanical ventilation may be required.

Hyperthermia is treated with aggressive sedation and physical cooling measures rather than with antipyretics. Organ failure may ultimately require kidney or liver transplantation.

Hospital admission

General indications for hospital admission include altered consciousness, persistently abnormal vital signs, and predicted delayed toxicity. For example, admission is considered if patients have ingested sustained-release preparations, particularly of drugs with potentially serious effects (eg, cardiovascular drugs). If there are no other reasons for admission, if indicated laboratory test results are normal, and if symptoms are gone after patients have been observed for 4 to 6 h, most patients can be discharged. However, if ingestion was intentional, patients require a psychiatric evaluation.

7 ACCIDENTS AT NUCLEAR AND RADIATION HAZARDOUS OBJECTS, THEIR MEDICAL AND TACTICAL CHARACTERISTICS. MEDICAL-EVACUATION CENTER IN RADIATION AND MEDICAL EVACUATION STAGES

Nowadays more than 450 nuclear reactors exist in the world, they produce more than 20% of the whole volume of electric power. There are 5 atomic electric stations in Ukraine, which have 15 power units.

Radiation disaster is an incident on the object with nuclear technology, when there is no control above the source of ionic radiation, which causes the irradiation of people.

Radiation disasters are divided into groups:

I. Industrial.

II. Communal:

1) local (less than 10 000 people are injected);
2) regional (more than 10 000 people are injected);
3) global (Consequences engulf the major part of the country).

Ionizing radiation injures tissues variably, depending on factors such as radiation dose, rate of exposure, type of radiation, and part of the body exposed. Symptoms may be local (eg, burns) or systemic (eg, acute radiation sickness). Diagnosis is by history of exposure, symptoms and signs, and sometimes use of radiation detection equipment to localize and identify radionuclide contamination. Management focuses on associated traumatic injuries, decontamination, supportive measures, and minimizing exposure of health care workers. Patients with severe acute radiation sickness receive reverse isolation and bone marrow support. Patients internally contaminated with certain specific radionuclides may receive uptake inhibitors or chelating agents. Prognosis is initially estimated by the time between exposure and symptom onset, the severity of those symptoms, and by the lymphocyte count during the initial 24 to 72 h.

Ionizing radiation is emitted by radioactive elements and by equipment such as x-ray and radiation therapy machines

Measurement of radiation

Conventional units of measurement include the roentgen, rad, and rem. The roentgen (R) is a unit of exposure measuring the ionizing ability of x-rays or gamma radiation in air. The radiation absorbed dose (rad) is the amount of that radiation energy absorbed per unit of mass. Because biologic damage per rad varies with radiation type (eg, it is higher for neutrons than for x-rays or gamma radiation), the dose in rad is corrected by a quality factor; the resulting equivalent dose unit is the roentgen equivalent in man (rem). Outside the US and in the scientific literature, SI (International System) units are used, in which the rad is replaced by the gray (Gy) and the rem by the sievert (Sv); 1 Gy = 100 rad and 1 Sv = 100 rem. The rad and rem (and hence Gy and Sv) are essentially equal (ie, the quality factor equals 1) when describing x-rays or gamma or beta radiation.

The amount (quantity) of radioactivity is expressed in terms of the number of nuclear disintegrations (transformations) per second. The becquerel (Bq) is the SI unit of radioactivity; one Bq is 1 disintegration per second (dps). In the US system, one curie is 37 billion Bq.

Types of exposure

Radiation exposure may involve:

– contamination;
– irradiation.

Radioactive contamination is the unintended contact with and retention of radioactive material, usually as a dust or liquid. Contamination may be:

– external;

– internal.

External contamination is that on skin or clothing, from which some can fall or be rubbed off, contaminating other people and objects. Internal contamination is unintended radioactive material within the body, which it may enter by ingestion, inhalation, or through breaks in the skin. Once in the body, radioactive material may be transported to various sites (eg, bone marrow), where it continues to emit radiation until it is removed or decays.

Internal contamination is more difficult to remove. Although internal contamination with any radionuclide is possible, historically, most cases in which contamination posed a significant risk to the patient involved a relatively small number of radionuclides, such as phosphorus-32, cobalt-60, strontium-90, cesium-137, iodine-131, iodine-125, radium-226, uranium-235, uranium-238, plutonium-238, plutonium-239, polonium-210, and americium-241.

Irradiation is exposure to radiation but not radioactive material (ie, no contamination is involved). Radiation exposure can occur without the source of radiation (eg, radioactive material, x-ray machine) being in contact with the person. When the source of the radiation is removed or turned off, exposure ends. Irradiation can involve the whole body, which, if the dose is high enough, can result in systemic symptoms and radiation syndromes, or a small part of the body (eg, from radiation therapy), which can result in local effects. People do not emit radiation (ie, become radioactive) following irradiation.

Sources of exposure

Sources may be naturally occurring or artificial.

People are constantly exposed to low levels of naturally occurring radiation called background radiation. Background radiation comes from cosmic radiation and from radioactive elements in the air, water, and ground. Cosmic radiation is concentrated at the poles by the earth's magnetic field and is attenuated by the atmosphere. Thus, exposure is greater for people living at high latitudes, at high altitudes, or both and during airplane flights. Terrestrial sources of external radiation exposure are primarily due to the presence of radioactive elements with half-lives comparable to the age of the earth (~4.5 billion years). In particular, uranium (^{238}U) and thorium (^{232}Th) along with several dozen of their radioactive progeny and a radioactive isotope of potassium (^{40}K) are present in many rocks and minerals. Small quantities of these radionuclides are in the food, water, and air and thus contribute to internal exposure as these radionuclides are invariably incorporated into the body. The majority of the dose from internally incorporated radionuclides is from radioisotopes of carbon (^{14}C) and potassium (^{40}K), and because these and other elements (stable and radioactive forms) are constantly replenished in the body by ingestion and inhalation, there are approximately 7,000 atoms undergoing radioactive decay each second.

Internal exposure from the inhalation of radioactive isotopes of the noble gas radon (^{222}Rn and ^{220}Rn), which are also formed from the Uranium (^{238}U) decay series, accounts for the largest portion (73%) of the US population's average per capita naturally occurring radiation dose. Cosmic radiation accounts for 11%, radioactive elements in the body for 9%, and external terrestrial radiation for 7%. In the US, people receive an average effective dose of about 3 millisieverts (mSv)/yr from natural sources (range ~0.5 to 20 mSv/yr). However, in some parts of the world, people receive > 50 mSv/yr. The doses from natural background radiation are far too low to cause radiation injuries; they may result in a small increase in the risk of cancer, although some experts think there is no increased risk.

In the US, people receive on the average about 3 mSv/yr from man-made sources, the vast majority of which involve medical imaging. On a per capita basis, the contribution of exposure from medical imaging is highest for CT and nuclear cardiology procedures. However, medical diagnostic procedures rarely impart doses sufficient to cause radiation injury, although there is a small theoretical increase in the risk of cancer. Exceptions may include certain prolonged fluoroscopically guided interventional procedures (eg, endovascular reconstruction, vascular embolization, cardiac and tumor radiofrequency ablation); these procedures have caused injuries to skin and underlying tissues. Radiation therapy can also cause injury to normal tissues near the target tissue.

A very small portion of average public exposure results from radiation accidents and fallout from nuclear weapons testing. Accidents may involve industrial irradiators, industrial radiography sources, and nuclear reactors. These accidents commonly result from failure to follow safety procedures (eg, interlocks being bypassed). Radiation injuries have also been caused by lost or stolen medical or industrial sources containing large quantities of the radionuclide. People seeking medical care for these injuries may be unaware that they were exposed to radiation.

Unintended releases of radioactive material have occurred, including from the Three Mile Island plant in Pennsylvania in 1979, the Chernobyl reactor in Ukraine in 1986, and the Fukushima Daiichi nuclear power facility in Japan in 2011. Exposure from Three Mile Island was minimal because there was no breach of the containment vessel as occurred at Chernobyl and no hydrogen explosion as occurred at Fukushima. People living within 1.6 km of Three Mile Island received at most only about 0.08 mSv (a fraction of what is received from natural sources in a month). However, the 115,000 people who were eventually evacuated from the area around the Chernobyl plant received an average effective dose of about 30 mSv and an average thyroid dose of about 490 mGy. People working at the Chernobyl plant at the time of the accident received significantly higher doses. More than 30 workers and emergency responders died within a few months of the accident, and many more experienced acute radiation sickness. Low-level contamination from that accident was detected as far away as Europe, Asia, and even (to a lesser extent) North America. The average cumulative exposure for the general population in various affected regions of Belarus, Russia, and Ukraine over a 20-yr period after the accident was estimated to be about 9 mSv. The earthquake and tsunami in Japan in 2011 led to releases of radioactive material into the environment from several reactors at the Fukushima Daiichi nuclear power plant. There were no serious radiation-induced injuries to on-site workers. Among nearly 400,000 residents in Fukushima prefecture, the estimated effective dose (based on interviews and dose reconstruction modeling) was < 2 mSv for 95% of the people and < 5 mSv for 99.8%. WHO estimates were somewhat higher because of intentionally more conservative assumptions regarding exposure. The effective dose in prefectures not immediately adjacent to Fukushima was estimated to be between 0.1 to 1 mSv, and the dose to populations outside of Japan was negligible (< 0.01 mSv).

Another significant radiation event was the detonation of 2 atomic bombs over Japan in August 1945, which caused about 110,000 deaths from the immediate trauma of the blast and heat. A much smaller number (< 600) of excess deaths due to radiation-induced cancer have occurred over the ensuing 60 yr. Ongoing health surveillance of the survivors remains among the most important sources of estimates of radiation-induced cancer risk.

While several criminal cases of intentional contamination of individuals have been reported, radiation exposure to a population as a result of terrorist activities has not occurred but remains a concern. A possible scenario involves the use of a device to contaminate an area by dispersing radioactive material (eg, from a discarded radiotherapy source of cesium-137). A radiation dispersal device (RDD) that uses conventional explosives is referred to as a dirty bomb. Other terrorist scenarios include using a hidden radiation source to expose unsuspecting people to large doses of radiation, attacking a nuclear reactor or radioactive material storage facility, and detonating a nuclear weapon (eg, an improvised nuclear device [IND], a stolen weapon).

Factors affecting response

Biologic response to radiation varies with:
– tissue radiosensitivity;
– dose;
– duration of exposure;
– the age of the patient.

Cells and tissues differ in their radiosensitivity. In general, cells that are undifferentiated and those that have high mitotic rates (eg, stem cells, cancer cells) are particularly vulnerable to radiation. Because radiation preferentially depletes rapidly dividing stem cells over the more resistant mature cells, there is typically a latent period between radiation exposure and overt radiation injury. Injury does not manifest until a significant fraction of the mature cells die of natural senescence and, due to loss of stem cells, are not replaced.

Cellular sensitivities in approximate descending order from most to least sensitive are:
– lymphoid cells;
– germ cells;
– proliferating bone marrow cells;
– intestinal epithelial cells;
– epidermal stem cells;
– hepatic cells;
– epithelium of lung alveoli and biliary passages;

– kidney epithelial cells;
– endothelial cells (pleura and peritoneum);
– connective tissue cells;
– bone cells;
– muscle, brain, and spinal cord cells.

The severity of radiation injury depends on the dose and the length of time over which it is delivered. A single rapid dose is more damaging than the same dose given over weeks or months. Dose response also depends on the fraction of the body exposed. Significant illness is certain, and death is possible, after a whole-body dose >4.5 Gy delivered over a short time interval; however, 10s of Gy can be well tolerated when delivered over a long period to a small area of tissue (eg, for cancer therapy).

Other factors can increase the sensitivity to radiation injury. Children are more susceptible to radiation injury because they have a higher rate of cellular proliferation. People who are homozygous for the ataxia-telangiectasia gene exhibit greatly increased sensitivity to radiation injury. Disorders, such as connective tissue disorders and diabetes, may increase sensitivity to radiation injury. Chemotherapeutic agents may also increase sensitivity to radiation injury.

Symptoms and Signs

Clinical manifestations depend on whether radiation exposure involves the whole body (acute radiation syndrome) or is limited to a small portion of the body (focal radiation injury).

Acute radiation syndromes (ARS)

After the whole body, or a large portion of the body, receives a high dose of penetrating radiation, several distinct syndromes may occur:
– cerebrovascular syndrome;
– gastrointestinal syndrome;
– hematopoietic syndrome.

These syndromes have 3 different phases:

– prodromal phase (minutes to 2 days after exposure): Lethargy and GI symptoms (nausea, anorexia, vomiting, diarrhea) are possible;
– latent asymptomatic phase (hours to 21 days after exposure).
– overt systemic illness phase (hours to > 60 days after exposure): illness is classified by the main organ system affected;

Which syndrome develops, how severe it is, and how quickly it progresses depend on radiation dose. The symptoms and time course are fairly consistent for a given dose of radiation and thus can help estimate radiation exposure.

The **cerebrovascular syndrome,** the dominant manifestation of extremely high whole-body doses of radiation (> 30 Gy), is always fatal. The prodrome develops within minutes to 1 h after exposure. There is little or no latent phase. Patients develop tremors, seizures, ataxia, and cerebral edema and die within hours to 1 or 2 days.

The **GI syndrome** is the dominant manifestation after whole-body doses of about 6 to 30 Gy. Prodromal symptoms, often marked, develop within about 1 h and resolve within 2 days. During the latent period of 4 to 5 days, GI mucosal cells die. Cell death is followed by intractable nausea, vomiting, and diarrhea, which lead to severe dehydration and electrolyte imbalances, diminished plasma volume, and vascular collapse. Necrosis of intestine may also occur, predisposing to intestinal perforation, bacteremia, and sepsis. Death is common. Patients receiving > 10 Gy may have cerebrovascular symptoms (suggesting a lethal dose). Survivors also have the hematopoietic syndrome.

The **hematopoietic syndrome** is the dominant manifestation after whole-body doses of about 1 to 6 Gy and consists of a generalized pancytopenia. A mild prodrome may begin after 1 to 6 h, lasting 24 to 48 h. Bone marrow stem cells are significantly depleted, but mature blood cells in circulation are largely unaffected. Circulating lymphocytes are an exception, and lymphopenia may be evident within hours to days after exposure. As the cells in circulation die by senescence, they are not replaced in sufficient numbers, resulting in pancytopenia. Thus, patients remain asymptomatic during a latent period of up to 4.5 wk after a 1-Gy dose as the impediment of hematopoiesis progresses.. Risk of various infections is increased as a result of the neutropenia (most prominent at 2 to 4 wk) and decreased antibody production. Petechiae and mucosal bleeding result from thrombocytopenia, which develops within 3 to 4 wk and may persist for months. Anemia develops slowly, because preexisting RBCs have a longer life span than WBCs and platelets. Survivors have an increased incidence of radiation-induced cancer, including leukemia.

Cutaneous radiation injury (CRI) is injury to the skin and underlying tissues due to acute radiation doses as low as 3 Gy. CRI can occur with ARS or with focal radiation exposure and ranges from mild transient erythema to necrosis. Delayed effects (> 6 mo after exposure) include hyperpigmentation and hypopigmentation, progressive fibrosis, and diffuse telangiectasia. Thin atrophic skin can be easily damaged by mild mechanical trauma. Exposed skin is at increased risk of squamous cell carcinoma. In particular, the possibility of radiation exposure should be considered when patients present with a painful nonhealing skin burn without a history of thermal injury.

Focal injury

Radiation to almost any organ can have both acute and chronic adverse effects. In most patients, these adverse effects result from radiation therapy. Other common sources of exposure include inadvertent contact with unsecured food irradiators, radiation therapy equipment, x-ray diffraction equipment, and other industrial or medical radiation sources capable of producing high dose rates. Also, prolonged exposure to x-rays during certain interventional procedures done under fluoroscopic guidance can result in CRI. Radiation-induced sores or ulcers may take months or years to fully develop. Patients with severe CRI have severe pain and often require surgical intervention.

Diagnosis:

- symptoms, severity, and symptom latency;
- serial absolute lymphocyte counts and serum amylase levels.

Diagnosis is by history of exposure, symptoms and signs, and laboratory testing. The onset, time course, and severity of symptoms can help determine radiation dose and thus also help triage patients relative to their likely consequences. However, some prodromal symptoms (eg, nausea, vomiting, diarrhea, tremors) are nonspecific, and causes other than radiation should be considered. Many patients without sufficient exposure to cause acute radiation syndromes may present with similar, nonspecific symptoms, particularly after a terrorist attack or reactor accident, when anxiety is high.

After acute radiation exposure, CBC with differential and calculation of absolute lymphocyte count is done and repeated 24, 48, and 72 h after exposure to estimate the initial radiation dose and prognosis. The relationship between dose and lymphocyte counts can be altered by physical trauma, which can shift lymphocytes from the interstitial spaces into the vasculature, raising the lymphocyte count. This stress-related increase is transient and typically resolves within 24 to 48 h after the physical insult. The CBC is repeated weekly to monitor bone marrow activity and as needed based on the clinical course. Serum amylase level rises in a dose-dependent fashion beginning 24 h after significant radiation exposure, so levels are measured at baseline and daily thereafter.

Other laboratory test are done if feasible:

– C-reactive protein (CRP) level: CRP increases with radiation dose; levels show promise to discriminate between minimally and heavily exposed patients;
– blood citrulline level: decreasing citrulline levels indicate GI damage;
– blood fms-related tyrosine kinase-3 (FLT-3) ligand levels: FLT-3 is a marker for hematopoietic damaged
– IL-6: Marker is increased at higher radiation doses;
– quantitative granulocyte colony-stimulating factor (G-CSF) test: levels are increased at higher radiation doses;
– cytogenetic studies with over dispersion index: These studies are used to evaluate for partial body exposure.

Treatment

– treatment of severe traumatic injuries or life-threatening medical conditions first;
– minimization of health care worker radiation exposure and contamination;
– treatment of external and internal contamination;
– sometimes specific measures for particular radionuclides;
– supportive care.

Radiation exposure may be accompanied by physical injuries (eg, from burn, blast, fall). Trauma resuscitation of the seriously injured takes priority over decontamination efforts and must not be delayed awaiting special radiation management equipment and personnel. Standard universal precautions, as routinely used in trauma care, adequately protect the critical care team.

Preparation

The Joint Commission mandates that all hospitals have protocols and that personnel have training to deal with patients contaminated with hazardous material, including radioactive material. Identification of radioactive contamination on patients should prompt their isolation in a designated area (if practical), decontamination, and notification of the hospital radiation safety officer, public health officials, hazardous material teams, and law enforcement agencies as appropriate to investigate the source of radioactivity.

Treatment area surfaces may be covered with plastic sheeting to aid in facility decontamination. This preparation should never take precedence over provision of medical stabilization procedures. Waste receptacles (labeled "Caution, Radioactive Material"), sample containers, and Geiger counters should be readily available. All equipment that has come into contact with the room or with the patient (including ambulance equipment) should remain isolated until lack of contamination has been verified. An exception is a mass casualty situation, during which lightly contaminated critical equipment such as helicopters, ambulances, trauma rooms, and x-ray, CT, and surgical facilities, should be quickly decontaminated to the extent possible and returned to service.

Personnel involved in treating or transporting the patient should follow standard precautions, wearing caps, masks, gowns, gloves, and shoe covers. Used gear should be placed in specially marked bags or containers. Dosimeter badges should be worn to monitor radiation exposure. Personnel may be rotated to minimize exposure, and pregnant personnel should be excluded from the treatment area.

Due to the low exposure rates anticipated from most contaminated patients, medical staff members caring for typical patients are unlikely to receive doses in excess of the occupational limit of 0.05 Sv/yr. Even in the extreme case of radiation casualties from the Chernobyl nuclear reactor accident, medical personnel who treated patients in the hospital received < 0.01 Sv. Several authoritative sources suggest that a dose of up to at least 0.5 Gy may be considered an acceptable risk for lifesaving activity.

External decontamination

Typical sequence and priorities are:

– removing clothing and external debris;
– decontaminating wounds before intact skin;
– cleaning the most contaminated areas first;
– using a radiation survey meter to monitor progress of decontamination;
– continuing decontamination until areas are below 2 to 3 times background radiation or there is no significant reduction between decontamination efforts.

Clothes are removed carefully to minimize the spread of contamination and placed in labeled containers. Clothing removal eliminates about 90% of external contamination. Foreign objects should be considered contaminated until checked with a radiation survey meter.

Contaminated wounds are decontaminated before intact skin; they are irrigated with saline and gently scrubbed with a surgical sponge. Minimal debridement of wound edges may be done if there is residual contamination after multiple attempts at cleaning. Debridement beyond the wound margin is not required, although embedded radioactive shrapnel should be removed and placed in a lead container.

Contaminated skin and hair are washed with lukewarm water and mild detergent until radiation survey meter measurements indicate levels below 2 to 3 times normal background radiation or until successive washings do not significantly reduce contamination levels. All wounds are covered during washing to prevent the introduction of radioactive material. Scrubbing may be firm but should not abrade the skin. Special attention is usually required for fingernails and skinfolds. Hair that remains contaminated is removed with scissors or electric clippers; shaving is avoided.

Inducing sweating (eg, placing a rubber glove over a contaminated hand) may help remove residual skin contamination.

Burns are rinsed gently because scrubbing may increase injury severity. Subsequent dressing changes help remove residual contamination.

Decontamination is not necessary for patients who have been irradiated by an external source and are not contaminated.

Internal decontamination

Ingested radioactive material should be removed promptly by induced vomiting or lavage if exposure is recent. Frequent mouth rinsing with saline or dilute hydrogen peroxide is indicated for oral contamination. Exposed eyes should be decontaminated by directing a stream of water or saline laterally to avoid contaminating the nasolacrimal duct.

The urgency and importance of using more specific treatment measures depend on the type and amount of the radionuclide, its chemical form and metabolic characteristics (eg, solubility, affinity for specific target organs), the route of contamination (eg, inhalation, ingestion, contaminated wounds), and the efficacy of the therapeutic method. The decision to treat internal contamination requires knowledge of the potential risks; consultation with a specialist (eg, CDC or REAC/TS) is recommended.

Current methods to remove radioactive contaminants from the body (decorporation) include:

– saturation of the target organ (eg, potassium iodide [KI] for iodine isotopes);
– chelation at the site of entry or in body fluids followed by rapid excretion (eg, calcium or zinc diethylenetriamine penta-acetate [DTPA] for americium, californium, plutonium, and yttrium);
– acceleration of the metabolic cycle of the radionuclide by isotope dilution, (eg, water for hydrogen-3);

– precipitation of the radionuclide in the intestinal lumen followed by fecal excretion (eg, oral calcium or aluminum phosphate solutions for strontium-90);
– ion exchange in the GI tract, (eg, Prussian blue for cesium-137, rubidium-82, thallium-201).

Specific management

Symptomatic treatment is given as needed and includes managing shock and hypoxia, relieving pain and anxiety, and giving sedatives (lorazepam 1 to 2 mg IV prn) to control seizures, antiemetics (metoclopramide 10 to 20 mg IV q 4 to 6 h, prochlorperazine 5 to 10 mg IV q 4 to 6 h, or ondansetron 4 to 8 mg IV q 8 to 12 h) to control vomiting, and antidiarrheal agents (kaolin/pectin 30 to 60 mL po with each loose stool or loperamide 4 mg po initially, then 2 mg po with each loose stool) for diarrhea.

There is no specific treatment for the cerebrovascular syndrome. It is universally fatal; care should address patient comfort.

The GI syndrome is treated with aggressive fluid resuscitation and electrolyte replacement. Parenteral nutrition should be initiated to promote bowel rest. In febrile patients, broad-spectrum antibiotics (eg, imipenem 500 mg IV q 6 h) should be initiated immediately. Septic shock from overwhelming infection remains the most likely cause of death.

Management of the hematopoietic syndrome is similar to that of bone marrow hypoplasia and pancytopenia of any cause. Blood products should be transfused to treat anemia and thrombocytopenia, and hematopoietic growth factors (granulocyte colony-stimulating factor and granulocyte macrophage colony-stimulating factor) and broad-spectrum antibiotics should be given to treat neutropenia and neutropenic fever, respectively. Patients with neutropenia should also be placed in reverse isolation. With a whole-body radiation dose > 4 Gy, the probability of bone marrow recovery is poor, and hematopoietic growth factors should be given as soon as possible. Stem cell transplantation has had limited success but should be considered for exposure > 7 to 10 Gy.

Aside from regular monitoring for signs of certain disorders (eg, ophthalmic examination for cataracts, thyroid function studies for thyroid disorders), there is no specific monitoring, screening, or treatment for specific organ injury or cancer.

Prevention

Protection from radiation exposure is accomplished by avoiding contamination with radioactive material and by minimizing the duration of exposure, maximizing the distance from the source of radiation, and shielding the source. During imaging procedures that involve ionizing radiation and especially during radiation therapy for cancer, the most susceptible parts of the body (eg, gonads, thyroid, female breasts) that are not being treated or imaged are shielded by lead aprons or blocks.

Although shielding of personnel with lead aprons or commercially available transparent shields effectively reduces exposure to low-energy scattered x-rays from diagnostic and interventional imaging studies, these aprons and shields are almost useless in reducing exposure to the high-energy gamma rays produced by radionuclides that would likely be used in a terrorist incident or be released in a nuclear power plant accident. In such cases, measures that can minimize exposure include using standard precautions, undergoing decontamination efforts, and maintaining distance from contaminated patients when not actively providing care. All personnel working around radiation sources should wear dosimeter badges if they are at risk for exposures > 10% of the maximum permissible occupational dose (0.05 Sv). Self-reading electronic dosimeters are helpful for monitoring the cumulative dose received during an incident.

Public response

After widespread high-level environmental contamination from a nuclear power plant accident or intentional release of radioactive material, exposure can be reduced either by:

– sheltering in place;
– evacuating the contaminated area.

The better approach depends on many event-specific variables, including the elapsed time since initial release, whether release has stopped or is ongoing, weather conditions, availability and type of shelter, and evacuation conditions (eg, traffic, transportation availability). The public should follow the advice of local public health officials as broadcast on television or radio as to which response option is best. If in doubt, shelter in place is the best option until additional information becomes available. If sheltering is recommended, the center of a concrete or metal structure above or below grade (eg, in a basement) is best.

Consistent and concise messages from public health officials can help reduce unnecessary panic and reduce the number of emergency department visits from people at low risk, thus keeping the emergency department from being overwhelmed. Such a communication plan should be developed prior to any event. A plan to decrease the demand on emergency department resources by providing an alternative location for first aid, decontamination, and counseling of people without emergent medical problems is also recommended.

People living within 16 km (10 miles) of a nuclear power plant should have ready access to KI tablets. These tablets can be obtained from local pharmacies and some public health agencies.

Preventive drugs

Radioprotective drugs, such as thiol compounds with radical scavenging properties, have been shown to reduce mortality when given before or at the time of irradiation. Amifostine is a powerful injectable radioprotective agent in this category. It prevents xerostomia in patients undergoing radiation therapy. Although thiol compounds have good efficacy in radioprotection, these compounds cause adverse effects, such as hypotension, nausea, vomiting, and allergic reactions. Other experimental drugs and chemicals have also been shown to increase survival rates in animals if given before or during irradiation. However, these drugs can be very toxic at doses necessary to provide substantial protection, and none currently are recommended.

Tests

1. The medical grading is:

A. Dividing of victims into groups according to the principle of requirements in homogeneous treatment-prophylactic and evacuation methods depending on medical indexes and concrete terms in the hearth of catastrophe.

B. Dividing of victims into groups according to the principle of requirements in homogeneous treatment-prophylactic methods depending on medical indexes.

C. Dividing of victims into groups according to the principle of requirements in the certain types of medicare and urgency of its providing.

2. Primary purposes of the medical grading:

A. To provide victims the timely providing of necessary medicare and rational evacuation.

B. As quick as possible to extract victims from the hearth of catastrophe.

C. o provide victims the timely providing of all of types of medicare.

3. Catastrophe is:

A. The situation, caused by nature forces and accompanied by considerable people losses.

B. Disablement, destruction of buildings, equipment as the result of influence of nature forces, which is accompanied by considerable people losses.

C. Large-scale accident or other event, which has serious or tragic consequences.

4. As for the reasons of ES (Emergency Situation), which can arise on the territory of Ukraine, they are divided into:

A. Technogenic, transport, specific.

B. Natural, technogenic.

C. Natural, technogenic, socially-political.

5. Flood is:

A. Temporary flood of significant part of the land as the result of influence of nature forces.

B. Natural phenomena, which arises as the result of heavy atmospheric precipitation.

C. Catastrophic blood, caused by the wave.

6. The main striking reasons of catastrophes are:

A. Poisons, natural catastrophes, floods, earthquakes, accidents on the atomic power stations.

B. Mechanical, chemical, radiation, termal, biological.

C. Chemical, radiation, termal, biological.

7. The main elements of medical-evacuational provision:

A. Sorting, evacuation, treatment.

B. Rendering of all the types of medical service, evacuation, isolation.

C. Medical grading, rendering of all the types of medical service, evacuation.

8. **The transportation of the victim with fractures of cervical vertebrae should be:**

A. In sitting position after immobilisation his neck with Kramer's splint.

B. In lying position.

C. In lying position after applying the splint on neck and head, on the stretcher and shield.

9. To the hospital types of medicare we refer:

A. Hospital, specialized medicare.

B. Skilled, specialized medicare.

C. Pre-doctor’s, medical medicare.

10. Optimum term of rending the pre-doctor’s medicare:

A. 50 min.

B. 1 hour.

C. 2-3 hours.

11. Phases of rendering of medicare in the centre of catastrophes:

A. Isolations, rescuing, renewals.

B. Neutralizations, rendering of medical service, treatment.

C. First medical aid, medical serviceof treatment in permanent establishment of hospital.

12. Basic elements of the treating-evacuation providing:

A. Sorting, evacuation, treatment.

B. Rendering of all of types of medicare, evacuation, isolation.

C. Medical sorting, rendering of all of types of medicare, medical evacuation.

13. Accident is:

A. Dangerous event, which creates threat for people’s lives and health, on the certain object, territory or area of water, leads to destruction of buildings, equipment, transport means, breach of production and transport processes, brings harm to environment.

B. Disablement, destruction of buildings, equipment, transport means, breach of production and transport processes, which causes threat for people’s lives and health on the certain object.

C. The situation, which is caused by nature forces or people’s activity and is accompanied by mass people's affection.

14. ES (emergency situation) is:

A. The breach of normal conditions of people’s lives and activity on the object or territory, which is caused by an accident, a catastrophe, a natural disaster, or other dangerous event, which brings (or may bring) about people’s death or significant material loss.

B. The situation, caused by natural catastrophe, and as the result: the victims’ needs of medical service don’t coincide with the possibility of rendering it by regional methods.

C. The catastrophe, which caused mass loss of population on the odject or territory.

15. Phases of rendering medical service in case of a catastrophe:

A. Isolation, salvation, recovering.

B. Neutralization, rendering medical service, treatment.

C. First aid, medical service, treatment at the hospital.

16. In case of emergency victims require:

A. Probability, sequence, timeliness.

B. Sequence, timeliness.

C. Qualified medical service, sequence, timeliness.

17. The Al'gover index is:

A. Ratio of frequency of pulse to the size of systolic arterial pressure.

B. Ratio of circulatory blood volume to the volume of bleeding.

C. Ratio of systolic arterial pressure to frequency of cardiac rhytm.

18. Types of medical grading:

A. Pre-medical, medical.

B. Diagnostic, prognosis.

C. Innerpointed, evacuation-transport.

19. The optimum period of rendering the first aid in the centers of the catastrophes is:

A. 30 min.

B. 1 hour.

C. 2-4 hours.

20. The optimum period of rendering the qualified medical service is:

A. 8-12 hours.

B. 1 day.

C. 3-4 hours.

21. What does CPR stand for?

A. Cardio-Pulmonary Resuscitation.

B. Coronary Pathogen Revival.

C. Capillary Process Review.

D. Call, Plan, Respond.

22. How many chest compressions should be performed each minute when giving CPR?

A. 20.

B. 60.

C. 10.

D. 120.

23. What is the recommended compression to ventilation ratio?

A. 10:1.

B. 20:1.

C. 15:2.

D. 30:2.

24. When you deliver the first rescue breath, what should you do if the victim's chest does not rise?

A. Perform the head tilt-chin lift.

B. Deliver a sharp blow to the center of the chest.

C. Give another breath.

D. Stop performing CPR.

25. What type of breath should be given when performing rescue breathing?

A. Normal breath.

B. Shallow breat.

C. Deep breath.

D. Onion breath.

26. Where is the chest compression landmark on an adult?

A. Center of the chest.

B. Center of the chest, one finger width below the nipple line.

C. One handwidth above where the ribs meet.

D. 4 inches below the sternum.

27. How should compressions be performed on an infant?

A. With the heel of one hand.

B. With the heel of one hand and the other hand on top of the first.

C. With 4 fingers of one hand.
D. With 2 fingers of one hand.

28. What is the maximum time you should take to check for normal breathing before giving your first 2 rescue breaths?
A. 5 seconds.
B. 10 seconds.
C. 30 seconds.
D. 60 seconds.

29. Closed-chest massage provides:
A. 20-40% of normal heart emission.
B. 70% of normal heart emission.
C. Normal ventilation.

30. When the heart stops Brain Death will occur within:
A. 1-2 Minutes.
B. 5-7 Minutes.
C. 12-15 Minutes.
D. 8-10 Hours.

31. The ABCs of CPR are:
A. Air, Burns and Cuts.
B. Adults, Babies and Children.
C. Airway, Breathing and Circulation/Compressions.
D. None of the above.

32. When checking for circulation/pulse you should locate:
A. Carotid artery.
B. Brachial artery.
C. Radial artery.

33. What is the discharge energy of electric defibrullation?

A. 200, 200, 360 Joule.

B. 200, 300, 360 Joule.

C. 200, 300, 400 Joule.

34. A child's pulse in comparison to an adult's is:

A. The same.

B. Faster.

C. Slower.

35. A person suffering from Shock should normally be:

A. Placed on their back with the legs raised.

B. Placed on their back with the head raised.

C. Walked to aid poor Circulation.

36. When performing CPR the chest of an adult should be compressed:

A. 10-20 mm.

B. 20-30 mm.

C. 40-50 mm.

D. 60-80 mm.

37. The pads of an AED for an adult should be placed:

A. On the lower-left side of the victim's chest and the lower-right side.

B. On the upper-right side of the victim's chest and the lower-left side.

C. On the upper-left side of the victim's chest and the lower-right side.

D. On the upper-left side of the victim's chest and the upper-right side.

38. When administering CPR to an infant:

A. Puff air from your cheeks, not your lungs.
B. Cover his nose and mouth with your mouth.
C. Allow the infant to exhale on his own.
D. All of the above.

39. To clear the victim's airway, you should:

A. lift chin up, turn head to the left;
B. push chin down, tilt head back;
C. lift chin up, tilt head forward;
D. lift chin up, tilt head back.

40. When administer ing CPR, what is breaths-to-compressions ratio?

A. 1 breath every 15 compressions.
B. 1 breath every 30 compressions.
C. 2 breaths every 5 compressions.
D. 2 breaths every 30 compressions.

41. Where do you position your hands to give abdominal thrusts for a conscious child who is choking:

A. In the middle of the abdomen just above the navel.
B. In the middle of the abdomen just below the navel.
C. On the navel.
D. On the rib cage.

42. When you deliver the first rescue breath, what should you do if the victim's chest does not rise?

A. Perform the head tilt-chin lift.
B. Deliver a sharp blow to the center of the chest.
C. Give another breath.
D. Stop performing CPR.

43. What is the maximum time you should take to check for normal breathing before giving your first 2 rescue breaths?

A. 5 seconds.
B. 10 seconds.
C. 30 seconds.
D. 60 seconds.

44. What is the main cause of airways obstruction:

A. A foreign body.
B. Retraction of the tongue.
C. Laryngospasm.
D. Bronchospasm.

45. The main signal to start performing CPR is:

A. Unconsciousness.
B. No pulse at the carotid artery.
C. Paralytic dilated pupils.
D. No reflexes.

46. If patency of airways is obstructed with fixed a foreign body one should use:

A. Hamlich maneuver.
B. Trandelenburg maneuver.
C. Saphar maneuver.

47. A patient B, 30 years old, has an external bleeding. Arterial pressure - 100/60 mm. Hg, pulse – 100. Define approximate volume of hemorrhage, using Algover index:

A. 5% of circulating blood volume.
B. 10 % of circulating blood volume.
C. 20% of circulating blood volume.
D. 30% of circulating blood volume.

48. A patient V, 2 years old, got superficial burns of I-II degrees, of total area – 15%. Your tactics:

A- Initial surgical department and ambulatory treatment.

B. Hospitalization to burn department.

C. Hospitalization to resuscitation department.

49. A patient G, 45 years old, got superficial burns of head, neck and left hand. Define the total area of burn:

A. 5 %.

B. 10 %.

C. 18 %.

D. 27 %.

50. In a traffic accident a 30-years old victim got closed fracture of middle third of femur diaphysis and multiple fractures of pelvic ring. What hemorrhage volume is possible at this injuries localization:

A. 0,5l.

B. 1l.

C. 2 l.

D. 3 l.

51. Beloglazov symptom (symptom of a cat's eye) is a true sign of:

A. Clinical death.

B. Biological death.

C. Teological (social) death.

52. According to the modern recommendations, the volume of air you breath in when performing of artificial pulmonary ventilation should compose:

A. 50 ml/kg of body weight (i.e. 1000-1500 ml).

B. 20 ml/kg of body weight (i.e. 1400-2000 ml).

C. 10 ml/kg of body weight (i.e. 700-1000 ml).

53. Adjustment of circulating blood volume in case of bleeding one should start with transfusion of:

A. Plasma.
B. Concentrated red cells.
C. Blood substitute.
D. Blood platelet aggregate.

54. Shock index of Algover is:

A. Ratio of central venous pressure to arterial pressure.
B. Ratio of pulse rate to systolic pressure.
C. Ratio of arterial pressure to central venous pressure.

55. Development of burn shock in adults with IIIB degree burns is possible when the burn area is:

A. More than 10%.
B. 20-25 %.
C. More than 30%.
D. 50 %.

56. When checking for circulation/pulse you should locate:

A. Carotid artery.
B. Crachial artery.
C. Cadial artery.

57. Development of burn shock in adults with II degree burns is possible when the burn area is:

A. More than 10%.
B. 20-25 %.
C. More than 30%.
D. 50 %.

58. How to render the first aid in case of the second - degree burn:

A. To open blisters and apply a gauze bandage.

B. Without opening blisters apply 5% iodine alcoholic solution on the burnt area.

C. To cool the burnt area, and without opening blisters apply a sterile bandage.

59. A victim (28 years old) got superficial burns of the front part of the body and the right hip. Define the total area of the burn surface:

A. 5%.

B. 10.

C. 18%.

D. 27%.

60. How to render the first aid in case of the burn caused by boiling water?

A. You should grease the burnt area with oil or badger's grease and apply a bandage.

B. You should apply spray "Pantenol", "Polcortonol", "Olasol" etc., and apply a bandage on the burnt area.

C. You should apply 5% iodine alcoholic solution on the burnt area.

D. You should cool the burnt area under running water during 10 minutes, to render anesthetic, and apply a sterile bandage.

E. You should apply a bandage with urine on the burnt area.

List of abbreviations

AED – Automatic external defibrillator
ARS – Acute radiation syndromes
Bq – The becquerel
CPR – Cardiopulmonary resuscitation
CRI – Cutaneous radiation injury
CRP – C-reactive protein
CT – Computed tomography
DTPA –Diethylenetriamine penta-acetat
ECG – Electrocardiogram
ES –Emergency Situation
FLT-3 –Fms-related tyrosine kinase-3
Gy –The gray
Hb – Hemoglobin
Hct – Hematocrit
IV – Intravenous
MRI – Magnetic resonance imaging
pH – Potential of hydrogen
PRICE – Protection rest, ice, compression, and elevation
Rad – The radiation absorbed dose
RICE – Rest, ice, compression, and elevation
TBSA – Total body surface area
VCB – Volume blood circulation

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