Ryazan State Medical University

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OCCUPATIONAL DISEASES

teaching aid for students of medical faculty

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The teaching aid "Occupational diseases" for 4th year students of the medical faculty, studying with the service of translation into English, is developed in accordance with the Federal state educational standard of higher professional education in the structure of the basic educational program in the specialty 31.05.01 Medical care. The teaching aid contains modern concepts of etiology, pathogenesis, clinical picture, diagnosis, treatment and rehabilitation, prevention, examination of working capacity of occupational diseases.

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Кафедра факультетской терапии с курсами эндокринологии, клинической фармакологии, профессиональных болезней

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Учебное пособие содержит современные представления об этиологии, патогенезе, клинической картине, диагностике, лечении и реабилитации, профилактике, экспертизе трудоспособности профессиональных заболеваний.

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INTRODUCTION IN OCCUPATIONAL DISEASES

Occupational disease medicine is the area of a medical science about diseases and health disturbances, arising under the influence of the industrial environment or labour process.

Professional pathology is independent clinical discipline having terminology, hypotheses, and theories of pathogenesis, methods and receptions of diagnostics, prophylaxis and the treatment.

FEATURES OF PROFPATHOLOGY AS A SCIENCE

1. The professional pathology includes diseases of respiratory organs, nervous, cardiovascular, hepatobiliar, musculo-sceletal systems, skin, and blood. For diagnostics and differential diagnostics of professional pulmonology (pneumoconiosises, professional bronchial asthma, professional bronchitises, toxic - chemical lesions of lungs) knowledge of general pulmonology is necessary. At inspection of patients with suspicion on professional defeats of skin it is necessary to know dermatology. It concerns of otorhinolaryngology at a professional pathology of the top respiratory ways and ears, oncology at malignant tumours of professional genesis, neurology at professional radiculopathies, polyneuropathies, and vibration disease. Knowledge of infectious diseases is necessary at work with patients with brucellosis, viral hepatitis, HIV. At professional intoxications knowledge of the general toxicology, hematology, nephrology, hepatology, pulmonology, psychiatry, neurology, biochemistry is required.

Process of diagnostics is impossible without knowledge of radiology, laboratory diagnostics, biochemistry, functional diagnostics, bases of endoscopy and other methods of inspection.

2. The professional pathology is closely connected to occupational health, epidemiology, social hygiene. Occupational health investigates factors of the industrial environment, labour process, its influence on the person, develops measures of prophylaxis of professional diseases. Epidemiology helps at the decision of presence of a causal relationship of an infectious pathology with occupation.
3. In professional pathology there is a complex influence of occupational factors.

4. Extraindustrial factors influence on the industrial factors effects: ecological conditions, a geochemical situation, a nutrition. This fact speaks about connection of occupational pathology with general hygiene, hygiene of nutrition, ecology.

5. Occupational factors of a various nature take place in occupational disease medicine. For example, influence of CO and high temperatures or low temperatures and vibration. Poly tropism of the majority of etiological factors causes development of polysyndromic pathology.

6. All symptoms and syndromes of occupational diseases are taken from the general practice.

Occupational hazards are connected with occupation, its technology and the equipment (chemical toxic and radioactive substances, allergens, infectious agents, an industrial dust, sources of ionizing radiations, noise and the vibration, the raised or lowered atmospheric pressure, high or low temperature, and also infra-red, ultra-violet, electromagnetic, laser radiations etc.), and also with labour process, its organization, intensity, duration. The strong tension of nervous system, vision, hearing, the voice, often monotonous movements, a significant tension of groups of muscles, the long compelled position of a body and other factors of labour process here concern.

There are two categories of occupational diseases:

- The first category is actually occupational diseases. They differ by specific clinical, functional and radio-morphological changes. Specificity of pathological process here takes place. It is vibrating disease, occupational intoxications, pneumoconiosises.

- The second category of occupational diseases is formed under influence of nonspecific occupational hazards. Such kinds of influences meet also outside of conditions of occupation. But sometimes at appropriate sanitary-hygienic characteristic of working conditions this pathology is treated as occupational (tuberculosis, viral hepatitises, oncological diseases, poor hearing, polyneuropathy, brucellosis, HIV, a number of intoxications etc.). The second category of professional diseases is dangerous as hypodiagnostics, and hyperdiagnostics.
FACTORS OF THE INDUSTRIAL ENVIRONMENT

There are five groups of factors.
1) Chemical factors.
   a) Chemical factors causing actually professional diseases:
      • Acute poisonings,
      • Chronic poisonings (intoxication),
      • The remote consequences of acute poisonings and chronic intoxications.
      Acute professional disease or poisoning arises suddenly after unitary (during no more than one labour shift) influence of occupational hazards of technological and labour process (or emergencies) are higher than allowable parameters at performance of work by the certain duty regulations (or carried out under orders of the official), on the certain workplace or in the premise which was not isolated from a source of influence of the harmful factor (except for allergens).
      The chronic poisoning (occupational disease) develops under the long influence of adverse occupational hazards.
      The remote consequences are diseases which can be developed through the certain time after acute or chronic poisoning and arises or after the period of time well-being, or passes at once in this condition (for example, late silicosis).
   b) Chemical factors causing general diseases which can be under certain conditions recognized professional
      • allergens (organic and nonorganic).
      • cancerogenes (organic and nonorganic).
2) The dust factor. Aerosols of desintegration and condensation.
3) Physical factors.
   • Vibration,
   • Radiation,
   • Temperature influences,
   • Noise,
   • Pressure differences.
4) Overload of organs and systems (concern to the general diseases recognized professional).
5) The biological factors cause professional infections (concern to the general diseases recognized professional).

**CLASSIFICATION OF PROFESSIONAL DISEASES**

1. The diseases caused by influence of chemical factors: acute and chronic poisonings (intoxications and their consequences with isolated or combinative lesion of organs and systems; diseases of skin (contact dermatitis, epidermosis, fotodermatitis, onychias, paronychias, toxic melanodermia, oil follicles), metal fever, teflon fever.

2. The diseases caused by influence of industrial aerosols: pneumoconiosises - silicosis, siderosilicosis, antracosilicosis, silico-silicatosis, asbestosis, carbonicoconiosises etc.; pneumoconiosises from hypofibrogenic dust; berilliosis and other kinds of exogenic allergic alveolitis; bissinosis. Chronic bronchitis (dust, toxic-dust bronchitis).

3. The diseases, caused by influence of physical factors: vibration disease, polyneuropathy of extremities, electroophthalmy, cataract, cochlear neuritis, radiation disease and local radiation injuries, chronic overheating, polyradiculoneuropathy.

4) The diseases connected to physical overloads and an overtension of various organs and systems: coordinator neurosis, diseases of peripheral nervous system, cervical and sacrolumbal radiculopathies, chronic myofibrosises, aseptic osteonecrosises, uteroposis, varicose dilatation of veins of lower extremities, chronic laryngitis, nodules of vocal cords etc.

5) The diseases caused by action of biological factors: infectious and parasitic diseases (tuberculosis, brucellosis, viral hepatitises, Acquired Immune Deficiency Syndrome etc.).

Outside of this etiological groupings are allergic and oncological diseases of a professional nature (bronchial asthma, angioneurotic (Quinke’s) edema, rhinosinusitis, conjunctivitis, urticaria etc., tumours of skin, respiratory organs, urinary bladder, liver, leukemias, tumours of bones).
Necessary conditions for correct diagnostics of professional diseases:

1. Studying the anamnesis of disease and life of the patient, his professional route including all kinds of carried out works from the beginning of labour activity. Revealing of possible contacts with professional harmfulnesses and duration of their influence during work, and also an establishment of the transferred professional and nonprofessional diseases in past is important.

For this studying of a employment record of the patient and his ambulatory card (or extracts from it about the past diseases and carried out professional examinations), extracts from case history is necessary.

2. Detailed acquaintance with character of work carried out by the patient. The anamnestic data should be objectively appreciated and documented. The major document here is sanitary-hygienic characteristic of working conditions. Sanitary-hygienic characteristic of working conditions of persons, directed in appropriate establishments of occupational pathology, is made by doctors on hygiene of work of the regional centers of the State committee of sanitary-epidemiological supervision. Without a hygienic estimation of the industrial environment and labour process the decision of a question on an accessory of the revealed disease to a category of professional diseases is impossible.

3. Revealing of a complex clinic-functional, hematological, biochemical, immunological, radiomorphological and other changes in a clinical picture, characteristic for the given concrete form of a professional pathology.

4. Definition of the chemical substance causing disease or its derivatives in biological environments (for example lead in urine and blood, paraamidophenole at a poisoning with benzene).

5. Definition of a specific sensitization concerning industrial allergens with application of cutaneous, endonasal and inhalation tests.

6. Studying of the data of periodic and preliminary medical examination.
The basic document which is used at definition of an accessory of the given disease to number of professional diseases is “The list of professional diseases” with the instruction on its application. Thus it is necessary to take into account, that in this document only the most typical and widespread kinds of works and manufactures are given.

Diagnostics of occupational diseases, and especially early forms demands of a deep knowledge in the field of professional, and as the general pathology from the doctor. Absence at doctors of various specialities of sufficient preparation on questions of a professional pathology conducts to late diagnostics of professional diseases.

**PRINCIPLES OF TREATMENT OF THE PROFESSIONAL PATHOLOGY**

Treatment should be:
1. Etiologic.
2. Pathogenetic
4. Complex.

At acute professional intoxications by poisons in which mechanism of action oxygen insufficiency (poisonings with carbonic oxide, amino and nitro connections of benzene, phosgene, cyanic connections, hydrogen sulphide takes place) complex treatment should be directed first of all on the immediate discontinuance of contact to toxic substance, removal of poison from an organism, detoxication, liquidation of symptoms of an intoxication. To pathogenetic methods of treatment of these intoxications oxigenotherapy is concerned. Among therapeutic means forced diuresis, vascular and cardiac preparations, alkalinization of plasma, hemodialysis, antimicrobial preparations can be applied. At separate chronic intoxications and diseases, accompanying by changes of bronchopulmonary apparatus, the complex of medical actions, besides oxygen therapy should include the means directed on improvement of drainage function of bronchi and restoration of bronchial passage, liquidation of bronchospasm, struggle against an infection, and correction of pulmonary and cardiac insufficiency. A significant place at treatment of the given pathology belongs to respiratory gymnastics, massage of
a chest, physiotherapeutic methods directed on liquidation of inflammation, bronchospasm, respiratory disorders.

In treatment of intoxications by metals (lead, mercury, and manganese) complexons (tetacinum-calcium, pentacinum, D-pennicilamin, sukimer etc.) are widely used.

Complex therapy of chronic professional neurointoxications and their remote consequences with the account of polysemiology includes the reparations directed on improvement of brain and peripheral blood circulation, metabolism of a nervous tissue, on normalization of an exchange of biogenic amines, neurogumoral and neurohormonal disturbances, vitamins, and also sedative preparations and tranquilizers are widely used.

Also massage, physiotherapeutic methods of treatment, balneotherapy are used. An appreciable role belongs to the actions directed on improvement of the general condition of an organism and its resistibility (a high-grade feeding, vitaminotherapy, sanatory treatment)

THE GENERAL PRINCIPLES OF OCCUPATIONAL DISEASES
PROPHYLACTICS

1) Engineering-technical actions directed on initial prevention:
   - Replacement of toxic substances with less toxic,
   - Hermetic sealing of technological processes,
   - Improvement of engineering,
   - Creation of effective ventilation.

2) Hygienic actions:
   - Providence with means of individual defense,
   - Application of protective ointments and pastes,
   - Correct illumination of a workplace,
   - Observance of a drinking mode,
   - The hygienic control of a workplace.

3) Medico - biological actions:
   - The device of inhalatories,
   - Sanitation of microtraumas,
   - Application of vitamin complexes,
• Application of adaptogenes at work with vibration, noise, ultrasound,
• Application of pectins at work with heavy metals,
• Creation of cabinets of psychological unloading.
VIBRATION DISEASE

Vibration disease is a professional disease, caused by vibration. For the first time, this pathology was described by Loring in 1911 as a syndrome of “dead fingers” among scabblers, and in 1955, it got the name of “vibration disease”.

The main factor, which causes the development of the disease, is vibration. From the physical point of view, vibration is a mechanical oscillation, which is repeated at definite periods.

Basic parameters of vibration are frequency (Hertz), vibrospeed (m/s), a level of vibration (dB).

The spectrogram of vibration:
1) Low-frequency - up to 32 Hertz.
2) Mid-frequency - 32 - 90 Hertz.
3) High-frequency - 90 Hertz and more.

The greatest value under danger of development of vibration disease is vibration in a range 16-250 Hertz.

Low-frequency vibration is well distributed on all body being resonant for many organs and systems. For each frequency there is the maximum permissible levels, measured in decibels (dB).

There is a local vibration, which impacts mostly onto hands of a worker when working with vibroinstruments (fig.1), and a general vibration, which impact the whole organism. Local vibration takes place when workers use pneumatic and electric instruments (chisel hammers, riveting hammers and chopping hammers). The impact of the general vibration can be observed in case if a worker works with the vibrating equipment (vibroplatform and automatic concrete distributors), as well as in case of transfer of vibration from working engines, machines and equipment to the floor.

Expression and the time for the development of the disease is determined by the zone of the amount of oscillation energy, which is transferred to the body of a human being or his/her limited part, as well as factors, which assist to the development of vibration disease: forced body position, cooling and noise.

Among occupational diseases, the vibration disease still holds a leading place and is mostly encountered among those, who work in metal processing, machine engineering, metallurgic, construction,
aircraft manufacturing, mineral resource industry, agriculture, transportation and many other spheres of national economy.

PATHOGENESIS OF VIBRATION DISEASE

Vibration disease appears mostly among workers of such professions as cutters, drillers, fettlers, face-workers (impact of low frequency local vibration), riveters, polishers, tool dressers (impact of high frequency local vibration), as well as drivers of heavy earth-moving machines (impact of general vibration).

In the basis of the vibration disease is a complicated mechanism of nervous and reflector disorders, which cause the development of nucleuses of stagnant agitation and to further stable changes both in receptor, as well as in various sectors of the central nervous system. A significant meaning in pathogenesis of the vibration disease is played by specific and non-specific reactions, which reflect adaptation and compensatory processes of the organism. It is considered that the vibration disease is a specific angiotrophoneurosis, when spasm of fine and bigger vessels can be observed (Fig.2).
In the genesis of trophic disorders, which develop at this disease, a significant role is played by changes in microcirculation, rheological properties of blood, disorders in obtaining and utilization of oxygen. There are also disorders in hypothalamic-pituitary-adrenal system, changes in correlation of vasoactive substances of rennin-angiotensin-aldosteronogenic system and hormones of pituitary-thyroidcompex, content of nucleotide, increase of prostaglandins in blood, affection of vitamin and microelement balance, as well as change of immune indicators. Besides that, neurohumoral and nervous-reflector disorders have phase character. They depend on the degree of the expression of vibration pathology. Thus, in initial stages of the disease, there is an increase of the functional activity of sympathico-adrenal system due to activation of mechanisms of adaptation and overexcitation of peripheral vegetative formations. Further, in case of progressing of pathology, this state changes by the normalization of excretion of catecholamines, and then inhibition of sympathico-adrenal mechanisms correspondingly to the decrease of adaptation possibilities of the organism.
CLINICAL PICTURE OF VIBRATION DISEASE

Due to the fact that manifestation of vibration disease is many-sided and polymorphous, and until now the classification of E.Andreyeva-Galanian and V.Artamonova is still pressing; it considers its various forms, conditioned by the action of local and general vibration. Prolong study of this pathology enabled to state various variants of its progressing with mainly the manifestation of neuro-vascular disorders or pathology of a locomotor system. E.Drogichyna and N.Metlina isolated seven syndromes of the disease:

1. angiodistonic,
2. angiospastic,
3. syndrome of vegetative polyneuritis,
4. neuritis,
5. vegetomyofascitis,
6. vestibular,
7. diencephal with neurocircular disorders.

Isolation of these syndromes is conditioned by the fact that the impact of additional production factors together with vibration (cooling down, microtraumatism, and physical tension) enabled to isolate some syndrome of the disease in the clinical pattern. At the same time, the progress of the disease has changed lately, what conditioned the necessity of the consideration of this classification, taking into account the action of local vibration of various intensiveness.

The clinic of the vibration disease is complicated, and it is distinguished by its variability and is not always specific. The disease develops gradually, thus for a long time patients might not go to the doctor due to seeming improvement of their state when working. Only an active medical examination can help to make a diagnosis. Depending on the character of the work, physical parameters of the acting vibration, total amount of time of its impact, place and area of collision with the source of vibration, symptoms manifest differently and peculiarly.

The clinical symptoms of any form of the vibration disease consist of the neurovascular disorder, disorders in neuro-muscular system, locomotor system, and metabolism. The main place in the clinics is possessed by angiodistonic syndrome with phenomena of
angiospasms of peripheral vessels. At the same time depending on the form if their manifestation is a localization of vascular and nervous–muscular disorders can be conditioned by the character of the action of vibration, in the range of which there are high and low frequencies. Thus, complaints of patients in the result of the action of low frequency vibration and significant “recoil” of a vibrating instrument can be numerous in the first stage already. These patients develop a vibration disease with mostly the affection of muscles, bone changes, angiodistonic manifestation, vascular hypotonia, atony of lesser vessels, pattern of polyneuritis, mostly vegetative, and a rather marked pain syndrome.

The vibration disease in the result of vibration, in the range of which high frequencies prevail, differs by the peculiarity of vascular disorders, and more marked cardiovascular syndrome.

**Vibration Disease from the Local Vibration**

In compliance with the existing classification of this form of the vibration disease, it has three forms of severity:

I – *initial manifestations*:

1) peripheral angiodistonic syndrome of upper extremities, including rare angiospasms of fingers;
2) syndrome of sensor (vegetative-sensor) polyneuropathy of upper extremities.

II – *moderately marked manifestation*:

1) peripheral angiodistonic syndrome of upper extremities often with angiospasmic fingers;
2) syndrome of vegetative-sensor of polyneuropathy of upper extremities: a) often with angiospasms of fingers;
   b) with stable vegetative-trophic disorders of hands;
   c) with distrophic disorders of a locomotor system for upper extremities and their belt (myofibrosis, periathrosis and arthrosis);
   d) with cervicobrachial plexopathy;
   e) with cerebral angiodistonic syndrome.

III – *marked manifestations*:

1) syndrome of sensomotor polyneuropathy of upper extremities;
2) syndrome of encephalopolyneuropathy;
3) syndrome of polyneuropathy with generalized acroangiospasms.

*Initial manifestations* of the disease progress in the form of peripheralangiodistonic syndrome or the syndrome of sensor polyneuropathy hands. The disease starts slowly with passing paresthesia. Patients complain to have numbness, pricking, feeling of butterflies in the stomach, ache in distal parts of arms, increased sensitivity to cold in fingertips. Pain and paresthesia can be noted only in calm state, after work and at night. Besides, manifestations take place when cooling, and in case of the change of atmosphere pressure, when doing heavy physical work. After prolong breaks in work, unpleasant sensations in hands disappear.

Patients with vibration disease in this stage the following symptoms can be observed: cyanosis, hypothermia of hands, hyperhidrosis, sometimes, palm dryness, and mottled skin. All these show the disorder of peripheral blood circulation in palms; these symptoms are not stable. Peripheral angiodistonic syndrome can be accompanied by finger whitening at general or local cooling (Fig.3).

![Fig.3. Syndrome of “dead fingers”, acroangiospasm.](image_url)
Acroangiospasms develop either on both palms simultaneously, or at first on the hand, which suffers from the vibration impact. At first they usually appear during cold periods of the year at general cooling down: suddenly there might be sudden whitening of tips of one or several fingers (except the first one) and lasts for several minutes, and then are replaced with cyanosis (stage of angiohypotonia), which can be accompanied by paresthesia. If the process develops, angiospasms can be spread onto other phalanxes, and then appear on the other hand. In the initial stage of the disease, Reino syndrome takes place rarely (about 1 or 2 times a month).

The perception of vibration and pain sensitivity decreases. At initial manifestations of vibration disease, there can be hypersthesia of fingers, which is replaced with hypoesthesia. Zone of the decrease of sensitivity gradually spreads onto palms and forearms. Trophic disorders in this stage of the disease are limited by the worn out pattern of fingers and X-disease of palms.

Peripheral angiodistonic syndrome is actually a clinical manifestation of vegetative polyneuropathy of upper extremities. With intensified pain and paresthesia in distal sectors of arms, expanded zones of hypoesthesia beyond palms diagnose the syndrome of vegetative and sensor polyneuropathy of upper extremities.

*Moderate marked manifestations* of the disease can be characterized by more marked intensiveness of pain and paresthesia in arms and intensification of the frequency of the development of acroangiospasms. Pain and paresthesia in distal sectors of upper extremities become more stable during a day. After work and at night they are intensified; sleep is affected; patients toss in bed and rub hands at night. During vacations or treatment, this unpleasant sensitivity in hands usually decreases, however it does not pass completely. The growth of expression of peripheral vegetative and vascular, sensor and trophic disorders takes place. In the morning, patients have swelling fingers, slow moving of fingers, which together with pain and paresthesia usually disappear or decrease soon after the work is commenced. Cold angiospasm of fingers develops after washing hands with cold water, or sometimes spontaneously. Fits of angiospasms can involve all the fingers; its duration grows up to 30 to 40 minutes. It is over with angiohypotonia with pain reaction and prolong ones (1 to 2 hours) with cyanosis of fingers. Here, the spasm
of capillaries changes with their atony. Peripheral vegetative and vascular disorders at this stage do not develop independently, but are a part of the syndrome of vegetative and sensor polyneuropathy of upper extremities. Further increase of the threshold of vibration sensitivity (Fig. 4), decrease of superficial sensitivity not only in distal, but also in proximal sectors of extremities can be observed. Sometimes, the zone of hypoesthesia expands to the chest and head.

In case of presence of stable swelling of fingers and palms, slow moving and moderately marked bending contracture of fingers, deformation of interphalanxes, limbs, X-disease of palms, changes of form and feeding of nails, a diagnosis can be made as to the syndrome of stable vegetative and trophic disorders. Here, nail plates can be in the form of watch crystalline lens, often they are thickened or thinned and dim.

Distrophic disorders in tissue of a locomotor upper extremities and their belt, and also can be manifested in the form of myalgia and myositis of extensors of palms and fingers, suprascapular muscle, periarthrosis and deforming of artorhis of elbow, shoulder and interphalanxes limbs.

![Image of vibration sensitivity study](image)

**Fig.4.** The study of vibration sensitivity.

From the side of the central nervous system, there is a neurosis-like syndrome, with mild vegetative dysfunction. In the measure of the
development of the disease, patients have intensified irritability, fatigability, headache, sleep disorder, cardialgia, dizziness, lability of pulse and arterial blood pressure.

Thus, if to sum up, it is characteristic for Stage II of the vibration disease to have deepening of clinical manifestations of the syndrome of a vegetative and sensor polyneuropathy of upper limbs with more diffused decrease of superficial sensitivity, more marked peripheral angiodistonic syndrome, stable vegetative and trophic disorder of bones, frequent angiospams of fingers, as well as the development of myofibrodistrophic syndrome.

Nowadays, marked manifestations can be met very seldom. Such patients have a syndrome of sensomotor polyneuropathy of upper extremities with the intensification of pain and paresthesia, manifestation of weakness in hands, as well as decrease of force in them. Here, there is hypotrophy of bone muscles, forearms, and the decrease of tendinous reflexes.

Some patients might have generalization of angiospasms and manifestation of the latter on toes as well. In such cases, a syndrome of vegetative and sensor polyneuropathy with generalized acroangiospasms can be diagnosed.

It is also necessary to make a stress, which is in the basis of clinical pattern of these forms of the vibration disease, which can be encountered today, initial manifestations of the disease and symptoms are put in the basis of the local vibration, which can be considered as a transitional one from initial to moderately marked manifestations. Besides that, there are symptoms of visceral pathology, e.g. change of the level of arterial pressure with overbalancing of hypertensia, functional disorder of the activity of alimentary gland, dyskenesia of a stomach, intestines, gall tracts, disorder of vitamin balance, as well as carbohydrate, protein, and mineral exchange. It is considered that these changes have reflector character and are conditioned by the disorder of endocrine and vegetative regulation.

**VIBRATION DISEASE FROM THE GENERAL VIBRATION**

There are three stages of the severity of a pathological process:
**I – initial manifestations:**  
1) angiodistonic syndrome (cerebral or peripheral);  
2) vegetative-vestibular syndrome;  
3) syndrome of sensor (vegetative-sensor) polyneuropathy of lower extremities.

**II – moderately marked manifestations:**  
1) cerebral-peripheral angiodistonic syndrome;  
2) syndrome of sensor (vegetative-sensor) polyneuropathy together  
   a) with polyradicular disorder (syndrome of polyradiculaoneuropathy);  
   b) with secondary lumbosacral plexus syndrome (due to osteochondrosis of the lumbar sector of the spinal cord);  
   c) with functional disorders of the nervous system (syndrome of neurasthenia).

**III – marked manifestations:**  
1) syndrome of sensormotor polyneuropathy;  
2) the syndrome of encephalopathy together with peripheral neuropathy (syndrome of encephalopolyneuropathy).

Patients in the initial stage of the disease complain to have headache, irritability, fatigability, and sleep disorder. Here, we can observe the lability of pulse and arterial pressure, though predominant signs are hypertensia, hyperhidrosis, and affection of dermatographic reaction. All these prove the development of cerebral angiodistonic syndrome. Together with this syndrome, there are manifestations of peripheral angiodistonic syndrome, for which it is characteristic to have unstable and moderately expressed paresthesia and pain in lower limbs, sometimes cramps of sural muscles. During the examination, it is possible to observe cyanosis or mottled skin, hypothermia of feet, hyperhidrosis of soles, reduction of perception of vibration and pain sensitivity on toes. If there is intensification of pain and paresthesia in feet, expression of peripheral vegetative and vascular disorders, decrease of superficial sensitivity on the polyneurotic type, mostly in distal sections of lower extremities prove the presence of the syndrome of vegetative and sensor polyneuropathy of lower extremities. In case of the development of the disease of Stage II, there are moderately marked symptoms of the syndrome of vegetative and sensor polyneuropathy of lower extremities. In some cases, similar
symptoms may take place in hands as well. Together with vegetative and sensor polyneuropathy, secondary lumbosacral syndrome develops in the result of osteochondrosis of the lumbar part of the spinal cord.

Marked manifestation (Stage III) of the disease can be observed very rarely. For this stage of the disease, it is characteristic to have sensomotor polyneuropathy (pain and weakness in lower limbs when walking, reduction of force and hypotrophy of specific muscles of shins and feet, pain in nerve trunks when palpating).

**VIBRATION DISEASE FROM THE COMBINED AFFECTION OF LOCAL AND GENERAL VIBRATION**

There are stages of three stages of the disease:

I – *initial*;

II – *functional*;

III – *marked manifestation*.

The disease starts gradually. Patients complain to have headache, dizziness, increased irritability, general sickness, and fast fatigability, ache in lower extremities, as well as their numbness and paresthesia. There can be fits of whitening of toes. The disease at this stage (initial) is manifested through neurasthenic syndrome with phenomena of vegetative dysfunction. The disease has compensated character, and after the termination of contact with vibration, the ability of the sick to work is renovated.

Further, headache becomes constant, agitation increases, and desire to whine appears. Periodically, there are “vegetative crises”: nausea, short-term lapse of memory, dizziness, and increased general hyperhidrosis. Skin coverlets become pale, eyes become brighter, pupils widen, muscles are tensed, and the body temperature increases. Fits end up with profuse hidrosis with further development of prostration. This stage (*functional*) can be characterized by the development of general angiodistonic phenomena with “vegetative crises”, lability of cardio-vascular system, and vegetative-sensor polyneuropathy of extremities. There is a marked asthenic syndrome.
At later stages of the disease, there are following sings: worsening of memory, sleep disorder, formation of diencephal syndrome (weight loss, anorexia, acute asthenia, microorganic symptoms of the affection of stem portion of brain and hypothalamic sector), there are changes in the cardio-vascular system (bradycardia, and arterial hypotensia). This stage (marked manifestation) has a number of peculiarities: headaches become more permanent. Crises with short-term loss of consciousness become more frequent, vegetative and sensitive polyneuropathy of extremities develops, as well as encephalopathy and diencephal syndrome.

**METHODS OF DIAGNOSTICS OF VIBRATION DISEASE**

Methods of diagnostics of vibrating disease:
1. Cold test: hands immerse for 5 minutes in water in temperature of 8-10 degrees of Celsium. Look a condition of skin of hands. If even one phalanx of fingers become whitening test is considered positive. Spots and cyanosis are not considered as positive reaction.
2. Skin thermometry: it is investigated by the electrothermometer with realization of a cold test. Change of skin temperature will carry out on a back surface of nail phalanxes of fingers of arms. In norm the temperature of skin on fingers changes within the limits of 27-31 degrees of Celsium. At vibrating disease it is reduced up to 18 - 20 degrees. After realization of a cold test at healthy persons the skin temperature is reduced up to 24-21 degrees and restored in 20-30 minutes. At vibrating disease the temperature after a cold test is reduced up to 16 degrees and less, and restoration up to initial temperature lasts 40 minutes and more.
3. Capillaroscopy (Fig.5). This method estimates change of capillaries of nail bed. Nail bed of 4\textsuperscript{th} finger of both arms is used. Pay attention to a background, coloring and quantity of capillary loops. In norm a background is light pink, and quantity of capillary loops is not less than 8 capillaries in 1 millimeter. The condition of capillaries is characterized as normal, spastic or atonic.
4. Vibrotest. This method has the important value. Change of a threshold of vibrating sensitivity allows to judge about degree of expressiveness of process. At presence of vibrating disease increase of a threshold on all frequencies with the slowed down restoration after giving of vibroloading is marked.

5. Algesimetry. In this case algesimeters are used. The method is based on definition of size of immersing of a needle, causing painful sensation, in millimeters. In norm the threshold of painful sensitivity on a back surface of a hand does not exceed immersing of 0.5 mm of a needle. At vibrating disease substantial increase of a threshold is observed.

6. Dynamometry. The spring dynamometer and Rozenblat’s dynamometer are used. At the expressed forms of vibrating disease decrease of force up to 15-20 kg (in norm 40-50 kg at men and 30-40 kg at women) and endurance up to 10-15 seconds (in norm 50-60 seconds) is quite often marked.

7. Stimulating electromyography (Fig.6). Speed of distribution of excitation on nervous fibers is determined. Dependence of changes of speed of distribution of excitation on a degree of expressiveness of vibrating disease is revealed.
8. Reovasography. The vascular tone and intensity of pulse blood-filling, a condition of venous outflow is estimated. Presence of asymmetry between upper and lower extremities, type of disturbance of a vascular tone is considered. There will carry out test with nitroglycerine.

9. Research of tissue blood-flow. The method is applied in a hospital with use of radioactive iodine - 131. In back side of a hand intracutaneously 5 microcurie is entered. Result estimate on time of resorption from intracutaneous department of 50 % of the indicator. In norm resorption of 50 % of radionuclide passes during 5 - 8 minutes. At vibrating disease significant delay of speed of tissue blood-flow is marked.

10. Thermography. It is applied to diagnostics of peripheral vascular disturbances at vibrating disease.

11. Rheoencephalography. It is applied to diagnostics of cerebral angiodystonic syndrome. The level of pulse blood-filling in pool of carotid arteries, a condition of a vascular tone and venous outflow is investigated.

12. Electroencephalography (Fig.7). It is recommended for an estimation of a degree of neurodynamic disturbances, particularly at patients with the vibrating disease caused by the general vibration.
Fig. 7. Electroencephalography.

13. Radiography:
   a) radiography of hands, feet, spine, joints.
   b) standard densitometry,
   c) radiography of arms with an estimation on age groups.
   d) high-detailed radiography when it is possible to separate this or that department and to estimate it qualitatively.


**DIFFERENTIAL DIAGNOSTICS OF VIBRATION DISEASE**

Differential diagnostics of the vibration disease is conducted to determine such diseases as Reino syndrome, syringomyelia, vegetative polyneuritis and myositis.

- Reino disease mostly develops at women; its development does not depend on the occupation. Clinically, it can be characterized by marked angiodistonic syndrome of peripheral vessels, presence of disorders of vibration, pain, temperature and tactile sensitivity, as well as changes in the internal organs, and locomotor system.
- Syringomyelia starts gradually. It is characteristic for it to have segmental disorder of sensitivity, atrophy, pareses, and paralyses; also finger whitening can sometimes take place. Together with disorders of pain temperature sensitivity according to the segmental type, there is tactile and muscle sensitivity.
- Vegetative polyneuritis can be characterized by disorders of sensitivity on polyneuritic type; disorders on polyneurotic type; it is not characteristic for it to have affection of vibration sensitivity and...
fits of angiospasms. In addition, affection of trophism, temperature and tactile sensitivity decrease can take place.

- Myalgia and myositis have definite connection with the occupation. They can be characterized by pain when palpating muscles, absence of peripheral vessels, specific disorders of sensitivity at plexitis (disorder of pain sensitivity at the absence of disorders of vibration, temperature and tactile sensitivity takes place).

**TREATMENT OF VIBRATION DISEASE**

Etiological principles of treatment of patients with vibration disease involve the principles of elimination (temporary for the period of treatment or full-time in case of absence of therapeutic effect) from the work under conditions of the impact of vibration and other unfavorable factors of production environment.

Among generally strengthening and treatment/preventive measures, it is necessary to consider aero-, gelio and hydrotherapy with the utilization of natural factors of the external environment: air baths, dosed sun irradiation, and swimming in open pools in summer.

As to special treatment – preventive measures, it is necessary to recommend vitamin therapy (ascorbic acid, B₁, PP and B₁₂), irradiation with rays, preparations, which increase non-specific reactivity of organism.

To conduct pathogenic therapy, it is recommended to use anticholinergic drugs, ganglionic blockers and acupuncture. Among anticholinergic drugs, good results are shown by spasmolytin and benactyzine; and ganglionic blockers - pachykarpin, benxohexamethonium and hexamethon. More positive result is given by combining ganglioblockers and anticholinergic drugs with preparations, which are capable to expand vessels (nicotine acid and papaverine). Nowadays, calcium channel blockers are recommended, first of all, the group of nifedipine (corinfar and cordafen, 10 mg three times a day for three weeks).

Non-medicamentous methods of treatment are widely applied to treatment of vibrating disease:
1. Balneotherapy (coniferous, pearl, sea baths).
2. Vortical baths.
4. Diadynamic currents on cervical - thoracic department of spine.
5. Phonophoresis of hydrocortisone on painful area.
7. Acupuncture.
9. Massage of arms, spine.

It is recommended to conduct a spinal blockade 0.25 % solution of diphacyl together with Novocain, UV irradiation on the level of segments C₃-C₄ and D₅ and D₆, starting with 2 or 3 biodoses, increasing it to 3 or 4; course is 7 to 8 sessions. It is also recommended to undergo hydrogen sulfide, nitric-thermal, rhodon baths and mud cure (37 – 38 °C) as well as rational meals.

**VERIFICATION OF THE ABILITY TO WORK**

At the disease of Stage I for patients, they are temporarily (for one month) employed at work beyond the action of vibration (with the provision of a leave on occupational inability to work in case of the decrease of earnings). When qualification of a worker at change of employment is decreased much, then a percentage of the loss of the ability to work for the period of re-qualification is set by the decision of a treatment – expert commission (one year).

Similarly, issues can be solved in case of vibration disease of I to II stages. Only to achieve a stable effect of such diseases, patients are transferred to work beyond the action of vibration for the period of two months.

Treatment of patients with Stage II of the disease should be done in hospital with further transfer to work, which is not connected with the impact of vibration or cooling down to fix results of treatment for 1 or 2 months. In case of acute decrease of qualification at the change of work, they can be assigned to undergo expert examination to determine the degree of the loss of the ability to work for the period of re-qualification (1 – 2 years).

As a rule, patients with vibration disease of Stage III have limited ability to work. They obtain a percentage of the loss due to
occupational inability to work or an invalidism group (III) due to the occupational disease.

Patients with vibration disease of the 1\textsuperscript{st} degree do not lose their ability to work due to general vibration. They undergo treatment, and then to stabilize its results, they are transferred for a month or two to work that is not connected with the impact of vibration, intensive noise, and receive a leave as to their inability to work.

At well-marked pathological changes of the 2\textsuperscript{nd} degree, it is necessary to undergo rational employment with the definition of the degree of the loss of the ability to work (for one year). For patients with vibration disease of Stage III, it is characteristic to have the decrease of occupational and general ability to work. They can obtain 2\textsuperscript{nd} or 3\textsuperscript{rd} group of invalidism in the result of the occupational disease.

**PREVENTIVE MEASURES**

Prophylactic actions:

a) limitation of time of influence of vibration,
b) control for vibrotools and if it is necessary their replacement,
c) replacement of vibrocapacious tools on others,
d) application of shock-absorbers (Fig. 8),
e) improvement of technological process,
f) normalization of a microclimate.

Fig. 8. Protection from vibration.
It is recommended to conduct hydraulic procedures – bathes for hands with the temperature of water 37 °C together with self-massaging; UV irradiation sub erythematous dosages of mostly cervical areas; gymnastics and regular medical check-ups.
PNEUMOCONIOSISES

Pneumoconiosises are professional diseases caused by long inhalation of an industrial dust and described by chronic diffuse aseptic inflammation of lungs with development of pneumofibrosis.

They are the most widespread form of a professional pathology of bronchopulmonary system and prevail in structure of professional diseases.

PATHOGENESIS OF PNEUMOCONIOSISES

The initial stage of development of anyone pneumoconiosis from influence of mineral dust consists in formation of “dust” depot which arises because the amount of a dust late in lungs at breath, exceeds amount of dust particles, which retire from lungs. Mechanical influence of some kinds of an industrial dust (asbestos etc.) participates in formation interstitial pneumofibrosis. It does not cause doubts as any dust is an foreign body.

In total it was offered about 60 hypotheses o pathogenesis of silicosis. And nevertheless the mechanism of development of fibrous process in lungs under influence of a mineral dust in many respects is not clear.

The immunological theory of pathogenesis of silicosis is developed. It is proved, that development of silicotical process is accompanied expressed immunopathological component as infringement cellular and humoral immunity. Expressed deficiency T-cells on a background of increase B–rosetting cells is formed. However the importance of these changes in development of pneumoconiosis is not clear. Bilateral stimulating connection between macrophages and T-lymphocytes which is carried out from the side of macrophage by interleukine-1 is found out. At the same time interleukine-1 stimulates collagen formation (Fig.9).

Now wide development has received a direction of research of the processes underlying destruction of macrophages (coniophages), cytotoxic of fibrogenous dust. These researches give reason for a hypothesis about the leading part of OH-groups on a surface of silicon in the mechanism of destruction of coniophages.
The direct reason of destruction of macrophages as a result of accumulation in lysosomes plenty of a dust is its self-destruction under influence of lysosomal lasises.

Basic value has in development of pneumofibrosis strengthening of processes of peroxidation of lipids of biomembranes under influence of a dust of dioxide of silicon and asbestos. Quartz initiates reactions of free radicals which are the reason of infringement of exchange processes in macrophages and influence metabolic processes in a connecting tissue of lungs. The initial stage of phagocytosis begins with their activation with sharp increase of consumption of oxygen and strengthening of generation of active forms of oxygen. It is a superoxid anion-radical, peroxide of hydrogen, hydroxil radical etc. This phenomenon is refered as “respiratory explosion”. The highest degree of generation of active forms of oxygen is observed at action of highfibrogenous dust. Free highly active radicals (active forms of oxygen) initiate a circuit of pathological reactions in tissue of lungs. They influence a vascular wall, elements of connective tissue, membranes of lysosomes, that conducts to their damage, activation of processes of oxidation of
arachidone acid, causing formation of biologically active mediators as leukotriens, thromboxanes, prostaglandines. These factors support and strengthen chronic inflammatory process which final phase is pneumofibrosis. At disintegration of alveolar macrophages the numerous factors influencing development of an inflammation and fibrosis of tissue of lungs are allocated. It is the factor, activating fibroblasts and synthesis of collagen strengthening by them, and the factor involving neutrophils. Under influence of the last neutrophil leukocytes will penetrate through endothelium of capillaries in pulmonary parenchyma and bronchoalveolar space. They have higher ability to generation of superoxid radicals, than macrophages.

Thus, the following factors are put in a basis of the theory of pathogenesis of pneumoconiosises:

1) Destruction of macrophage at its overload (a working hypertrophy) the numerous absorbed dust particles and developing decompensation of endocellular organells. This mechanism prevails at inhalation of highly dispersic fractions of smallfibrogenous dust.

2) Destruction of macrophages owing to interaction of hydroxil groups Si-OH and formation of hydrogen connections with phospholipids membranes of macrophages.

3) Initiation by quartz of free-radical reactions, activation the peroxidation of lipids and disturbance of the metabolic processes, conducting to formation of structures of connective tissue. The immunologic processes caused by influence of a dust, conducting of pneumofibrosis (increase of production by macrophages of interleukines).

**PATHOMORPHOLOGY OF PNEUMOCONIOSISES**

Chronic influence of industrial aerosols already in an initial stage of an exposition causes a picture of catarrhal inflammation of mucous membranes of the top respiratory ways which further is transformed in chronic atrophic, less often the hyperplastic form.

In pulmonary tissue and radical lymphatic nodes are formed cellular - dust nodules, consisting of macrophages in which cytoplasm is dust, and also consisting of fibrocytes and histiocytes. On their
periphery the congestion of lymphocytes is observed. Between the cells forming nodulus in lungs, growth of collagenic fibres is marked. In lungs meet also microatelectasises and perinodular emphysema (Fig.10).

Fig.10. Pathomorphology of pneumoconiosis.
At silicosis in an early phase growth of a connective tissue on a course of vessels, bronchial tubes, interalveolar partitions takes place. It is observed as focal pneumofibrosis as nodules. They are located in pulmonary tissue and regionar lymphatic nodes. It characteristic is perinodular emphysema. At bignodular form of silicosis in lungs are formed plural nodules, consisting from whirlwindform located hyalinosing fibres, consist from connective tissue, it is possible them calcification. Blood vessels are narrowed, with dystrophic changes, lymphatic nodes with the phenomena of a sclerosis. Progressing of biggranulematous silicosis is characterized by formation of rough nodal and diffuse pneumoconiosises. emphysema is developed.

At silicatosises in lungs the picture of interstitial sclerosis is observed. The nodules are determined in a small amount (talcosis, asbestosis, mica pneumoconiosis etc.). At asbestosis the nodulus is submitted by particles of the asbestine fibres covered with a serous membrane.

Influence of aerosols of metals results in development of dissemination with fibrous reaction.

The special place is occupied with a pathology caused by influence of beryllium. The granulomas represent cellular-fibrous formations with huge multinuclear cells. First it is observed broncho-bronchiolitis, pneumonitis, proliferation of lymphoid and hysteocytar elements. The pneumosclerosis of focal and diffuse character with early collagenosis, destruction of collagenic fibres further is formed.

Inhalation of a dust of small fibrogenous metals (iron, tin, barium and etc.) at a long exposition conducts to development of diffuse pneumosclerosis with prevalence of changes over its adjournment.

Firm metals (tungsten, molybdenum, titan, tantalum, zirconium) and their alloys cause pneumonitis, fibrotic alveolitis, diffuse pneumosclerosis.

**CLASSIFICATION OF PNEUMOCONIOSIS**

Classification consists of 4 sections: etiological groupings, the radiological, morphological and clinic-functional characteristic with indications of complications of pneumoconiosis.
Etiological classification

1) Pneumoconiosises, developing from influence it is high and moderate fibrogenous dust (with the contents of free dioxide of silicon (SiO₂) more than 10%): silicosis and pneumoconiosises from the mixed dust (antracosilicosis, silicosilicatosis, silicosiderosis etc.) are characterized by progressing current.

2) Pneumoconiosises from influence of small fibrogenous dust (with the contents of free dioxide of silicon less than 10%): silicatosises (contain dioxide of silicon in the connected condition - asbestosis, talcosis, caolinosis, cement pneumoconiosis etc.), carboconiosises (antracosis, grafitoses etc.), pneumoconiosis of grinders, pneumoconiosises from radiocontrast dusts (siderosis, pneumoconiosis electric welders, baritosis, etc.) are characterized by benign course.

3) Pneumoconiosises from influence of aerosols of toxic-allergic action (metals-allergens, plastic, grain, tobacco, flour a dust) - berylliosis, aluminosis etc.

The radiological characteristic of pneumoconiosises

The diagnosis of pneumoconiosis is substantially the radiological diagnosis. Radiologically pneumoconiosises are characterized by diffuse changes of pulmonary tissue as interstitial (Fig.11) or nodular fibrosis (Fig.12), or the nodal formations developing on a background nodular or interstitial fibrosis.

Radiologically, the degree of severity of coniotic fibrosis is estimated by the nature of the detected dark shadows by their shape, size, profusion, i.e., the density of saturation of these shadows by 1 cm² and their length (prevalence) in the zones of the right and left lungs.
Fig.11. Interstitial pneumoconiosis.

Fig.12. Nodular pneumoconiosis.
There are two forms of shadows:
1) rounded;
2) linear irregular shape.

Three gradations are distinguished by the size of the shadows:
1. Rounded shadow is indicated by symbols:
   a) "p" up to 1.5 mm in diameter;
   b) "q" - from 1.5 to 3 mm in diameter;
   c) "r" - from 3 to 10 mm in diameter.
2. The linear irregular-shaped shadows:
   a) "s" - thin linear lines up to 1.5 mm wide;
   b) "t" - average, linear from 1.5 to 3 mm wide;
   c) u - rough, shadows with irregular shape.

The first radiological stage (Fig.13b) is characterized by presence in lungs a small amount of nodules up to 3 mm in diameter on a background of moderate diffuse interstitial changes.

The second stage - nodular pneumoconiosis is characterized by diffuse uniform arrangement numerous fine nodules in the size from 1 to 10 mm. The normal lung pattern is not differentiated. Fibrous condensation of lungs radices are more expressed, than in the first stage and mediastinal lymphatic nodes are increased (fig.14a).

The third stage (fig.14b) is observed as a result of merge of pneumoconiotical nodules and formations of fibrous nodules and conglomerates of various size and quantity (nodes are more than 1 sm in diameter).

The clinic-functional characteristic of pneumoconiosises

The clinicofunctional characteristic (clinical picture) of pneumoconiosises includes clinical and functional attributes of disease: bronchitis, bronchiolitis, emphysema of lungs, pulmonary insufficiency (1, 2, 3 degrees), cor pulmonale and complications of pneumoconiosises.

Distinguish the following variants of current of pathological process:
1. Quickly progressing.
2. Slowly progressing.
3. Regressing.
4. Later development (formation of process in years after cessation of work in conditions of influence of a dust).

![Image of radiological photographs]

**Fig. 13.** Radiological photograph of lungs 
- a - normal, 
- b - silicosis, stage I.

![Image of radiological patterns]

**Fig. 14.** Radiological pattern 
- a – silicosis, stage II, 
- b - silicosis, stage III.

**The clinic-functional characteristic of pneumoconiosises**

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Complications of pneumoconiosis

1. Tuberculosis.
2. Pneumonia.
5. Cancer of lungs.
6. Bronchial asthma.
7. Caplan’s syndrome (rheumatoid arthritis at patients with silicosis), scleroderma.
8. Spontaneous pneumothorax.
9. Chronic cor pulmonale with development of pulmonary-cardiac insufficiency.

**DIAGNOSTICS OF PNEUMOCONIOSISES**

1. Studying a professional anamnesis and the sanitary-hygienic characteristic of working conditions.
2. Radiological research, including tomography and roentgenograms.
3. Radiopneumopolygraphy (estimates ventilating function of lungs on zones).
4. Spirometry.
5. Research of gases of blood.
6. Research of central hemodynamic.
7. Radiopulmography with $\text{Xe}^{133}$ for revealing early changes, an establishment of character, localizations, prevalence of process.
8. At diagnostics of berylliosis - high-sensitivity skin test (application 0.5-1% of solution BeCl). At occurrence of erythema test is positive.
9. Definition of antibodies to beryllium.
10. Fibrobronchiscopy with biopsy of lungs.
11. Tuberculesis diagnostics (Coch’s and Mantoux tests, Diaskin test, sputum examination).

Of course, the doctor should not forget about General clinical methods of diagnosis in patients with pneumoconiosis (CBC, ECG, EchoCG, biochemical blood analysis, urine test etc).

**TREATMENT OF PNEUMOCONIOSISES**

In treatment there are no effective pathogenetic remedies. Apply:

1. Complete cessation of the impact of the etiological factor.
3. An ultra-violet irradiation.
4. At absence of pulmonary insufficiency: electrophoresis with novocain, chloride calcium; Bernard's currents and ultrasound on a chest. They stimulate lymph and blood circulation.
5. Adaptogenes (eleutheroococcus, pantocrinum, tinctura Schizandrace chinensis).
7. Inhalations of alkaline and mineral waters.
8. Oxygenotherapy.
9. Reduction of bronchial obstruction through the prolonged use of bronchodilator drugs (ipratropium bromide, salbutamol, fenoterol). At incomplete effect of short acting bronchodilators long acting bronchodilators are used (formoterol, salmeterol, tiotropium bromide).
10. At treatment of cor pulmonale: cardiac glycosides, blockators of angiotensin converting enzyme, diuretics, calcium cannal antagonists).
11. At berylliosis and hypersensitive pneumonitises - corticosteroids, azatyoprinum.
12. Treatment of tuberculosis.

**DIFFERENTIAL DIAGNOSIS OF PNEUMOCONIOSISES**
1. Disseminated tuberculosis of lungs.
2. Sarcoidosis of respiratory organs.
3. Histiocytosis X.
5. Carcinomatous lymphangioiyis.

**PROGNOSIS OF PNEUMOCONIOSISES**

Patients with pneumoconiosises from small fibrogenous and radiocontrast dust at absence of complications and pulmonary insufficiency can continue the work with dynamic supervision of the doctor. But also here work in conditions of high concentration of a dust in the closed spaces and with physical tension is contra-indicated. Silicosis of the first degree (interstitial) provides the employment without invalidization. At nodular forms the medical and working prognosis is frequently adverse. These forms are progressed. Passage into work without contact with low temperatures, physical loadings, dust content, toxic and irritating substances in this case is necessary. If this passage conducts to loss of qualification than the third group of invalidity on professional disease is established. At 2-3 stages of process with respiratory insufficiency of 2-3 stage the second group of invalidity is established.

**CHARACTERIZATION OF SPECIFIC TYPES OF PNEUMOCONIOSIS**

**Silicosis**

The reason – inhalation aerosol containing crystalline silica in the amount of more than 10%. This type of PC is most common among workers in the mining industry in the underground mining of minerals in quartz-bearing rocks. In recent years, reducing dustiness of the air in the working area, improved diagnostics of dust pathology led to the pre-possession of the initial stages of the pathological process, characterized by a slowly progressive course. But there may also be nodular, progressive forms, but rarely.
Asbestosis

Asbestosis is among the most common and difficult flowing process. Terms of its development in modern conditions more than 10 years, but with high dust content can be shorter.

Asbestos dust is an irritant and cytotoxic effects. Asbestos particles accumulate in the alveoli, perivascular tissue, lymphatic ways and lymph nodes. Reactive proliferative processes develop in alveolar walls, they thicken and condense. Normal morphological structure are replaced by connective tissue.

For asbestos is characterized by the presence of widespread pleural adhesive, especially in the lower and middle parts. Emphysema is pronounced. Can be single nodular formation caused by the inhalation of quartz that is included with becoming dust.

Typical for asbestos morphological substrate are asbestos bodies, which are found not only in the lung tissue, but also sputum.

The clinical picture of asbestos is determined by chronic bronchitis, pneumofibrosis and pulmonary emphysema. At first, as an irritation syndrome, a cough appears. In the future (with continued exposure asbestos) shortness of breath with exertion, recurrent pain in the chest. Later weakness, sweating appear, reduced working capacity.

Examination reveals moderate cyanosis. At a percussion – a box sound (emphysema). Auscultation in all fields is listened harsh breathing, occasionally dry rales, and pleural friction rub.

Radiologically, there is a deformation of lung picture, widening of radixws. The pleura is often thickened. In the upper parts of the compensatory emphysema. In the case of progression of pulmonary fibrosis pleurodiaphragmatic and pleuropericardial adhesions are formed. Major complications – cancer of the lung and pleura, bronchoectasis. Tuberculosis in these patients is rare.

Talcosis

Talc - water magnesium silicate is widely used in perfume industry, rubber and other industries. Work experience before the
development of the disease is more than 15 years. This is a relatively benign pneumoconiosis with little progression course.

The symptoms are not pronounced sharply. Possible dry cough, shortness of breath, rarely chest pain when breathing, dry rales. Lung function changed slightly.

On radiographs there is a strengthening and deformation pulmonary pattern of a linear type with shadows nodules up to 2 mm. Complications are rare.

Carboconiosis

Carboconiosis include anthracosis, grafitosis, carbon black pneumoconiosis. It is pneumoconiosis from coal dust exposure with varying degrees of coalification, which is the main criterion of its fibrogenic properties.

Anthracosis is found in miners, stokers, workers, elec-and-electrode coke-chemical plants with the experience of more than 10 years. The dust is mixed (containing silicon dioxide).

The clinic is determined by chronic bronchitis, diffuse pneumofibrosis, pulmonary emphysema. Linear- reticular fibrosis is typical. Nodular formations in the lungs are not typical.

Violations of respiratory function correlated with the severity of the process.

Pneumoconiosis from electric welding and gas welding works

When these works are formed by aerosol condensation, the composition of which depends on the nature of the work-piece and electrodes. The majority of the exposition is over 15 years. Dust x-ray contrast. The photographs show an increase in the deformation of the lung pattern of interstitial character with small amount of focal shadows up to 2 mm.

The clinic is not prominent. In progression transformation into nodular form occurs. In the post-exposure period progression of pneumoconiosis of the welder is not happening. It flows without
expressed respiratory insufficiency. Tuberculosis and other complications are rare.

**Pneumoconiosis of grinders (emery)**

It occurs from aerosols of mixed composition, which is formed when sharpening tools, grinding products of different materials. The basis of the working tool (circle) is corundum (Al₂O₃) or carborundum (SiC), which have weakly expressed fibrogenic action. In the air of working zone to stay closer than the aerosols, iron, and other metals.

Pneumoconiosis of grinders is a benign process with a strikingly pronounced symptoms of fibrous process, possibly with a small number of focal shadows. The dynamics of the disease is compensated, not progressing.

**Pneumoconiosis from exposure to aerosols toxic-allergic action**

They are caused by metal beryllium. The most common substances consist of beryll (beryllium aluminum silicate – Be₃Al₂(SiO₄), chrysoberyl (BeAl₂O₂) and phenakite (Be₂SiO₄).

Contact with beryllium and its compounds is possible in the production of metallic beryllium ores, in the production of its alloys, their processing. Beryllium and its compounds enter the body in the form of aerosol or vapors through the respiratory system. A peculiar form of pathology develops in contact with beryllium salts with the skin.

The first signs of intoxication may appear in different terms of contact: from a few days to 10 years or more.

**Clinical forms of beryllium intoxication:**
1. Acute pneumonitis;
2. Diffuse bronchiolitis;
3. Granulomatous disease of the lungs;
4. Fibrosing alveolitis.

The pathological process in the lungs from the effects of the metal ion of beryllium and its soluble compounds is called as beryllium pneumoconiosis.

Beryllium and its compounds have a polyvalent action:
- irritant;
- general toxic;
- allergic;
- carcinogenic;
- embryogenic.

Beryllium is a hapten causing hyperergic reactions of slow type. The body's response to beryllium antigen is accompanied by the activation of immunoglobulin G and A and the lack of IgM. The number of B-lymphocytes increases against the background of T-cells decrease, i.e. the state of cellular sensitization develops. There is significant individual predisposition to berylliosis in people with immunodeficiency.

Chronic berylliosis occurs in two forms: granulematous and predominantly interstitial. The process is developed as an outcome of acute intoxication, or as a primary chronic form. The process can develop a few months or even years after the termination of contact with beryllium.

For the initial stage of the disease is characterized by weakness, fatigue, shortness of breath during exercise, dry paroxysmal cough, possible pain in the chest, weight loss of 8-10 kg, fever. Percussion is determined by boxed sound, on auscultation- dry and moist rales in the lower parts of the lungs. Cor pulmonale is developed.

Marked arterial hypoxemia and compensatory erythrocytosis are noticed.
OCCUPATIONAL BRONCHIAL ASTHMA

Occupational bronchial asthma is the disease, characterized by bronchospasms, hypersecretion of bronchial glands, swelling of mucous membrane of bronchi, and which is etiologically connected with the action on the bronchial apparatus by the agents on the workplace of a worker. Thus, occupational bronchial asthma, which is observed under various occupational conditions, is etiologically connected with the impact of occupational hazards.

Some epidemiological research showed that 2 to 14% of all the patients with asthma suffer from professional bronchial asthma. The frequency of professional bronchial asthma much varies in various occupational groups. Thus, it is considered that among those farmers who contact with animals and birds, about 6% of people have asthma, and as to those who work in bakeries – about 10% have asthma.

ETIOLOGY OF OCCUPATIONAL BRONCHIAL ASTHMA

In the etiology of occupational bronchial asthma (OBA), an important role is played by the following matters: allergic agent of animal (wool, silk, hair, feather, pieces of epidermis, bees and helminthes) and plant (pollen of herbs, bushes, trees, flowers, wooden, grain and flour dust, volatile oil, flax and tobacco) origin; a large number of chemical matters (metal compounds – chromium, nickel, cobalt, manganese; formalin synthetic polymers, dyes, and pesticides); medicinal drugs (hormones, vaccines, ferments, protein and vitamin concentrates, as well as forage antibiotics). Among medicinal drugs, the most important are antibiotics (especially penicillin, more seldom – streptomycin, biomycin, and tetracycline), as well as vitamins, sulfanilamide, analgetics, hormonal drugs and aminazine.

Generally speaking, etiological factors can be divided into the two following groups: allergic agents and asthmogenic agents. The former include flour, especially, wheat flour, natural silk, epidermis of animal fur and skin, castor oil; dust of green coffee beans; detergents; and various medicinal drugs. The latter one includes wooden dust, cotton, lacquers, pesticides and phenol.
PATHOGENESIS OF OCCUPATIONAL BRONCHIAL ASTHMA

During contacts of a worker with occupational allergic agents, there is an increase production of antibodies of class IgE in the body. Antibodies class IgE are fixed on mast cells (immune stage), after what degranulation of mast cells with the discharge of a great number of bronchospastic and vasoactive matters - histamine and serotonin (pathochemical stage) takes place. Under the impact of biologically active matters, permeability of microcirculatory flow is increased; swellings, severe inflammation and bronchospasm (pathophysiological stage) develop (Fig.15). Clinically, this is manifested by the disorder of bronchial permeability as well as the development of fits of bronchial asthma. This is a so-called atopic occupational bronchial asthma, in the genesis of which reagent type of immediate hypersensitivity takes place.

Fig.15. Pathophysiology of bronchial asthma.

Prolonged impact of astmogenic agents causes changes in the reactivity of target cells (first of all, mast cells, located along the respiratory tract). Change of reactivity of these cells is first of all accompanied by excessive production of biologically active matters
(histamine and leukotriene). Bronchial spasms, swelling of mucous membrane, increased permeability of bronchi cause asthma attack.

An important meaning in the development of OBA is also caused by heredity and genetics, as well hormonal disorders, disbalance of vegetative nervous system, and respiratory infections. As to the last factor, it is considered that there are several variants of the interaction between allergy and infection: as to the first – infection in the bronchial tree causes formation of bacterial allergy, which causes bronchospasm; as to the other one – infection improves the permeability in the tissue of infectious allergic agents, and as to the third one in the opposite – sensitization of the organism is an infection “conductor”. The development of infectious-inflammatory process in bronchial tree of those who have occupational bronchial asthma are assisted by atrophic processes in the mucous (result of the contamination of the production environment with matters of irritating action: solvents, acids, alkaline, vapors and gases of various toxic matters). This is manifested by intensified hemorrhage of tissue metabolites and stimulates the production of autoantibodies. The same is caused by sensitization of organism to agents of infectious processes in the bronchial tree.

Along the intensification of infectious and allergic component on the background of the occupational allergy in the pathogenetic process, besides the reagent type of allergy, there are other types of allergic reactions. In the blood, the number of circulating immune complexes is growing (joining of industrial and infectious allergy agents with antibodies of IgA class). These complexes activate the system of complement, and in the result, the pathologic process includes kinin, neutrophilic and macrophage, as well as some other systems. Pathological process develops with more severity with asthmatic exacerbations. This very joining of infectious and allergic component causes the development of hypersensitivity of slow type (there are chemical and toxic factors of lymphocytes, and T-factors are activated).

There are two main forms of OBA:
- occupational bronchial asthma with allergic mechanism;
- occupational bronchial asthma with nonallergic mechanism (among them aspirin induced asthma).
• occupational bronchial asthma with allergic and nonallergic mechanisms

**CLINICAL PICTURE OF OCCUPATIONAL BRONCHIAL ASTHMA**

Main clinical manifestations of the OBA is an attack of expiratory dyspnea, cough, weezing sounds. It appears mostly at night. The beginning of it is the feeling of stuffed nose, coughing and difficulties in breathing. Breathing is noisy and accompanied by distant weezing and whistling sounds. The patient has to take a specific position (sitting and supporting himself with arms), where shoulder belt is fixed: shoulders are moved up and forward, the head is like drawn into the shoulders, the chest is in the aspiratory state, and movement are limited.

There is a box percussion sound, on auscultative examination there is a harsh breathing with prolonged expiration, dry weezing and whistling sounds can be heard. Pulse is frequent, the body temperature is normal or increased.

Patients with occupational bronchial asthma have changes in peripheral blood (eosinophilia), Kurshman’s spirals, Charko-Leyden crystals in sputum examination.

Development of occupational bronchial asthma depends on the peculiarities of the occupational anamnesis (character and type of allergic agents). Thus, for the occupational bronchial asthma, which is like atopic one, presence of symptoms of exposition and elimination (appearance of asthma attack when contacting with the allergic agent and its termination after the termination of the action of an allergic agent). Especially, it is obvious after the rest (vacations and weekends) during the period of the so-called monovalent sensitization. Timely rational work change at the stage of pathologic process can prevent its further progressing. In case of continuation of work under conditions of occupational factors, which had caused the disease, its progress leads to worse conditions due to the development of polyvalent allergy. During this period, termination of the contact of patients with occupational factors does not bring the improvement of their condition (the period of polyvalent sensitization).
So, there are typical features of OBA:

- dependence of the disease on the intensity and duration of exposure of the causative factor: the emergence of symptoms during and after exposure to allergens in the workplace;
- combination of asthma with other clinical manifestations of occupational allergy (skin, upper respiratory tract);
- elimination effect (periodicity of respiratory symptoms with improvement on weekends and during the holiday period);
- effect of reorganization (the deterioration of the subjective state and increasing the severity of respiratory symptoms after returning to the workplace (contact with allergens);
- reversible nature of bronchial obstruction (cough, shortness of breath).

There are several degrees of bronchial asthma severity (Fig.16):

<table>
<thead>
<tr>
<th>Severity of Asthma</th>
<th>Frequency of Daytime Symptoms</th>
<th>Frequency of Nighttime Symptoms</th>
<th>PEF of FEV1/ PEF Variability</th>
<th>Suggested Management (with inhaler as needed)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mid intermittent</td>
<td>≤2 days per week</td>
<td>≤2 nights per month</td>
<td>≥80%/&lt;20%</td>
<td>None necessary</td>
</tr>
<tr>
<td>Mild persistent</td>
<td>&gt;2 times per week &lt;1 time per day Attacks affecting activities</td>
<td>&gt;2 nights per month</td>
<td>≥80%/&lt;20-30%</td>
<td>Low-dose inhaled corticosteroid</td>
</tr>
<tr>
<td>Moderate persistent</td>
<td>Daily Attacks affecting activities</td>
<td>&gt;1 night per week</td>
<td>60-80%/&gt;30%</td>
<td>Low to medium dose inhaled corticosteroid Plus long acting β-agonist</td>
</tr>
<tr>
<td>Severe persistent</td>
<td>Continuous Limited physical activity</td>
<td>Frequent</td>
<td>≤60%/&gt;30%</td>
<td>High dose inhaled corticosteroid plus long acting β-agonist, oral anti-inflammatory if needed and oral glucocorticoid as needed</td>
</tr>
</tbody>
</table>

Fig.16. Degrees of bronchial asthma severity.

Occupational hazards, which cause local irritation of the respiratory organs or cause dust (toxic and dust) bronchitis or pneumoconiosis, can lead to bronchial asthma with no clear
elimination syndrome, thought worsening of the state with more frequent asthma attack takes place among the patients of the group as well, when they renew their contact with occupational factors (exposure symptoms). When the person terminates his contact with an allergic agent, asthma attack is not replaced by the complete remission though. In the clinical pattern, there are symptoms of inflammatory process in the bronchial tree, and upper respiratory tracts. Mucopurulent sputum is discharged, where pathogenic bacteria are seeded.

**DIAGNOSTICS OF OCCUPATIONAL BRONCHIAL ASTHMA**

Clinical manifestation of the OBA does not differ from those, which take place with the asthma of different etiology. Specific difficulties can take place in the process of definition of the etiologic factor in the genesis of this or that form of asthma. Thus, it is very important to study the occupational anamnesis of the patient, sanitary and hygienic characteristics of his/her workplace, as well as the data on allergen anamnesis, clinical manifestation and immune methods to examine a patient.

The presence of the contact with industrial allergic agents, production dust and irritating matters, asthma attack at work and significant improvement of the state during vacations or staying at hospital on sick leave, correspondence of the clinical pattern, as well as all the factors, which can assisting the development of asthma (heredity, hormonal disorders, diseases, life conditions, etc), enables to suspect occupational bronchial asthma which needs specific allergen examination.

Methods of allergen examination, which need immediate participation of the patient (skin allergen tests and provocative inhalation testing) is conducted in case of satisfactory feeling of the patient during the remission stage. General contraindications for these methods of diagnostics are acute fever states and inflammatory processes; active tuberculesis, pregnancy, decompensation diseases of heart, liver and kidneys; thyrotoxicosis; as well as complicated forms of bronchial asthma.
Mostly, scratch test or internal tests are used. To carry out scratch test, one drop of allergen is put onto the palm portion of the forearm, and through it the scratch is made. The reaction is assessed in 20 to 30 minutes, then 24, 48 and 72 hours. As a rule, immediate positive reaction takes place. When conducting of the allergen reaction under skin, it is necessary to administer from 0.05 to 0.1 ml of the allergen, which contains one skin dosage. Positive reaction is of the slowed-down type and it is assessed in 24, 48 and 72 hours since the administering of the allergen.

Provocative inhaling testing is conducted only in the phase of bronchial asthma remission and only in hospital. After the percussion and auscultative examination of lungs, spirogram is taken. Provocative inhalation testing is considered positive, if FEV₁ is reduced by 10 %, comparing with initial data.

Among the methods of allergen laboratory diagnostics to find out sensitization to industrial allergens, the following are used:

- reaction of a blood cell to the hapten in vitro - reaction of specific blood leukocyte accumulation, tests on damage and alternation of blood neutrophyls and reaction of direct specific damage of blood basophiles;
- serologic reactions – reaction of compliment binding and reaction of passive hemagglutination;
- specific cell reactions on hypersensitivity in vitro – reaction of specific rosette formation, reaction of termination of blood leukocyte migration

Only complex evaluation of the occupational and allergologic anamneses, of the corresponding documentation regarding the conditions of work and dynamics of the disease, and also results of specific allergologic and immune examination of the patient enable professionals to state the professional genesis and etiological factor of bronchial asthma.

**TREATMENT OF OCCUPATIONAL BRONCHIAL ASTHMA**

Treatment of patients with OBA is carried out according to the General principles of treatment of patients with other forms of
bronchial asthma, but its mandatory condition is the termination of contact of the patient with any industrial substances that have sensitizing and irritating effect. Treatment objectives: the primary objective of OBA treatment is to achieve and maintain control of the clinical manifestations of the disease. In the course of treatment, the following tasks are solved in each particular patient:

- relief of exacerbation;
- selection of adequate basic therapy;
- reduction of the risk of development of complications;
- reducing the risk of side effects during the course.

Complex treatment of patients with OBA includes non-pharmacological and pharmacological therapy.

The main drugs for emergency care – β₂-agonists short-acting (salbutamol, fenoterol, etc.), anticholinergic drugs (ipratropium bromide).

For long-term control of asthma are primarily used by inhalational corticosteroids and long-acting β₂-agonists (salmeterol, formoterol), and their combined forms (Seretide Multidisk, Symbicort Turbuhaler). Because of the severity of OBA and the lack of effectiveness of the treatment systemic corticosteroids are used.

Mucolitics are used – acetylcysteine, ambroxol.

Current treatment standards suggest a step-by-step approach to prescribing therapy depending on severity, which is described in detail in the national programme and clinical guidelines (GINA).

Among non-medicinal methods of the therapy for patients with occupational bronchial asthma, reducing diet therapy, needle reflexotherapy, curing gymnastics, respiratory gymnastics, physiotherapy (ultraviolet, ultrahigh frequencies, and electrophoresis), sanatorium-and-spa treatment (Crimea) and pneumotherapy.

Nonpharmacological treatment includes physical therapy, physiotherapeutic methods of treatment: needle reflexo-therapy, respiratory gymnastics, ultraviolet, ultrahigh frequencies, electrophoresis, sanatorium-and-spa treatment (Crimea) climatotherapy. Patient should avoid β-blockers, as well as NSAIDs (in aspirin induced form of OBA).


**VERIFICATION OF WORKABILITY IN OCCUPATIONAL BRONCHIAL ASTHMA**

When making decision on workability and job of patients with OBA, it is always necessary to remember that independently from the degree of the disease severity, they are contra-indicated the contact with matters of sensitized and irritating action, staying under unfavorable meteorological conditions and significant physical activity.

Workability of patients with bronchial asthma of mild degree is usually kept, but they need rational job.

When bronchial asthma of mean severity among patients can be significantly restricted or completely lost. In connection with the development of respiratory insufficiency and decompensation of chronic cor pulmonale in patients with severe degree, as a rule, there is inability to work, and many of them require external assistance and supervision.

**PREVENTIVE MEASURES**

The task of medicinal preventive measures is to keep workability of workers and employeres, and to prevent development of occupational medicinal examinations to select those who had to start working under conditions of possible contact with allergens. It is also important also to define initial sings of the disease and rational work beyond contacts with production allergens.
CHRONIC DUST BRONCHITIS

Dust bronchitis is one of the occupational diseases, caused by prolonged impact of occupational dust. It is characterized by diffusive inflammation of bronchi and is an initially chronic diffusive endobronchitis.

ETIOLOGY OF CHRONIC DUST BRONCHITIS

The development of dust bronchitis depends in prolonged inhaling of much dispersed dust with small amount of quartz or even without it (cement, herbal, or wooden dust).

The appearance of disease is influenced by the presence of unfavorable conditions: work conditions (microclimate, heavy work, or noise); a number of unprofessional factors (sex, age, smoking, infection in the past, or diseases of upper respiratory tracts).

PATHOGENESIS OF CHRONIC DUST BRONCHITIS

In case of dust action on the body, disorder of some systems of protection of bronchi-pulmonary apparatus is observed, like mucociliary transportation, local immunity, and surfactant system (Fig.17). There are disorders of evacuation of dust portions and secretion function of bronchi on the background of structural changes of ciliary epithelia.

Dust bronchitis is characterized by atrophic and sclerotic changes in all the structures of bronchial tree, which form on the initial basis of the disease already, also by changes of bronchi motor activity, and hypersecretion.

In the pathogenesis of the disease, bronchospasm is very important. It appears in the result of reflector reaction of bronchial muscles to dust particles or sensitization to allergens, contained in the industrial aerosol (chromium, manganese, nickel, phenol-formaldehyde resins, etc). Pathogenic microflora of respiratory tracts influences the development of the inflammatory process in bronchi and allergization of the patient.
At this disease, decrease of cell and humoral immunity decreases also, and significant meaning is also possessed by some genetic factors, in particular deficit of $\alpha_1$-inhibitor of the protease.

At dust bronchitis, bronchi, bronchial tubes and alveoli are affected. The action of dust first causes relevant reaction from the side of mucous membrane in the form of bronchi hypersection. Number of goblet cells increases. Reological properties of mucus change, its viscosity are increased. Then cells of ciliary epithelia die, basal membrane, infiltration with lymphoid cells starts. This period is clinically determined as endobronchitis.

With time, endobronchitis transits into panbronchitis, and then into peribronchitis. Centers of infections in perobroncial cell are accompanied by perineal sclerosis and transition of inflammatory changes into parenchyma of lungs. This phase of reamed inflammation, which is along formation of various grades of sclerosis expression and obliteration of fine bronchi transits into the third stage – reconstruction.

Fig.17. Pathogenesis of chronic bronchitis.
Thus, evolution of chronic bronchitis can be presented by consecutive pattern of hyperthrophic changes of bronchi with atrophic ones with further development of catarrhal mural deforming bronchitis. Spreading of inflammatory changes in distal sections of bronchial tree is accompanied by the violation of production of surface active matter – surfactant, which causes the development of bronchospasm and assists the appearance of sever complication—obstructive emphysema of lungs.

**CLASSIFICATION OF CHRONIC DUST BRONCHITIS**

1. **Etiological grouping:**
   a) dust (exposure to industrial aerosols, non-toxic, irritant and allergenic),
   b) toxic-dust (the effects of industrial aerosols containing toxic dust, irritating or allergic-ing connections),
   c) professional bronchitis from influence of industrial fibrous dusts of a natural and artificial origin.

2. **Clinical and functional characteristics:**
   a) simple,
   b) obstructive,
   c) emphysema-bronchitis with tracheobronchial dyskinesia.

3. **The character of changes of the bronchial mucosa:**
   a) the catarrhal endobronchitis.
   b) endobronchitis catarrhal-atrophic,
   c) atrophic endobronchitis,
   d) endobronchitis catarrhal-sclerosing.

5. **The level of the lesion:**
   a) proximal,
   b) distal.

6. **The severity of the process:**
   a) mild,
   b) moderate,
   c) severe.

7. **By type of ventilation violations:**
   a) non-obstructive,
   b) mixed (obstructive-restrictive),
8. The phase of the disease:
   a) exacerbation,
   b) remission.

8. Complications:
   a) pneumosclerosis,
   b) emphysema,
   c) pneumonia,
   d) bronchiectasis,
   e) adhesive pleurisy,
   f) bronchial asthma,
   g) malignant neoplasms,
   h) hemoptysis.

9. Functional insufficiency of pulmonary and cardiovascular systems:
   a) respiratory failure I-III degree;
   b) cor pulmonale (compensated, subcompensated, decompensated),
   c) heart failure I-III degree.

**CLINICAL PICTURE OF CHRONIC DUST BRONCHITIS**

Dust bronchitis begins gradually, has a chronic course with periods of remissions and exacerbations.

Under easily and moderately expressed bronchitis the main sting-battle are cough and shortness of breath. In half of the patients, pain is noted in the chest. On examination, percussion sound with boxed shade, vesicular breathing weakened, dry rales. Feature of dust bronchitis is a pleural rub and crepitation in posterolateral parts due to pleura involvement and development of fibrosis in the lung. Moist rales are heard in isolated cases when a bacterial infection is attached.

Bronchitis of moderate severity are joining infectious-inflammatory processes contributing to infringement of a motility of the bronchi, contributes to the formation of persistent obstructive disorders, emphysema, signs of respiratory distress and pulmonary hypertension. Cough and shortness of breath increase.

Progression of the disease leads to the development of severe forms of professional bronchitis, which can be attributed to the
outcome of the disease with the development of severe respiratory failure and chronic cor pulmonale. The reason for the pathological process progression can be joining infectious-inflammatory process, in patient with secondary immunodeficiency. Complications of professional dust bronchitis are obstructive emphysema, peribronchial fibrosis, pneumonia, bronchiectasis, bullous emphysema, hemoptysis, neoplasms.

**DIAGNOSTICS OF CHRONIC DUST BRONCHITIS**

1. WHO criteria for diagnosis: cough with sputum for more than 3 months per year for at least two years.
2. The study of occupational anamnesis, sanitary–hygienic characteristics of working conditions, data on preliminary and periodic medical examinations (to confirm the presence of a long experience of working in dusty conditions, the maximum permissible concentration, the nature of the dust, no other etiological factors in the development of chronic bronchitis).
3. Fiber-optic bronchoscopy with the assessment of the mobility of the posterior wall of the trachea.
4. Chest X-ray, computed tomography (CT) can reveal signs of emphysema, diffuse or polysegmental pulmonary fibrosis, peribronchial infiltration or pneumonia, bronchiectasis.
5. Spirometry. Carrying out functional and pharmacological tests with bronchodilators.
6. Examination of blood gas composition.
7. Study of General blood test and General sputum analysis.
8. ECG and ultrasound examination of heart to detect signs of overload of the right heart and pulmonary hypertension (chronic cor pulmonale).

**TREATMENT OF CHRONIC DUST BRONCHITIS**

Tactics of treatment of dust bronchitis is based on the resultsof examination of patients and is conditioned by mostly symptoms, functional state of the external respiration, blood circulation, nervous
and other systems, presence and explicitness of an allergic component, as well as the state of immune reaction.

Considering that at dust bronchitis, there is the development of atrophic processes in mucous membrane of the bronchial tree on the first stages of the disease; main treatment should be directed at the increase of general reactivity of the organism, stimulation of general regenerative processes in the mucous tunic of bronchi, as well as liquidation of bronchospasms. So, treatment of dust bronchitis:

1. Bronchodilators.
2. Glucocorticoids in uneffectivness of maximum doses of bronchodilators (Beclomethasone; budesonide).
4. Antibacterial therapy—penicillin drugs, fluoroquinolones, cephalosporins, macrolides.
5. Oxygenotherapy.
7. Physiotherapy.

**VERIFICATION OF THE ADILITY TO WORK IN CHRONIC DUST BRONCHITIS**

Issues of the verification of the ability to work for those, who have dust bronchitis, are solved individually, with the consideration of the severity of the disease, age, work period, occupation of the sick and work conditions.

The patient with dust bronchitis of stage I can continue working in the competence of his/her occupation with obligatory dynamic medical examinations (not less than twice a year).

Patients with bronchitis of stage II are subject to rational employment, which is not connected with the influence of dust, irritating matters, and unfavorable weather factors as well as without significant pressure. The decrease of qualification at transfer to another job is the basis to send the patient to the Treatment and technical verification commission to get disablement status (as a rule, it is group III invalidity) due to the occupational disease.
Patients with stage III of bronchitis due to frequent cases of exacerbation of inflammatory process and the development of cardiac and pulmonary decompensation lose the workability completely and often need external help, what conditions the need for them to get disablement group II or I in the result of the occupational disease.

**PREVENTIVE MEASURES**

Main preventive measures of bronchitis is the conduct of technical, sanitary and hygienic measures, aimed at further improvement of the work environment for workers of dusty professions.

Measures of medical preventive measures, first of all, a quality conduct of medical examinations, both preventive and periodical, are very important. Another important preventive measure for dust bronchitis is timely and rather long treatment of acute inflammatory diseases of respiratory organs, active anti-smoking campaign.
In various spheres of industry – metallurgic, chemical, oil-processing, pulp and paper, pharmaceutical, and mechanical engineering – mix of chloral, sulfur and nitrogen have become rather popular. They all can be in the air of the work zone in the form of irritating gases: chloral, chloro-hydrogen, sulphur trioxide, hydrogen sulphide, nitrogen oxide and ammonia.

Toxic substances, irritant:
2. Sulfur compounds: sulfur dioxide, hydrogen sulfide, dimethyl sulfate, sulfuric acid.
6. Carbonyl compounds of metals: lithium carbonyl, Nickel carbonyl.
7. Soluble compounds of beryllium: beryllium fluoride, beryllium chloride, beryllium sulfate.

Acute intoxication occurs in emergency situations, when it is possible to inhale significant concentrations of toxic substances irritant.

Degree of intoxication severity is determined by:
- concentration of poison in the air of the working area;
- duration of action;
- general reactivity of the organism;
- the specific effects of the substance.

The depth of the lesion depends on the solubility of the toxic substance in the water. Soluble substances (chlorine, sulphur dioxide, ammonia) are mainly on the mucous membranes of the upper respiratory tract, trachea and major bronchi. The action occurs
immediately without a latent period. Insoluble in water substances (oxides of nitrogen, phosgene) affect mainly the deep bronchial ways. There is a hidden period of different duration.

Furthermore in cases of poisoning by irritants there are the reflex influence of irritation of interoreceptors of the bronchial tree, accompanied by regard to a violation of his motor skills.

In acute intoxications with substances of irritating action are observed:
1. Acute toxic laryngotracheitis.
2. Acute toxic bronchitis with diffuse lesions of large and medium-sized bronchi.
3. Acute toxic bronchiolitis.
4. Acute toxic pulmonary edema.
5. Acute toxic pneumonia.

**ACUTE TOXIC AFFECTION OF BRONCHOPULMONARY APPARATUS**

Under industrial conditions, accidental situations can appear, in case of inhaling toxic matters of significant concentrations. Appearance of intoxication is caused by the following: high concentration of the chemical matter in the air; duration of its action; general reactivity of the organism; as well as physical and chemical properties of poisoning matters.

**PATHOGENESIS**

Irritating matters when having impact onto the body of the worker, get in contact with the moisture of respiratory tracks and creation compounds, which have burning properties (hydrochloric acid with the action of chloral, salt cake - sulphuretted hydrogen, etc). These compounds cause disorders of respiratory functions due to local irritating action, as well as the disorder of the reflector character (impact onto the interoreceptors of bronchis). The result is spastic contraction of heart muscles, respiratory and cardio-movement centers. Spreading and heaviness of affections depend on the degree of dissolving of toxic matters in water.
Matters, which are easily dissolved in water (chloral, chloropicrin, ammonia, and sulphuretted hydrogen), have impact mostly onto the mucous membrane of tracheas and large bronchi. Clinically, it is manifested by an acute laryngotracheitis and acute toxic bronchitis.

Matters, which are difficult to be dissolved in water (nitrogen oxide, phosgene, chloropicrin and dimethyl sulphate), they deeply permeate into the bronchopulmonary system, and affect small bronchi and bronchioles. And clinically, this can be conditioned by the appearance of acute bronchitis and broncholitis.

**ACUTE TOXIC LARYNGOTRACHEITIS**

In the clinical development, there are three phases of severity.

*Mild phase* is characterized by hyperemia of mucous membrane of upper respiratory tracts; and in some places small hemorrhages are observed.

*Moderate phase*: swelling of mucous membrane, coarse voice and sometimes its complete loss are observed.

*Severe phase* is characterized by the necrosis of mucous membrane with creation of ulcer in it. Possible development of acute swelling of lungs with further asphyxia and death of the patient are observed.

**ACUTE TOXIC BRONCHITIS**

There are three phases of the severity of acute toxic bronchitis.

*Mild phase*: (superficial or catarrhal toxic bronchitis) is characterized by the following: painful coughing, pain and “scratchy” throat, squeezing and scorching throat, as well as obstructed breathing. During the percussion, it is possible box sound can be heard, mostly in lower side portion of lungs, during auscultative examination, scattered dry rales can be heard on the background of harsh breathing. Duration of this phase of bronchitis is from 3 to 7 days; complications are absent.

*Moderate phase*: patients complain to have rhinorrhea, epiphora, obstructed breathing via a nose, intensive pain in the chest, fit-like
coughing with sputum discharge. Cyanosis and dyspnea can be well heard. On percussion signs of emphysema are observed; during auscultative examination – dry rales and sometimes some moist rales can be heard. As to the cardio-vascular system – tachycardia is observed. As a rule, the temperature of body is increased to low grade, moderate neutrophilic leukocytosis, as well as increased ESR. The duration of this phase of bronchitis is from 7 to 10 days.

Severe phase is characterized by the presence of marked cyanosis, and dyspnea at rest. Objective signs of emphysema include dry and moist rales all over the surface of lungs. This phase lasts for 2 to 6 weeks, and in case of adequate treatment, complete recovery is possible. Further progress of acute toxic bronchitis is possible under conditions of joining infection, its transition into a chronic form with the development of pneumosclerosis.

ACUTE TOXIC BRONCHIOLITIS

It develops during the impact of toxic matters of irritating action, first of all those, like dimethyl sulfate, joining of beryl.

In mild cases, patients complain to have coughing, small amount of phlegm, moderate dyspnea, and low grade fever. Above the lungs, basal emphysema can be observed; small moist crepitations in small amount can be heard.

From the point of peripheral blood, small leukocytosis and increased ESR can be observed. This stage lasts for from several days to 2-3 weeks.

In more marked phases, dyspnea is increased, coughing becomes unbearable, and sometimes it is fit-like, and it is accompanied by pain in the chest, and thick mucoid sputum. Patients complain to have headache, loss of appetite, increase of temperature to 38-39 ºC, and general weakness. Marked cyanosis takes place, and tachypnoea (30–40 per minute). Objectively, there are sings of emphysema, borders of lungs are expanded; their movement is reduced. Above all the surface of lungs and especially in lower portions, great amount of medium and small bubbling moist capitations can be heard. As to the cardio-vascular system, tachycardia can be observed; decrease of arterial
pressure and muffled heart sounds can be heard. Liver increases, it becomes more painful during palpitation.

In the peripheral blood, increase of hemoglobin, erythrocytes, leukocytosis with left shift, relative lymphopenia, and sometimes, eosinophilia can be observed, and ESR increases up to 50 mm/h. Proteinuria and cylindruria can be observed in urine.

On the chest radiogram there are decrease of transparency of lung field in middle and lower portions. Lung roots are expanded.

Patients with acute toxic bronchiolitis either recover or receive various complications: bronchopneumonia, transition to the chronic form with obliteration of the lumen bronchioles.

**ACUTE TOXIC PNEUMONIA**

It appears in the result of short-term impact of the toxic matters and is characterized of acute beginning, short-term progress, and absence of the inclination to the appearing of new centers.

Pneumonia in the result of the action of gas appears in an acute form, within several hours after accidental aspiration of petroleum or its permeating into the respiratory ways. Cyanosis, dyspnea and intensive pain in the half, which is the location of pneumonia infiltration, are observed, as well as coughing with sputum. The temperature increases up to 40°C.

During percussion decreased percussion sound is observed on the side of affection; and during auscultative examination: bronchial breathing and crepitations are observed. In the peripheral blood, there are sings of the inflammatory process (leukocytosis, lymphopenia and the increase of ESR).

On the radiological picture, an area of pneumonic infiltration in the form of homogenous shadowing, which is localized mostly in the front portion of lungs.

Oil and alkaline inhalations are recommended, as well as antitussive drugs (Libexin), and antibiotics.
ACUTE TOXIC PULMONARY EDEMA

Acute toxic pulmonary edema (TPE) is the most serious and dangerous form of acute toxic affection of bronchopulmonary apparatus. Etiological indications of its appearing can be nitrogen oxides and chloropicrin.

In the mechanism of development of TPE, an important place is taken by the impact of toxic matter onto the activity of ferment systems, which contain SH groups. They are accompanied by high increase of the permeability of alveolar membranes with the disorder of metabolism. In the interstitial tissue, high protein liquid is accumulated in alveoli.

Besides an immediate action of toxic matters onto the ferment systems, the mechanism of TPE is impacted, which is proved by the decrease and often prevention of the development of TPE due to elimination of some sections of the nervous system (vagosympathetic blockade and cutting of the vagus nerve on the neck).

In the development of TPE, five periods can be named:

The first one or the period of irritation. Clinical manifestation: epiphora, coryza, coughing, “scratchy” throat, and squeezed chest; duration: 15 to 20 minutes.

The second one or the period of imaginary well-being. Clinical manifestation: insignificant dyspnea, pulse instability, and signs of moderate emphysema; duration from 3 to 8 hours.

The third period or the period of the increase of the edema. Patients complain to have squeezed chest, dyspnea, coughing with sputum discharge. During the percussion, box sound above the lungs; during the auscultative examination: fine moist rales. The number of rales increases fast.

On the radiological picture of lungs, the pattern is vague and roots are expanded.

In peripheral blood increase of ESR is observed, as well as leukocytosis with the left shift and lymphopenia.

The fourth period or the period of the end of edema. Clinical manifestation: dyspnea and coughing increases, bloody sputum is discharged, and breathing is bubbling. During auscultative examination, significant number of heterogeneous moist rales.
Radiologically, it is possible to observe spotty shadows, which are conditioned by the accumulation of swelling liquid in alveoli (Fig. 18). These shadows create big merged areas in some places.

When researching blood, its clotting is observed, which is manifested through the increased of hemoglobin, erythrocytes and leukocytes. Blood viscosity is increased.

The amount of oxygen in the arterial blood decreases sharply, but the amount of carbon dioxide increases; the so-called hypercapnic (blue) type of hypoxemia develops. The arterial pressure is normal or a little increased. Blue asphyxia can develop into the gray one.

![Fig. 18. Toxic pulmonary edema.](image)

The gray type of hypoxemia is characterized by low contain of blood of carbon dioxide, merging of the lung edema with the decrease of cardio-vascular activity (collapse). The patient’s face gets gray pale hint and is covered with cold sweating. Mucous membrane are of dirty gray color. Limbs are cold and damp when touched. The pulse is frequent and thready; the arterial pressure decreases fast.

The *fifth period* or the period of reverse development of the TPE. It is characterized by the decrease of dyspnea, cyanosis, coughing, and the amount of discharged sputum, as well as crepitations in lungs. The pattern of peripheral blood is normalized. In 2 to 4 days, a patient
recovers. The temperature stays increased (37.5 to 38.0°C) during the week.

Complications of TPE are pneumonia and the development of pneumosclerosis.

Patients are recommended to take oxygen (oxygen inhalations are compiled with vapors of 30% alcohol with the purpose to prevent the creation of foam). Eyes are washed with 2% solution of sodium chloride and instill with albucid (30% solution), Novocain 1–2 drops of 1% solution. A nose and throat are rinsed with the solution of sodium bicarbonate.

In case of the development of spasms of glottis 1.0 ml of 0.1% solution of atropine should be done subcutaneously.

People, who had contacts with damps, need to be examined in hospital. With the purpose to decrease the permeability of vessels, 5 to 10 ml of 10% solution of calcium chloride are introduced intravenously.

With strong hypoxemia, the following is recommended: oxygen therapy (oxygen with alcohol vapors); bloodletting (from 300 to 500 ml of blood) under the control of the arterial blood.

With the gray type of hypoxemia are recommended: inhalations with oxygen (60% with the addition of 5% of carbonic acid); means which stimulate the respiratory center (caffeine, and ephedrine); antibiotics with the purpose of infection prevention (development of bronchopneumonia).

In cases of mild affection of bronchopulmonary apparatus with matters of toxic and chemical action, patients return to their work.

For patients with mean or severe phases of affection, it is necessary to make sure that results of the treatment stay for long; these patients need temporary termination of work in the areas with the contact with chemical matters of irritating nature. In case of the decrease of qualification for the term of more than two months, they can receive a sick leave or receive an invalidism group due to their occupation disease.

Preventive measures are the following: sealing-in of the equipment, utilization of individual means of protection of respiratory organs, as well as conduct of preliminary and periodical medical examination of workers.
CHRONIC TOXIC DISEASES OF BRONCHOPULMONARY APPARATUS

Chronic diseases of bronchopulmonary apparatus develop among workers of chemical enterprises and are the result of long-term impact regarding small concentrations of toxic matters of irritating action. They can also be the result if one (or several) acute affection of bronchopulmonary apparatus.

Chronic toxic diseases are more often had in such forms as affection of upper respiratory tracts (chronic rhinitis, pharyngitis, laryngitis and tracheitis), as well as chronic toxic bronchitis.

Affection of upper respiratory tracts (nose, throat and larynx) has, at first, catarrhal and then atrophic character. A patient has the feeling of dryness in the nose; heartburn, disorder of nose breathing, scratchy throat, sometimes nose bleeding as well as coarse voice. After the examination, hyperemia of mucous tunic is observed, as well as its thickening. For the action of chromium and fluorine (especially, in high concentrations), it is characteristic to have necrotic tonsillitis affection in the area of nose septum.

At dynamical examination, it is possible to find some pattern in the development of deep erosion, which is finished with the formation of connective tissue scar or the perforation of the septum.

Chronic toxic bronchitis is a diffuse affection of the bronchial tree, which is characterized by the recurrent and progressing development of the disease.

Pathogenesis. In case if the organism of a worker is impact by irritating matters, hyperplasia of cup-shaped cells of bronchial glands with the hypersecretion of mucus and the change of their properties. Secretory, cleaning and protection functions of the mucous tunic of bronchi are affected, what assists fast to the development of inflammatory process. Chronic toxic-infectious inflammation, metaplasia and atrophy of epithelium are formed. They are manifested with swelling, collapse of small bronchi, and scar changes, which finally form broncho-obstructive syndrome.

The result of toxic bronchitis is the diffusive pneumosclerosis with its unchangeable components, like emphysema, pneumosclerosis, bronchiectasis.
There are three phases of chronic toxic bronchitis: mild, mean and severe.

*Mild phase.* Patients suffer from dry coughing, sometimes with small amount of purulent phlegm or muco-purulent sputum character. In lungs, some capitations can be heard on the background of coarse breathing.

Acute conditions are rare in this stage. Usually they appear under the condition of unfavorable microclimatic factors or joining of an intercurrent infection.

Deviations on the radiological picture at this phase are not found. Mild changes on spirometry are found.

*Moderate stage.* It is characterized by the intensification of coughing; amount of phlegm discharge increases (it is coming closer to purulent one); dyspnea appears during physical exercises. Fit-like coughing can develop. Percussion sound gets box sound on the background of harsh (sometimes, weak) breathing; scattered dry and moist crepitations can be observed. Acute conditions are more frequent and longer. On the radiological picture, intensification and deformation of lung pattern can be observed, mostly in lower portions; lung fields become more transparent. Obstructive changes on spirometry are present.

*Severe stage.* As a rule, it is a complicated bronchitis. More often, marked bronchoobstructive syndrome with the transfer to the secondary bronchial asthma or with appearance of bronchiectasis takes place.

Manifestations of bronchoobstructive syndrome remind attacks of bronchial asthma.

In some cases, clinical pattern reminds the progress of bronchoectatic disease (patients discharge from 300 to 500 ml of purulent sputum, and frequent hemoptysis is observed).

Coughing becomes permanent, much amount of purulent sputum, often with blood and unpleasant odor, are observed. Obstructed respiration, which transits into fits of dyspnea are observed. Patients get cyanosis, frequent respiration; nails get the form of clock glass, and phalanx of fingers look like drum sticks.

During auscultative examination, in lungs, it is possible to hear scattered dry and moist rales, mostly in lower portions of lungs. From the side of cardio-vascular system, there is tachycardia; tones of the
heart are dull; the accent of II tone can be heard above the pulmonary artery; congestion can develop, first in small and then in the large blood circulation circle.

In the blood, there is compensatory polycythemia (increased amount of hemoglobin and erythrocytes).

During radiological examination, it is possible to note deforming diffusive pneumosclerosis and lung emphysema. Independently from the overbalance of some clinical form, the severity of the state of such patients is conditioned by the increasing decompensation of the respiratory function and decompensation of cor pulmonale.

To treat chronic affection of upper respiratory tracts, alkaline and oil solution inhalations are used.

The treatment of chronic toxic bronchitis envisages means, which dissolve sputum and facilitate its discharge: mucolytic and expectoration medications. Bronchodilators are indicated.

Significant place in the treatment of chronic toxic bronchitis is played by oxygenotherapy, respiratory gymnastics, massage of the chest, and physiotherapeutic procedures (inductotherapy, electrophoresis of Calcium chloride).

In case of infection development, antibiotics are recommended; with cardiac decompensation – cardiac glycosides (corglucon and strofantin), diuretics (furocemide, antagonists of aldosterone).

Verification of the ability to work. In case of chronic affection of upper respiratory tracts, patients are able to work according to their occupation under condition of dispensary observation and normalization of work conditions. Presence of ulcerous-inflammatory processes is the condition to provide a medical leave (temporary work).

Patients with mild and moderate phases of chronic toxic bronchitis need rational work beyond the area with dust action, matters of irritating action and physical overstrain. In case of the impossibility to get such a job and the decrease of qualification, they are sent to the Verification Commission to get the invalidism group.

Patients with complicated forms of bronchitis are unable to work as a rule; and sometimes need external help (II or I group of invalidism).
Preventive measures. Preventive measures are in the implementation of progressive technologies into the production process (sealing-in of the equipment, its further mechanization, effective ventilation and keeping to safety rules), as well as utilization of individual protection means and medical examination of workers.
INTOXICATION OF AROMATIC HYDROCARBONS

To aromatic hydrocarbons there are concern: benzene (Fig.19), its homologs, nitro-, halogeno- and aminoderivatives of benzene. They are applied in various industries. Benzene is widely applied in various reactions of organic synthesis. It is valuable raw material for manufacturing of synthetic products; it meets in structure of some kinds of oil, motor fuel, in small amounts it contains in technical combustible gases, in oil petroliums – solvents. It can be as an admixture in its homologs (toluene, xilole) and other organic solvents. Maximum permissible concentration of benzene is 5 milligrams on cubic meter of air.

Chlorine benzene is widely applied in the industry as solvent, as a component at organic synthesis. It is turned out by chlorination of benzene at the presence of catalysts (together with other derivatives of benzene). MPC (maximum permissible concentration) of
chlorinebenzene is 50 mg on cubic meter. Hexachlorinecyclohexane (hexachlorane) is applied in quality of insecticide and larvicide. MPC for $\gamma$ - isomer is 0,05 mg on cubic meter, for a mix of isomers is 0,1 mg on cubic meter of air.

At influence of aromatic hydrocarbons different organs and systems can be damaged: bone marrow, peripheral blood, central nervous system, and skin, mucous membranes of eyes and upper respiratory ways, liver, lens of an eye (development of cataracts). Development of tumors is possible.

Character of toxic action of aromatic hydrocarbons appreciably depends on chemical structure and presence of methylc, amidic, nitrogroups or atoms of chlorine in benzene ring. So, for example, benzene and it homologs on the toxic action are referred to poisons, oppressing processes of hemopoiesis. Halogen-derivates of benzene cause irritation of mucous membranes of eyes and respiratory ways. Among amino-and nitroconnections of benzene there are substances which promote formation of methemoglobin, hemolysis of erythrocytes, lesion of liver, development of cataracts, tumours.

Let's begin consideration of intoxications by aromatic hydrocarbons with the substances causing characteristic changes in blood, caused by lesion of marrow hemopoiesis, by development of hypo-and aplastic conditions of bone marrow. The heaviest disturbances are caused with benzene.

Benzene is a liquid with specific aromatic smell easily soluble in spirit, ether, fats, and lipoids and hardly soluble in water.

Under production conditions penetration of benzene and its many connections into an organism of the person is probably through lungs as steams and through the intact skin. At influence of benzene the development of acute and chronic intoxications is possible. Acute poisonings arise owing to short-term inspiration of the big concentration of steams of benzene at casual its escape in a premise or in an operating time in the closed spaces (cleaning of cisterns from - under benzene etc.). Chronic intoxication develops at long inspiration of small concentration of steams of benzene and at regular hit of it on integuments. At acute intoxications benzene can be found out in blood, brain, liver, adrenal glands. At chronic intoxications the most part of it is determined in fatty tissue and bone marrow. The
significant part of benzene is removed from an organism with expired air and urine. Other part of benzene is oxidized with formation of phenol, diphenols, which are removed with urine as glucuronic acids and connections with sulfur.

**PATHOGENESIS OF INTOXICATION OF BENZENE AND ITS HOMOLOGS**

Mechanisms of development toxic hemodepression are varied and difficult. They include possible direct cytotoxic action on the earliest cells precursors of hemopoiesis - pluripotent stem cells and on a microenvironment of the last (stromal cells of a bone marrow and others hemopoietic organs, not cellular elements). Consequence of specified action is reduction of quantity of stem cells, disturbance of their proliferation and differentiations.

By cytokinetic researches of a bone marrow even at low levels of influence of benzene suppression of proliferation of cells precursors of neutrophils and erythrocytes, compensated activation of hemopoiesis, hindering by development of peripheral cytopenia for a long time, is marked.

It is necessary to take into account influence of toxic substances - hemodepressants on morphofunctional condition of cells of hemopoiesis, caused by intervention in processes of peroxidative oxidation of lipids, synthesis of DNA, oxidative phosphorylation. Consequence of it is defect of production and reduction of survivability of cells, first of all it concerns to granulocytes.

The role of autoimmune mechanisms in development of hemodepression, connected with disturbance of antigen-recognizing properties of T-lymphocytes and their depressive action on myelopoiesis is also established.

The balance of some vitamins is disturbed: the contents of vitamins of group B (first of all pyridoxine and cyanocobalamin), participating in the process of marrow hemopoiesis, and also an ascorbic acid which takes part in regulation of coagulation of blood and normalization of permeability of walls of capillaries in reduced.

Benzene has effect directly on the central nervous system, causing development of neurodystrophic complex of symptoms.
The degree of expressiveness of depression of erythro-, leuko-, and thrombocytopenia, caused by toxic substance can be various. It depends on intensity and duration of action of the etiologic factor, individual sensitivity of an organism to its action, condition of endogenic factors influencing on hemopoiesis, particularly at women (deficiency of iron, dysfunction of thymus, thyroid gland, ovaries etc.).

**PATHOANATOMICAL PICTURE**

For acute intoxication by benzene the phenomena of asphyxia are characteristic. It is marked stagnant plethora of internal organs and punctate haemorrhages in lungs, pleura, epicardium, peritoneum, mucous membranes of gastrointestinal tract. Edema, plethora of brain substance and its tunics, fine haemorrhages in them are marked.

At the expressed chronic intoxication common anemia and hemorrhagic diathesis which manifestations are punctate haemorrhages in a skin, mucous membranes, an oral cavity, serous tunics of internal organs, are observed. Quite often hemorrhages can be observed in pia maters, substance of the big hemispheres of a brain, its ventricles. At the heavy forms of intoxication, accompanying with depression of hemopoiesis, aplasia of a bone marrow with lesion of all three its sprouts (practically disappearance of cells) and redundant fibrosis of elements of stroma is marked. In a liver and kidneys dystrophic changes, interstitial sclerosis are observed. Occurrence of infiltrates from plasmatic cells is possible.

**CLINICAL PICTURE OF INTOXICATION OF BENZENE AND ITS HOMOLOGS**

*Acute intoxication.* Poisonings with benzene are accompanied by lesion of the central nervous system with the phenomena of general cerebral disturbances which can be observed also at intoxication by the poisons having narcotic properties.

At an easy degree of acute intoxication by benzene victims are in a condition of easy euphoria. There is a general weakness, dizziness,
noise in ears, headache, nausea, vomiting, staggering at walking. All indicated phenomena are unstable and completely disappear within several hours, not causing any disturbances in other bodies.

At acute intoxication of average degree of heaviness general weakness, headache are strengthened. The inadequate behavior, anxiety are marked. There is pallor of integuments, body temperature is reduced, and breath becomes frequent. Disturbance of cardiovascular activity: trembling (frequent, weak) pulse, falling of arterial pressure is observed. Muscular twitchings, tonic and clonic spasms, expansion of pupils are marked. Full loss of consciousness and coma are possible. At the patients, who have transferred acute intoxication of average degree of heaviness, after some time there can come full recovery. Sometimes there are proof functional disturbances of nervous system as astheno-vegetative syndrome.

The severe degree of acute intoxication by benzene is characterized by almost instant loss of consciousness, development of toxic coma, accompanying by standstill of breath owing to a paralysis of the respiratory centre. At such conditions there comes death more often. Changes in blood are shown only as moderate short-term leukocytosis owing to disturbance of the central regulation of hemopoiesis. Deep lesions of marrowy hemopoiesis at acute intoxication by benzene are not observed.

**Chronic intoxication.** First of all for this form of intoxication lesion of marrow hemopoiesis is characteristic. The clinic is represented by aggregate of hematological symptoms which are combined with changes of other organs and systems.

If in a clinical picture the anemic syndrome is conducting that general weakness, fatigue, often dizzinesses, quite often a headache, sensation of front sights before eyes, dyspnea at physical loading prevail. Integuments and visible mucous at patients are pale, displacement of borders of deep cardiac dullness to the left is observed, above an apex and in the field of a projection of pulmonary arteries systolic murmur is quite often listened. Lymph nodes and spleen are not enlarged.

When depression of thrombocytosis prevails, various clinical manifestations of hemorrhagic syndrome (bleeding of gingivae, skin haemorrhages, menorrhages, and nasal bleedings) can be developed.
Expressiveness of hemorrhagic syndrome is determined by weight of lesion of hemopoiesis. In an origin of hemorrhages disturbance of hemocoagulation and structural changes of vascular wall of stem cells down to development of “marrowy fibrosis” with the subsequent breaks of vessels play a role.

Change of peripheral blood at influence of hemotoxic substances is characterized by cytopenias, which are mainly easy. Sometimes cytostatic reactions carry transitory character. Most frequently the first hematological symptom is leukopenia which can carry transitory character. Proof reduction of quantity of leukocytes - less than 4, 0 *10/l has diagnostic value. Leukopenia, as a rule, is formed due to reduction of the contents of neutrophils that results to relative lymphocytosis. There are qualitative changes of leukocytes: increase of the contents of neutrophils with pathological granularity, their hyperpigmentation, rejuvenation of leukogram with displasement to the left. Along with leukopenia moderate thrombocytopenia (less than 180*10⁹/l) and erythrocytopenia can be marked. The contents of reticulocytes is in norm, or it is a little bit increased (>12%).

When depression of erythropoiesis prevails, in peripheral blood there are basically changes of red blood: the contents of hemoglobin (<115g/l at women and < 132g/l at men) and quantity of erythrocytes (< 3,7*10¹²/l at women and < 4,0*10¹²/l at men) decreases. Anemia is usually moderate, normochromic. At deep depression of hemopoiesis expressed pancytopenia in blood is found out. Thus ESR is sharply accelerated, time of a bleeding (> 6-10 minutes) is lengthened.

The picture of sternal punctates is various. At moderate cytopenia of peripheral blood it is characterized by attributes of easy hypoplastic condition (decrease of segmented neutrophils with decrease of number of young forms of myeloid line), changeable reticulocytosis. Presence of the last alongside with hyperplasia of erythroid sprout, increase of mitotic activity of cells of myeloid line testifies to activation of regenerative processes and it is regarded as compensatory reaction on influence of hematotoxic factor.

The typical representative of such poisons is benzene. The picture of acute intoxication was stated above.

The chronic intoxication by benzene proceeds with primary lesion of hemopoiesis and nervous system, and also changes in other organs and systems.
Long contact to benzene results in development of chronic benzoic intoxication (easy, average and heavy degree) and to leukemias (acute and chronic).

A) Clinical forms of primary lesion.
   1. Changes in system of hemopoiesis. It is the typical form of cytopenia (now it is moderately expressed with prevalence of leukopenic conditions) and various reaction of marrowy hemopoiesis (from compensatory tension of hemopoietic functions up to expressed hypo- and aplastic conditions).
   2. Hemorrhagic syndrome. There are disturbances in system of coagulation, change of properties of a vascular wall.
   3. Changes in nervous system:
      a) functional disturbances of the central nervous system with vegetative hyper- and hyporeactivity,
      b) vegetative polyneuritis,
      c) asthenooorganic syndrome.

B) Possible disturbances of other organs and systems.
   1. Changes of cardio-vascular system (dystrophy of myocardium, propensity to hypotension).
   2. Lesion of liver (enlargement, change of functional tests).
   5. Disturbance of steroid function of adrenal glands.

With reduction of working concentration of benzene in air of a working zone easy and erased forms of a chronic intoxication are observed. Influence of benzene is more often marked at the women having latent deficiency of iron, dysfunction of thyroid gland, disturbance of genital function. Changes in blood as cytopenic reactions carry easy transitory character. Easy symptoms of hemorrhagic diathesis (bleeding of gingivae, nasal bleedings, and increase of menstrual losses of blood) which can be the earliest, and sometimes and a unique clinical symptom, are possible. The quantity of thrombocytes can be kept within the limits of norm or can be reduced.

The functional disturbances of the central nervous system caused by benzene’s narcotic action are most typical for modern easy forms
of its chronic intoxication.

The average degree of chronic intoxication by benzene is characterized by the greater expressiveness of clinico- hematological symptoms. The phenomena of hemorrhagic diathesis are observed. Disturbances of cardio - vascular system, separate functional tests of liver, development of vegetative - sensitive polyneuropathia are possible. In peripheral blood is moderately expressed anemia, leukopenia and RSE are increased. In sternal punctate the changes testifying about moderately expressed hypoplastic condition of hemopoiesis are observed.

The heavy form of chronic intoxication does not practically meet now. It is characterized by deep pancytopenia, absence of reticulocytosis; ESR is very increased. In a bone marrow is true hypoplasia. Hemorrhagic syndrome is sharply expressed. Arterial hypotension, dystrophy of myocardium, attributes of toxic hepatitis are observed. Changes of nervous system are manifested by expressed asthenic or asthenoorganic syndrome (toxic encephalopathia).

Chlorinebenzene is a liquid used as solvent and a component at various synthesizes. In the concentration exceeding MPC, it causes less expressed depression of hemopoiesis, than benzene. Distinctive feature is lesion of erythropoiesis in the greater degree and development of moderately expressed anemia. Membranous permeability of erythrocytes is disturbed. Because of it processes of ageing of erythrocytes and reduction of life expectancy of circulating erythrocytes are accelerated. Quite often combination with leukopenia and thrombocytopenia takes place. There can be same neurologic disturbances, that at an intoxication by benzene. Early attributes of influence of chlorinbenzene are changes of skin (epidermitises, dermatitises, onychodystrophias).

Toluene. It is applied as solvent and to reception of other reagents. Toxic action is characterized at acute intoxications by lesion of the central nervous system and irritation of mucous of eyes, respiratory ways. The chronic intoxication is accompanied by decrease of level of erythrocytes, poikilocytosis, anisocytosis, moderate leukopenia with relative lymphocytosis. Sometimes small thrombocytopenia takes place. At regular hit of xylole on a skin dermatosises arise.

Styrene. It is a liquid which is used for manufacture of plastic,
synthetic rubbers and polyester pitches. Styrene has narcotic action. More expressed irritation of mucous membranes is marked. Toxic lesion of liver is possible. Moderate leukopenia, relative lymphocytosis, small thrombocytopenia and reticulocytosis are observed.

*Dichlorinbenzene.* It is applied as solvent, to manufacture of dyes and as insectofungicide. On toxic action it reminds chlorinbenzene. In a clinical picture the irritation of mucous membranes of eyes and respiratory ways are observed.

In blood decrease of level of hemoglobin, reduction of quantity of erythrocytes and thrombocytes and also occurrence of methemoglobinemia are marked.

**DIAGNOSTICS OF INTOXICATIONS BY BENZENE AND ITS HOMOLOGS**

Plan of investigation of benzene and its homologs intoxication includes:

1. Study of documentation (copies of the employment record book; extract from the outpatient card about past diseases, conducted medical examinations; sanitary and hygienic characteristics of working conditions).
2. Objective examination of the patient.
3. General blood test with platelets.
5. General urine test.
7. Algesimetry.
8. Electromyography.
9. ECG.
10. Consultation of neurologist

The differential diagnosis will be carried out with:
1. Hemodepressions of medicinal genesis.
2. Benign distributive neutropenias, marked at diseases of gastrointestinal tract, neurosises (reduction of quantity of circulating
cells and their congestion in marginal pool; there are no changes of myelogram).

3. Various forms of anemias. Basically it is iron deficiency anemia owing to chronic loss of blood. Exception of megaloblastic anemias is important.

4. The diseases accompanying by hypersplenism (thrombophlebitic spleen, cirrhosis of a liver, Felty’s syndrome, lymphogranulomatosis, tuberculosis and syphilis of a spleen).

**TREATMENT OF INTOXICATIONS BY BENZENE AND ITS HOMOLOGS**

The maximum attention should be payed to haematological changes.

The wide complex of vitamins of group B, vasotonic preparations (vitamins C, P) are used. At expressed depressions of hemopoiesis with a view of maturation of young elements hemostimulators (Natrii nucleinatis, Pentoxyllum, Leukocitinum etc.), immunomodulators (Decaris) appoint. At hemorrhagic syndrome appoint an aminocaproic acid, Vikasolum, chloride calcium, an ascorbic acid, Dicinon. At deep pancytopenias repeated hemotransfusions, transfusions of leukocytic mass, thromboconcentrate in combination to vitamins of group B, preparations which consolidate the vessels, corticosteroids, anabolic hormones are indicated. At deficiency of iron iron supplements are indicated.

_The period of restoration from intoxication._

1. Partial restoration.
   a) improvement of erythropoiesis, thrombocytopoiesis,
   b) decreasing of neurological disturbances,
   c) reduction of hemorrhagic syndrome,
   d) normalization of the sizes of a liver and its functional parameters,
   e) improvement of condition of myocardium.


4. Progressing of process:
a) strengthening of functional disturbances or formation of organic lesion of nervous system,
b) outcome in various hematological forms (seldom).

**VERIFICATION OF WORKABILITY IN INTOXICATIONS BY BENZENE AND ITS HOMOLOGS**

Basic rule at the decision of questions of examination of work capacity is discontinuance of contact with harmful etiologic factor irrespective of degree of expressiveness of depression of hemopoiesis. The most true decision is a duly training for a new profession and rational employment on the works which have been not connected to influence of hematotropic substances. At long restoration of hematological disturbances and unsuccessful employment payment of “percent of loss of work capacity (interest of disability)” is justified. Definition of group of invalidity on professional disease takes into account an individual approach in view of changes of blood and other symptoms of intoxication, character of labour process, age and accompanying pathology.

**INTOXICATION BY AMINO- AND NITRO- COMPOUNDS OF BENZENE**

Most frequently in the industry meet: aniline (MPC = 0, 1 mg / m), nitroaniline (MPC = 0, 1mg/m), nitrobenzene (MPC=3mg/m) etc. They are used in manufacture of synthetic dyes, plastic, pharmaceutical preparations, in the textile industry, by manufacture of explosives etc.

Aromatic amido- and nitrocompounds enter in an organism through a skin. This way of entering plays the leading part at high temperature of air in industrial premises. After hit in an organism these connections are found out in a brain, kidneys, a cardiac muscle, a liver. They can create depot in fatty cellular tissue.
**PATHOGENESIS**

Toxic action of aromatic nitro- and aminocompounds is reduced to disturbance of formation of pigment and to occurrence in blood of a pathological pigment methemoglobin. Bivalent iron of hemoglobin is oxidized in trivalent (Fig. 20).

![Diagram of hemoglobin and methemoglobin]

**Fig.20. Methemoglobin.**

In physiological conditions in blood of the person constantly there is formation of methemoglobin and its restoration up to hemoglobin to the help of active fermented systems of erythrocyte. Methemoglobin connects toxic substances in norm creating complexes with them. Methemoglobin is destructor of redundant quantities of peroxide of the hydrogen, formed in process of intraerythrocytar energy metabolism.

At methemoglobinemia the oxygen capacity of blood is sharply decreased as methemoglobin is unable to connect oxygen. Methemoglobin increases also affinity of oxygen to oxihemoglobin, reduces its dissociation at transition from lungs to capillaries. Respiratory function of blood is disturbed. Restoration of methemoglobin at sharp unitary influence occurs sufficiently quickly (3 - 7 days). At long influence has not time for proliferation.
Amido-and nitrocompounds of benzene are capable to formation of one more pathological derivative of hemoglobin - sulfgemoglobin. Sulfgemoglobinar is observed on a background of methemoglobinemia as concentration of aromatic amino- and nitrocompounds, which are necessary for formation of sulfgemoglobin, are higher, than those at which influence methemoglobin is formed.

Specific attribute of influence of formatters of methemoglobin are degenerately changed erythrocytes with presence in them of pathological inclusions – Heintz’s bodies. Heintz’s bodies are product of denaturation and precipitation of hemoglobin. Their occurrence is connected to action of toxic substances on sulfhydryl groups and others tyole systems of cytoplasm of erythrocytes. Consequence of degenerate changes in erythrocytes with formation of Heintz’s bodies in them can be development of hemolysis which is considered as secondary in pathogenesis of lesion of system of blood by formatters of methemoglobin. The quantity of Heintz’s bodies depends on heaviness of the developed intoxication.

**PATHOLOGICAL ANATOMY**

Acute venous plethora of internal organs, brain, and edema of brain are found out. Blood is original chocolate-brown color, slowly coagulated. There are numerous fine haemorrhages in serous and mucous membranes of a stomach, an intestine, and lungs. Histologically dystrophic changes in a liver and kidneys are found out. In a lumen of curvatured canaliculuses of kidneys methemoglobininc cylinders are formed. In a spleen and lymph nodes adjournment of hemosiderin owing to hemolysis of erythrocytes takes place.

**CLINICAL PICTURE OF ACUTE INTOXICATION**

The degree of heaviness is determined by a level of accumulation of methemoglobin and developed therefore hypoxemia.

*Mild degree.* General weakness, a headache, dizziness, cyanosis of mucous membranes, fingers, auricles, in rare cases the bad organization in environmental conditions disturb the person.
Occurrence of cyanosis is observed at the contents of 15% of methemoglobin (Fig. 21). After some hours complaints disappear, methemoglobinemia is reduced, work capacity is restored.

<table>
<thead>
<tr>
<th>Methemoglobin Concentration</th>
<th>% Total Hemoglobin</th>
<th>Symptoms^a</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 1.5 g/dl</td>
<td>10%</td>
<td>None</td>
</tr>
<tr>
<td>1.5-3.0 g/dl</td>
<td>10-20%</td>
<td>Cyanotic skin discoloration</td>
</tr>
<tr>
<td>3.0-4.5 g/dl</td>
<td>20-30%</td>
<td>Anxiety, lightheadedness, headache, tachycardia</td>
</tr>
<tr>
<td>4.5-7.5 g/dl</td>
<td>30-50%</td>
<td>Fatigue, confusion, dizziness, tachypnea, tachycardia</td>
</tr>
<tr>
<td>7.5-10.5 g/dl</td>
<td>50-70%</td>
<td>Coma, seizures, arrhythmias, acidosis</td>
</tr>
<tr>
<td>&gt; 10.5 g/dl</td>
<td>&gt;70%</td>
<td>Death</td>
</tr>
</tbody>
</table>

^aAssumes hemoglobin = 15 g/dl. Patients with lower hemoglobin concentrations may experience more severe symptoms for a given percentage of methemoglobin level.

^bPatients with underlying cardiac, pulmonary, or hematologic disease may experience more severe symptoms for a given methemoglobin concentration.

Fig. 21. Methemoglobin concentrations and clinical symptoms.

Moderate degree. At an intoxication there is cyanosis of visible mucous and skin, clear neurological symptomatic is marked (a headache, dizziness, disturbance of orientation, stammering speech, increase of tendinous reflexes, languid reaction of pupils to light). Contents of methemoglobin in blood reaches to 30-50 % (Fig.21). There is a plenty of Heintz’s bodies. Some slowing down of ESR is marked. Clinic - laboratory changes are observed during 5-7 days.

Severe degree. Sharply expressed cyanosis of integuments and mucous membranes, which sometimes get blue-black shade takes place, and is caused not only by significant met-and sulfhemoglobinemia, but also the expressed venous stagnation. Heaviness is determined by increasing neurological symptoms. At blood acute methemoglobinemia (more than 50%), a plenty of Heintz’s bodies, increase of quantity of sulfhemoglobin are present. For 5-7 day development of hemolytic anemia is possible. In blood reticulocytosis, macrocytosis, normoblastosis are observed. Stimulation of regeneration of erythroid line is caused by hypoxemia,
presence of products of disintegration of degenerately changed erythrocytes which are significant irritators of erythropoiesis. In case of development of intravascular hemolysis hemoglobinuria with development of renal syndrome is observed. Hyperbilirubinemia due to indirect fraction of bilirubin is marked. In case of massive influence of formatters of methemoglobin relapses of intoxication can be observed. It is connected to an exit of poison deposited in fatty tissue and liver in blood. Relapses are provoked by reception of alcohol and thermal procedures. Duration of the basic symptoms of such form of intoxication makes 12-14 days.

**DIAGNOSTICS OF ACUTE INTOXICATION**

The data of professional route, speaking about high concentration of poison are necessary. Clinic-laboratory symptoms are considered. The main thing is definition of methemoglobin in blood and Heintz’s bodies in erythrocytes.

**CLINICAL PICTURE OF CHRONIC INTOXICATION**

The anemia has regeneratour character and is accompanied by compensatory reticulocytosis. Sometimes erythrocytes with basophilic granularity are appeared. In blood single Heintz’s bodies and small amount of methemoglobin (5-7%), disappearing fast after exit from manufacture, can be found out. Except for that toxic lesion of liver, nervous system (neuro-circulatory distonia, astheno-neurotic syndrome), organs of vision, urine-excreting ways is found out. Expressiveness of symptoms depends on structure of poison. Development of professional cataract, changes of blood and a toxic hepatitis is typical.

**DIAGNOSTICS OF CHRONIC INTOXICATIONS**

The data of professional route (long contact to substance) are
necessary. The complex of disturbances in blood, liver, nervous system is considered.

**TREATMENT OF ACUTE AND CHRONIC INTOXICATIONS**

1) Exit from atmosphere containing gas.
2) washing of affected skin by water and a weak solution of permanganate of potassium is necessary.
3) Oxigenotherapy up to liquidation of cyanosis.
4) At presence of hypoxemia - short-term inhalation with carbogene.
5) For acceleration of restoration of methemoglobin in hemoglobin enter 1% solution of methylen blue (1-2 ml on 1 kg of weight of a body in 5% glucose) (Fig.22). Chromosmon may be used (1% solution of methylen blue in 25% glucose).
6) 40% solution of glucose (30 - 40 ml), 30% solution of hyposulfite of sodium, 5% solution of an ascorbic acid (up to 60 ml) concern to the substances activating process of demethemoglobinization. Introduction of 600 gram of cyanocobalamin intramuscularly is recommended.

![Methemoglobinemia Treatment](image)

Fig.22. Methemoglobinemia treatment.

7) Hyperbaric oxigenation is applied.
8) Forced diuresis is applied.
At chronic intoxication by formatters of methemoglobin the volume and character of therapeutic actions depends on basic clinical syndrome.

**VERIFICATION OF WORKABILITY IN INTOXICATIONS BY AMINO- AND NITRO- COMPOUNDS OF BENZENE**

At mild forms of intoxication there comes quickly full restoration of work capacity and workers can come back to former work. In case of development of severe forms of intoxications after treatment temporary translation into work outside of contact to toxic substances and registration of a labour medical certificate (sick list) is recommended. At presence of the proof residual phenomena and complications on the part of various organs and systems (liver, system of blood, nervous system) discontinuance of work in contact with formatters of methemoglobin and a direction on medical-society expert commission for an establishment of group of invalidity for the period of training for a new profession is necessary.

**AFFECTION OF URINARY SYSTEM IN INTOXICATIONS BY NITRO- COMPOUNDS OF BENZENE**

Aromatic aminocompounds (benzidine, dianizidine etc.) are applied in manufacture of dyes. Long contact to these connections at unsatisfactory working conditions can result in occurrence of dysuric phenomena and to development of benign tumours of urine-excreting ways, mainly a bladder (papilloma), with the subsequent transformation in cancer that allows to attribute them to group of obligate cancerogens.
DISEASES CAUSED BY DISTURBANCE OS SYNTHESIS OF PORPHYRINES AND HEME

Biosynthesis of porphyrines is universal biological process as porphyrines as complexes with metals (metalloporphyrines) make a basis of hemoglobin and myoglobin, and also the vital power enzymes (cytochroms B and C, cytochromoxidase, catalase, peroxidase). The porphyrines have ability to neutralization of toxic substances for a cell (exogenic and endogenic). Therefore they play the important role in preservation of homeostasis.

Synthesis of porphyrines occurs in erythroblasts of a bone marrow, in mitochondrial apparatus of a liver and kidneys, in cells of central nervous system. The basic part of porphyrines goes on synthesis of heme. It is difficult enzymatic process which each stage is adjusted by the certain key enzyme.

Participating in synthesis of heme enzymes can be divided into three groups. The first group is connected to synthesis of aminolevuline acid in amber-glycine cycle. Key enzyme is synthetase of aminolevuline acid, Koenzyme of this reaction is piridoxalphosphate, derivative of vitamin B₆. The second group of enzymes transforms aminolevulina acid in porphobilinogen. Key enzyme is dehydratase of aminolevuline acid. The third group of enzymes is connected to the final stage of synthesis of heme (Fig.23). Key enzymes are decarboxylase and hemesynthetase.

A line of enzymes contain sulfohydrile groups, carboxyle groups and aminogroups. Toxic substances, especially heavy metals, can block these groupings in enzymes, replacing atoms of hydrogen in them and by that breaking activity of enzymes. The substances from group of “thiol poisons” which enter interaction with the substances containing sulfur, and, in particular, with sulfohydrile groups are most active in this plan. In such way many toxic substances are capable to cause changes in biosynthesis of porphyrines. Disturbances of porphyrines metabolism are established at intoxications by phosphorus, benzene, fluorine, oxide of carbon, acrilates, formators of methemoglobin etc. However among all industrial poisons, capable to cause those or other disturbance of synthesis of porphyrines and heme,
exclusive position borrows lead, at which action they have initial character and define pathogenesis of intoxication.

**INTOXICATION BY LEAD**

Lead and its compounds are widely used in the industry. As sources of lead serve its extraction from lead-bearing ores and melt from concentrates and metal waste products (secondary resources). Lead finds application in mechanical engineering- and instrument making, radio electronics (application of lead-bearing solders), in storage, cable, typographical manufacture, at melting of nonferrous metals, in ferrous metallurgy, manufacture of crystal, paints and enamels for the china-faience industry. Most frequently use its following inorganic connections: oxide of lead - lead glete (PbO), red oxide of lead - lead minium (Pb₃O₄), lead chromate - crocoit, or yellow cronexes (PbCrO₄), lead azide (Pb(N₃)₂, lead shine galenite (PbS) etc.

To “lead-dangerous” professions trades founders of lead, accumulators making, composers of charge in manufacture of crystal, operators of mechanical devices in manufacture of lead pigments

Fig.23. Heme synthesis pathway.
concern. Cases of saturnism at the persons engaging in stamping of metal products, by manufacturing of lead fraction, at the display arrangers, painting utensils lead-bearing paints are described.

Lead influences as aerosols - suspensions of the smallest particles of oxide lead, received owing to condensation and oxidation of steams on air. At professional influence the basic way of receipt of lead to an organism is inhalation. Its receipt and through gastrointestinal tract (GIT) (with food, water) is possible. At an inhalation way receipt of lead in an organism depends on its concentration in air, distribution of particles on the sizes, forms of them, a chemical compound, physical and chemical properties and respiratory volume easy. Receipt of lead through GIT depends on a condition of organs of digestion, character of food. The low content of calcium, iron and proteins in a diet increases resorption of lead in GIT. The absorbed lead acts in blood and is distributed in internal organs in the quantities dependent on a level of blood supply of these organs and tropism of them to metal. The lead present in an organism shares on exchanged (10%) and stable (90%) fractions.

To exchanged fraction concerns the lead of blood, 95% of which is connected with erythrocytes, and lead of parenchymatous organs (a liver, kidneys etc.). The content of metal in them is in a condition of dynamic balance with a level of lead in blood. From the point of view of toxic action on an organism the exchanged fraction has the most essential value. The lead which is taking place in bones concerns to stable fraction. This fraction reflects long cumulative influence while the exchanged fraction testifies to the current or recent contact to lead.

Elimination of lead from an organism occurs to urine (about 75%) and through GIT (about 15%). On a share of other ways of elimination of lead (the saliva, sweat glands, etc.) is necessary 6-7%.

**PATHOGENESIS OF LEAD INTOXICATION**

The lead concerns to poisons with polytropism. It defines by variety of pathogenetic mechanisms of intoxication. The leading part among them is allocated to disturbance of biosynthesis of porphyrines and heme. As a result of injuring action of lead on biosynthesis of porphyrines, activity of dehydrogenase of delta-aminolevuline acid
first of all is reduced, consequence of that is the increase of the content of delta-aminolevuline acid in urine. Braking action of lead on decarboxilase of coproporphyrine and hemesynthetase, regulating connection of bivalent iron with protoporphyrine, results in increase of excretion of coproporphyrine with urine, to increase of the content of free protoporphyrine in erythrocytes and iron in blood serum, and in erythroblasts of a bone marrow (sideroblasts). As a result of these disturbances hypochromic hypersyderemical sideroachrestical sideroblastic anemia is developed. However hyperproduction of coproporphyrine (CP) and protoporphyrine (PP) can have other mechanism: due to their synthesis directly from aminolevuline acid. At this mechanism increase of a level of PP of erythrocytes is observed without hypersyderemia. Besides of enzymopathic action on synthesis of heme lead breaks process of recycling of iron and synthesis of globin. Globin concerns to the major regulators of normal biosynthesis of heme. Alongside with it direct action of lead on erythrocyte is established. Lead causes disturbances of polyfunctional structures of erythroblasts and mature forms, inhibit activity of some enzymes of energy metabolism that results in disturbance of functional full value and viability of erythrocyte, consequence of that is reduction of duration of their life and the accelerated destruction. In reply to it compensatory activation of erythropoiesis, to which display reticulocytosis concerns, is observed.

Pathogenesis of neurological symptoms of saturnism is combined. Alongside with the degenerate changes of nervous cells caused by direct action of metal and its intervention in processes of regulation of vessels, motor function, metabolism of mediators, hormones, vitamins, the significant role is allocated to disturbances of metabolism of porphyrines. Participation of porphyrns in process of myelinisation is shown. There are data on vasoconstrictive action both porphyrines, and their predecessors (aminolevuline acid, porphobolinogen), that explains similarity and expressiveness of vegetative disturbance at saturnism and porphyrias.

In a basis of disturbance of motor function of intestine at lead colic lay connected with demyelinisation dystrophic changes in intramural ganglions of intestine and a solar plexus. At a dystrophy in Auerbach’s and Mejsner’s plexuses regulating action of vegetative nervous system on intestinal peristalsis is broken.
In pathogenesis of changes of cardiovascular system, especially in the period of colic; the leading part belongs to disturbance of vegetative nervous system with its expressed hyperreaction.

**PATHOLOGICAL ANATOMY**

The acute changes are marked in nervous cells of a molecular layer of cerebral cortex at absence of reaction of mesodermal elements. In nervous cells of forward horns of a spinal cord their vacuolisation, dissolution of a chromatophilous substance, pigmentation, picknosis of nuclei, shrinkage of bodies of cells and even their destruction are observed. Various changes as shrinkage of nervous cells with loss of their structure or vacuolisation are marked in peripheral nodes of sympathetic nervous system. Dystrophic processes occur and in peripheral nerves. Besides in various departments of central nervous system including in a spinal cord, significant vascular disturbance as fine fresh haemorrhages, stasises, sometimes thrombuses are marked.

**CLINICAL PICTURE OF LEAD INTOXICATION**

Lead amazes all systems except for system of breath (Fig.24).

On the first place there is a syndrome of defeat of blood which is characterized by disturbance of porhyrin metabolism and parameters of red blood. Most content of delta-aminolevuline acid is changed most early. It is the most sensitive indicator of contact to lead. The increase of metabolites of porphyrine metabolism in bioenvironments – aminolevuline acid, CP in urine and PP in erythrocytes, - concerns to early, authentic and specific attributes of intoxication by lead. Direct dependence of expressiveness of changes of these parameters on a level of influence of lead and a degree of weight of a poisoning is established. Occurrence of reticulocytes in blood a and the increased quantity of erythrocytes with basophilic granularity, as a rule, is observed at action of the increased concentration of lead. These parameters usually precede development of a “lead” anemia. Despite of the non-specificity, these changes of red blood with metabolites of porphyrine metabolism are the important parameters of intoxication.
The anemia at saturnism concerns to group hypochromic hypersyderemic sideroachrestic sideroblastic anemias, i.e. its most
typical attribute is hypochromia of erythrocytes at increased content of iron of blood serum and presence of siderocytes in peripheral blood, and sideroblasts in a bone marrow. However at the expressed intoxications the anemia can be characterized by normochromia of erythrocytes and a normal level of iron in blood serum. It speaks significant reduction of life expectancy of erythrocytes under influence of high concentration of lead. To it testifies expressed reticulocytosis. Presence of an anemia is an indisputable attribute of the expressed intoxication.

On the second place there is pathology of nervous system. Neurosaturnism can proceed as asthenic, astheno-vegetative syndrome, and also polyneuropathy and encephalopathy of various degree of expressiveness.

At initial displays of asthenic or astenovegetative syndrome complaints to the general weakness, undue fatiguability, a headache, dizziness, irritability, the bad dream, hyperhidrosis are marked. At objective inspection the muscular hypotonia, block of dermographism, hyperhidrosis, the tendency to bradycardia, lability of arterial pressure come to light. The specified complaints and changes can be a various degree of expressiveness.

The frequent form of neurosaturnism is peripheral polyneuropathy. At its initial form vegetative disturbances prevail: pains, paresthesias, and sural cramrs (especially in rest condition, at night). Morbidity is objectively marked by easy cyanosis or pallor of integuments, hyperhidrosis, hypothermia, at palpation on a course of the peripheral nerves, symmetric distal disturbances of sensitivity, all over again as hyperesthesia, and then hypesthesia. Decrease of excitability of olfactory, flavoring and visual analyzers is typical. Decrease of force in extremities can be observed. The expressed forms of peripheral polyneuropathy are characterized by a combination of vegetative-sensitive and motor polyneuritical disturbances. Development of a syndrome of encephalopolyneuropathy in modern conditions is observed extremely seldom. Taking into account non-specificity of neurological symptoms, acknowledgement of its professional character demands use of some electrophysiological methods (electromyography, definitions of speed of distribution of a pulse on a peripheral nerve etc.) and obligatory correlation with
specific laboratory parameters (aminolevuline acid, CP of urine, PP of erythrocytes, changes of blood, lead in bioenvironments).

On the third place disturbances of GIT stand. Disturbance of system of digestion at a lead intoxication are expressed in the form of gastropathy (disturbance of gastric secretion as in view of its increase, and as its decrease). Lead renders inhibiting action on intestinal enzymes. Because of it suffers parietal digestion. The dyskinesia of small and large intestine is observed. The hypermotor dyskinesia of a small intestine is most typical. Resorptioonal and motor-evacuator functions of intestine are broken.

The listed changes cause unpleasant taste in a mouth, a nausea, an eructation, decrease of appetite, heavy feeling in epigastrium, and also changeable pains in abdomen, propensity to constipation.

The heaviest disturbance at saturnism is intestinal (lead) colic. It is characterized by attacks of sharp pains in an abdomen, a proof constipation up to 5-7 days. The constipation is not yielded to action of laxative preparations and clysmas. Arterial pressure raises, bradycardia is appeared. The body temperature rises up to 37, 6-37, 8 degrees. Comes to light moderate leukocytosis, urine is of dark-red color (for the account of excretion of plenties of coproporphyrine) is allocated. The patient is excited. The abdomen involves, intense, painful in all departments. At palpation pains decrease. Symptoms of irritation of peritoneum are not present. The skin of the patient is pale with a grayish shade, sclers are subicteric, lead border on gingivae is possible.

Lead colic is combined with the expressed changes of peripheral blood (an anemia, reticulocytosis, increase of quantity of erythrocytes with basophilic granularity), porphyrine metabolism (increase of content of aminolevuline acid and CP in urine and PP in erythrocytes). In the period of colic the content of lead in bioenvironments is considerably increased. As provoking moments for development колики the most various factors can serve, most often of which is reception of alcohol. Expressiveness of clinical semiology in the period of colic is caused by a degree of disturbance of vegetative departments of nervous system in this connection this syndrome can be regarded as original “a vegetative crisis”.

On the fourth place there is a defeat of a liver. The liver plays the important role during a metabolism of lead in an organism. At heavy
cases of saturnism the expressed disturbances of function of a liver, down to development of a toxic hepatites were described. At modern forms of saturnism disturbances of only separate functional tests of a liver are marked that is caused by enzymopathic action of lead. Disturbances of pigmented function, shifts in an albuminous spectrum can be marked. For defeat of a liver at intoxication lead typically presence of a dyskinesia of bile-excreting ways.

On the fifth place there is a defeat of cardiovascular system. Its changes at influence of lead are convertible, have nonspecific character and are expressed in instability of arterial tension with the tendency to hypertension, to increase of a tone of peripheral vessels. There is supervision when relapsing colic resulted further in development of hypertonic disease.

On the sixth place there is lesion of endocrine system. It is expressed in disturbance of menstrual function, premature labor, reduction of the period of lactation at women, and at men - in decrease of a sexual potentiality. Function of a thyroid gland is broken aside its increase.

Current of a lead intoxication is characterized by the waviness caused by receipt of metabolic active lead from depot in blood that promoted by the transferred diseases, the use of alcohol etc.

*The initial form of intoxication.* Clinical symptoms of intoxication are absent. Only laboratory changes are marked: increase of aminolevulinic acid of urine up to 115 mkmol/g of creatinine (norm is up to 19 mkmol), CP of urine up to 450 nmol on 1g of creatinine (norm is up to 120 nmol), reticulocytosis up to 25 % (norm up to 12‰), increase of quantity of basophilic-granular erythrocytes up to 40 on 10000 (norm up to 15 on 10000). The content of hemoglobin and erythrocytes within the limits of norm, a level of lead in blood does not exceed 50 mkg %, or 0, 25 mkmol% (norm up to 40 mkg%, or up to 0, 19 mkmol%).

*The mild form of intoxication.* The clinical symptoms are shown as asthenic or asthenovegetative syndrome, initial forms of peripheral polyneuropathy. Changes of GIT - syndrome of a motor dyskinesia - can be observed. Disturbances of separate parameters of function of a liver are possible. Laboratory changes are expressed increased excretion of aminolevulinic acid up to 190 mkmol/g of creatinine, CP up to 770 nmol/g of creatinine, the increase of quantity of basophilic-
granular erythrocytes up to 60 on 10000, reticulocytosis up to 40‰ is marked. Decrease of a level of hemoglobin at men up to 120 g/l, at women up to 110 g/l is possible. The content of lead in blood is no more than 80 mkg%, or 0, 38 mkmol%.

The severe form of intoxication. This stage is characterized by development of one of syndromes or their combination: colic, anemic syndrome, polyneuropathy, astheno-vegetative syndrome, encephalopathy, toxic lesion of a liver. Changes of porphyrine metabolism have by an exchange the expressed character: excretion of aminolevuline acid is more than 190 mkmol/g of creatinine, CP-770 nmol/g of creatinine. Reticulocytosis is more than 40‰, quantity of basophilic-granular erythrocytes is more than 60 on 10000. The anemia of hypochromic or normochromic character with decrease of a level of hemoglobin at men lower than 120 g/l and at women lower than 110 g/l is marked. The content of lead in blood is more than 80 mkg % or 0, 38 mkmol%.

At definition of the form of intoxication it is necessary to have in view, that presence of all listed syndromes is unessential. Sometimes lesion of one organs and systems corresponds to easy form, and others - to the expressed form of intoxication. The diagnosis is established according to the most expressed syndromes of the struck systems.

The prognosis. Postcontact current of saturnism is characterized by the basic tendency to restoration which terms are defined by a degree of expressiveness of intoxication. The greatest number of cases of recovery falls to the first 4 years after the discontinuance of contact. Long stabilization of process, and at times and absence of recovery in case of the expressed intoxication by lead speaks stability of changes of nervous system (a syndrome of polyneuropathy), is especial at presence of encephalopathy which return development is not observed. The long absence of restoration can be caused by insufficient treatment and wrong employment. All workers, exposed to influence of lead, and also transferred intoxication, are subject to dispensary supervision of the shop doctor.

**DIAGNOSTICS OF LEAD INTOXICATION**
The diagnosis of an intoxication is based by lead on the data of professional anamnesis, the sanitary-and-hygienic characteristic of working conditions, preliminary and periodic medical examinations, and also complaints and results of clinical and laboratory inspections of the worker.

Differential diagnostics of saturnism should be carried out with a line of the general diseases depending on conducting syndrome of intoxication.

At anemic syndrome the lead intoxication should be differentiated first of all from iron deficiency anemias, malignant neoplasms of stomach and an intestine proceeding with similar clinical-laboratory semiology (pallor of integuments, a pain syndrome, hypochromic anemia, reticulocytosis, and increase of quantity of basophilic-granular erythrocytes). However normal level of aminolevuline acid, CP and lead in urine, the low content of iron in blood serum, the trophic disturbance caused by hypocideremia, allow to reject the diagnosis of saturnism.

It is necessary to differentiate the lead intoxication from thalassemia for heterozygotic form of which hypochromic anemia, reticulocytosis, increase of number of basophilic-granular erythrocytes, hyperbilirubinemia are characteristic. Normal content of aminolevuline acid, CP and lead in urine at patients with thalassemia, targetform of erythrocytes, family character of disease, the increase of a spleen never observably at saturnism, allows to differentiate these two diseases.

Differential diagnostics of saturnism should be carried out with group of porphyrias and first of all with acute alternating porphyria (AAP). AAP is similar on a clinical picture to intoxication by lead (polyneuropathy, the expressed vegetative disturbances, abdominal syndrome, allocation of red urine). Differential diagnostics is based on definition of porphyrines and their predecessors in urine: at AAP substantial growth excretion of porphobilinogen and uroporphyrine is always observed at moderate increase of level of aminolevuline acid in urine and normal PP of erythrocytes. For saturnism substantial increase of aminolevuline acid and CP in urine, PP in erythrocytes at normal excretion of porphobilinogen and uroporphyrin is typical.
Lead colic also frequently demands of differential diagnostics. Clinical features of this syndrome: character of behavior of the patient (anxiety, excitation), often change of position in beds, reduction of pains in an abdomen at its palpation, red color of urine at absence of hematuria (hypercoproproporphyrineuria), and also the expressed changes of blood (an anemia, reticulocytosis, increase of basophilic-granular erythrocytes), porphyrine metabolism.

Difficulties arise at an establishment of the reason of development of peripheral polyneuropathy, especially in the remote postcontact period when there comes full restoration of other clinical and laboratory attributes of a poisoning. In such cases unitary (diagnostic) introduction of complexon (tetacinum-calcium) with definition of the contents of lead in urine before and after introduction is recommended. Substantial increase of excretion of lead after introduction of complexon allows to connect polyneuropathy with the transferred lead intoxication.

**TREATMENT OF LEAD INTOXICATION**

In therapy of saturnism complexons are widely used - the cyclic connections having in structure various functional groups which form connections with an ion of lead. As a result of this reaction complexes practically not dissociating, well soluble, and quickly removed of an organism by kidneys are formed. Most frequently for treatment of saturnism derivatives of polyaminocarbone acids - *tetacinum* - *calcium* and *pentacinum*, having high secretory activity concerning lead are used. Unitary introduction of a therapeutic doze of complexon results in increase of removing of metal with urine in 50-100 times and more. Both preparations are used for treatment of the mild and severe forms of intoxication. They are capable to stop within day lead colic. The circuit of treatment: 20 ml of 10% of a solution of tetacinum-calcium or 40ml of 5% solution of pentacinum enter daily intravenously slowly within 3 days with the subsequent interval in 3-5 days. Course of treatment consists of 2 or 3 cycles, i.e. 6 or 9 injections. At lead colic introduction of complexon 2 times per day is possible.
Last years it is widely applied D-penicillamin (Cuprenilum). Its advantages are orally reception and good bearableness. It is issued in capsules on 150 mg. It is accepted after meal. The daily doze is from 450 up to 900 mg, duration of reception depends on expressiveness of intoxication. Collateral action is expressed in allergic reactions and dyspepsia. At long application thrombocytopenia, agranulocytosis, anemia, disturbance of GIT are possible. Contra-indications - the increased sensitivity to penicillin, diseases of kidneys with disturbance of secretory function.

**VERIFICATION OF WORKABILITY IN LEAD INTOXICATION**

Expert questions are solved depending on forms of a poisoning, age, the experience, qualification of the patient, sanitary-and-hygienic working conditions. At the initial form after treatment temporary translation into work without contact to lead for 1-2 months with the subsequent returning to former work is recommended. Persons with the initial form of intoxication deserve of special attention since duly treatment allows to warn progressing of saturnism and to keep work capacity. At an intoxication of an mild degree patients are sent for easy work up to 2 months. Further they can be returned for former work under condition of full normalization of all parameters. At remaining attributes of polyneuropathy or in case of relapse the discontinuance of contact to lead is necessary. Rational employment and training for a new profession is recommended. In some cases patients go on medical-social commission of experts. At the severe forms of intoxication contact with lead stops and the patient goes on on medical-social commission for definition of group invalidity and % of occupational disability.

**PREVENTIVE MEASURES**

The most effective preventive measure is, certainly, replacing lead and its compounds with other non-toxic matters at corresponding productions.
Maximum mechanization of operations of processing of materials which contain lead; sealing-in of sources of dust discharge; equipping of production zones with rational ventilation, mechanical purification of work premises from dust. In premises with much dust, people should work in respirators or industrial filtering gas masks.

When working with lead and its compounds, it is necessary to keep closely to the rules of personal hygiene, prohibit eating at work places; smoking should be permitted only on specially equipped rooms. Significant role in prevention of intoxication with lead is on preventive eating products with pectin matters (fruit non-clarified juices and apples), as well as preliminary and periodic medical examinations.
CONTROL TESTS

1. The purpose of the periodic medical check up is:
   a) dynamic monitoring of the health of workers in conditions of occupational hazards and unfavorable conditions of work
   b) establishing a timely initial signs of occupational diseases and its prevention
   c) diagnosis of common diseases, preventing continued work in hazardous
   d) diagnosis of the disease in order to prevent accidents and ensure the safety

2. Who can make a conclusion about professional suitability of a worker after preliminary examination:
   a) the employer
   b) pulmonologist
   c) occupational pathologist

3. What documents are required to diagnose an occupational disease?
   a) sanitary and hygienic characteristics of working conditions;
   b) characteristic of the worker;
   c) the outpatient card indicating the extent of the period of work;
   d) a copy of the employment record.

4. Features of occupational diseases as a clinical discipline are:
   a) close relationship with occupational hygiene
   b) close relationship with communal hygiene, food hygiene, ecology
   c) close relationship with general pathology
   d) the integrating nature of the discipline

5. Sanitary and hygienic characteristics of working place is made by:
   a) administration of the enterprise
   b) a representative of the trade union committee of the enterprise
   c) safety inspector
   d) hygienists specialist
   e) district therapist
6. What should be taken into account when medical and social expertise is performed?
   a) the nosological form of the disease
   b) the degree of functional impairment
   c) the nature of the current and the forecast
   d) patients profession, age, length of harmfulness, qualification, the presence of second profession

7. The etiological factor of the vibration disease is:
   a) vibration in living rooms
   b) the vibration transmitted from home devises
   c) transport vibration
   d) all of the above

8. The source of transport-technological vibration is:
   a) excavators
   b) agricultural tractors
   c) trucks
   d) snowplows

9. The source of technological vibration are:
   a) equipment for drilling wells
   b) forge-and-press equipment
   c) pump units and fans
   d) the tractor

10. Additional risk factors in vibration disease pathogenesis are:
    a) unfavorable microclimate
    b) physical activity
    c) static stress
    d) emotional stress
    e) chemical factors

11. Important factor in pathogenesis of vibration diseases is:
    a) hardness of materials
    b) the nature of the surface to work with
    c) technical condition of the mechanisms
12. Vibration disease affects:
   a) peripheral nervous system
   b) urinary system
   c) musculoskeletal system
   d) vestibular apparatus

13. The reason for the Ca++ accumulation in smooth muscles of vessels in patients with vibration disease is:
   a) reduction in the activity of Ca$^{2+}$-ATPase;
   b) decreased cholinesterase activity;
   c) increased activity of superoxide dismutase;

14. Cold test is positive when:
   a) cyanosis of the fingers appears;
   b) hyperemia of the brushes appears;
   c) whitening of one phalanx of fingers appears;
   d) marble color of brushes appears;
   e) all options are taken into account.

15. Angiodystonic syndrome in a vibration disease occurs due to:
   a) irradiation of agitation from vibration sensitivity centers to vasomotor CNS zone
   b) vascular intima damage
   c) effect of vibration on the adrenergic receptors biomembranes of smooth muscle of peripheral vessels
   d) catecholamine metabolism disturbance

16. Polyneuropathy in case of vibrational disease develops due to:
   a) ischemia of sensory fibers of somatic nerves due to reflected vasoconstriction
   b) vibration affection of on the receptors of vibratory senses and skin receptors
   c) increased level of gamma- GTP
   d) disturbances in serotonin, histamine, prostaglandin, bradykinin releasing
   d) irradiation of agitation from centers of vibration sensitivity to centers of pain and temperature sensitivity
17. First degree of vibration disease from local vibration is characterized by:
   a) peripheral angiodystonic syndrome with rare and mild angiospasm of the fingers;
   b) vegetative-vestibular syndrome;
   c) syndrome of vegetative-sensory polyneuropathy of lower extremities;
   g) syndrome of senso-motor polyneuropathy of upper extremities and cervicobrachial plexopathies;

18. Second degree of vibration disease from local vibration is characterized by the following:
   a) Syndrome of vegetative-sensory polyneuropathy of upper extremities with disorders of the musculoskeletal system of hands and shoulders
   b) syndrome of vegetative-sensory polyneuropathy of upper extremities with secondary lumbosacral radicular syndrome
   c) syndrome of senso-motor polyneuropathy of upper extremities with persistent vegetative-trophic disturbances
   d) syndrome of vegetative-sensory polyneuropathy of upper extremities with frequent angiospasms of the fingers.

19. First degree of vibration disease from whole-body vibration is characterized by:
   a) angiodistonic syndrome (cerebral or peripheral)
   b) vegetative-vestibular syndrome
   c) sensory polyneuropathy of lower extremities

20. What is the aim of pallestesiometry?
   a) to assess the degree of changes in small vessels of the fingers
   b) to check the threshold of vibration sensitivity
   c) to identify the angiodistonic syndrome
   d) to check pain sensitivity

21. $^{131}$I is used in case of vibration pathology:
   a) for examination of tissue blood flow
   b) when carrying out thermography
c) during the MRI

d) when performing pallestesiometry

22. Algesimetry is used to check:
   a) the strength and endurance of the muscles to physical effort
   b) the study of pain sensitivity
   c) the electric resistance of the skin
   d) the assessment of sensomotor systeme
   e) the vascular tone

23. Syndrome of "white fingers" in first degree of vibration disease from the local vibration typically is characterized by:
   a) spontaneous appearance of whitening
   b) duration of whitening for several minutes
   c) whitening captures only the terminal phalanx of some fingers
   d) acrospasmends spontaneously

24. Polyneuropathy in second degree of vibration disease from the local vibration is characterized by:
   a) permanent pain in hand and forearms
   b) hypoesthesia from the level of elbow or shoulders
   c) constantparesthesias
   d) significant increasing of vibration thresholds

25. What can be observed in case of miofibrodistrophical syndrome?
   a) myogeloses
   b) Geberden's nodules
   c) xanthelasms
   d) Becker's cysts

26. Vegeto-sensory polyneuropathy in vibration disease should be differentiated from:
   a) funicular myelosis
   b) mixededeme induced neurologic disorders
   c) diabetic polyneuropathies
   d) peripheral nerves lesion due to lung cancer

27. Examples of ganglioblockers:
a) benzohexonium
b) ketoprofen
c) pachycarpin

28. Examples of spasmolitics:
   a) papaverine
   b) drotaverina hydrochloride
   c) omeprazole
   d) diprofen

29. Examples of alpha-blockers:
   a) dihydroergotoxin
   b) nicergoline
   c) phentolamine
   d) tropaphen

30. Examples of antihypoxants and antioxidants:
   a) emoxipine
   b) mexidol
   c) mexicor

31. What can be used for cerebral angiodystonic syndrome treatment in case of vibration disease:
   a) cinnarizine
   b) apizartron
   c) voltaren
   d) ambroxol

32. Treatment of polyneuropathies in case of vibration disease:
   a) thiamine
   b) oxycobalamine
   c) milgamma

33. What can be used for treatment of neck and shoulder plexopathies:
   a) betaserc
   b) aertal
   c) voltaren
   d) thiogamma
34. What can be used for treatment of myofibrodystrophic syndrome:
   a) diclophenac gel
   b) milgamma
   c) nimesulide

35. What can be used for the treatment of vegetative-sensitive polyneuropathy in case of vibration disease:
   a) galvanization
   b) electrosleep
   c) darsonvalization
   d) inductothermy
   e) magnetotherapy

36. What can be used for treatment of peripheral angiodystonic syndrome in case of vibration disease:
   a) diadynamic currents
   b) ultrasound therapy
   c) ozocerite
   d) infrared radiation

37. Prophylactic measures for the prevention of vibration disease include:
   a) hygienic monitoring
   b) workplaces checking up
   c) preliminary sanitary supervision
   d) preventive treatment

38. Vibration disease prophylaxis:
   a) rational nutrition
   b) vitamin therapy
   c) gymnastics
   d) self-massage of hands

39. The most severe form of pneumoconiosis from the group of silicosis is:
   a) asbestosis
b) talcosis
c) coalinosis
d) cement pneumoconiosis
e) olivine pneumoconiosis

40. The most typical variant of the fibrous process with silicatosis is:
   a) slowly progressing
   b) rapidly progressing
   c) regressing

41. Aerosols with pronounced fibrogenous properties contain free silicon dioxide:
   a) 5%;
   b) more than 10%
   c) do not contain silicon dioxide

42. The most common complication of silicosis is:
   a) tuberculosis
   b) silicoarthritis
   c) pneumothorax
   d) lung cancer

43. The most informative diagnostic method for dust bronchitis is:
   a) chest X-ray
   b) pneumotachometry
   c) spirometry
   d) bronchoscopy with biopsy
   e) sputum analysis

44. Which disease is characterized by regression on X-ray:
   a) silicosis
   b) asbestosis
   c) siderosis
   d) anthracosilicosis
   e) silico-silicatosis

45. The most common type of bronchial mucosa affection for dust exposure is:
a) atrophic
b) hypertrophic
c) catarrhal
d) all of the above

46. Which occupations are at risk of dust bronchitis:
   a) miners of coal mines
   b) sandblasters
   c) working textile enterprises
   d) working cement plants
   e) milling machines

47. Most commonly used groups of drugs for dust bronchitis are:
   a) bronchodilators
   b) mucolytics
   c) antibiotics
   d) cytostatics

48. Diagnostic criterias of silicosis are:
   a) changes in peripheral blood
   b) the presence of "dust cells" in sputum
   c) X-ray data
   d) spirometry data

49. Pneumoconiosis from inhaling asbestos dust is called:
   a) metalloconiosis
   b) silicosis
   c) silicatosis
   d) carboconiosis

50. Bissinosis arises from inhalation of:
   a) silicon dioxide aerosol
   b) carbon-containing dust
   c) plant fiber dusts

51. Allergens of plant origin:
   a) cotton dust;
   b) flour dust;
c) jute dust
d) silk dust

52. Manufacturing allergens:
   a) nitric sour about that
   b) ammonia
   c) carbondisulphide
   d) formaldegyde
   e) chrome

53. The diagnosis of occupational asthma is based on:
   a) symptom of exposure
   b) no allergy in anamnesis
   c) symptom of elimination
   d) severe respiratory failure

54. Immunological investigation of bronchial asthma includes:
   a) exposure test
   b) type-specific IgE level
   c) inhalation provocation test
   d) bloodeosinophilia

55. The most common complications of toxic pulmonary edema are:
   a) pneumonia
   b) acutecorpulmonale
   c) anemia
   d) acute leukemia
   e) lymphogranulomatosis

56. Curative interventions in toxic pulmonary edema (with blue hypoxemia):
   a) oxygen therapy
   b) anti-inflammatory therapy
   c) bloodletting
   d) glucocorticoids
   e) diuretic drugs

57. Toxic-chemical forms of respiratory organs pathology include:
a) long-term complications of acute intoxication  
b) bronchobronchiolitis  
c) chronic toxic-chemical bronchitis

58. The most common example of poisons that cause hemopoiesis depression is:  
a) hexamethyldiamine  
b) benzene  
c) sulfonamides  
d) styrene

59. Acute occupational poisoning by aromatic hydrocarbons is characterized by:  
a) suffocating action  
b) narcotic action  
c) myelotoxic action  
d) hemolytic action

60. The maximum permissible concentration of benzene is:  
a) 0.05 mg per cubic meter of air  
b) 5 mg per cubic meter of air  
c) 0.1 mg per cubic meter of air  
d) 50 mg per cubic meter of air

61. Benzene and its homologues in chronic intoxication acts on:  
a) pluripotent stem cells  
b) the bone marrow stromal cells  
c) non-cellular elements  
d) for all the listed morphological elements

62. The most commonly affected systems for chronic hydrocarbon intoxication are the blood and:  
a) bronchopulmonary system  
b) nervous system  
c) musculoskeletal system  
d) liver

63. Chronic benzene intoxication is characterized by:
a) changes in the hematopoiesis system  
b) bronchoobstructive syndrome  
c) hemorrhagic syndrome  
d) changes in the nervous system

64. The possible violations of other organs and systems in the chronic toxicity of benzene:
   a) myocardial necrosis  
b) liver damage  
c) digestive glands functional disorders  
d) vitamin imbalance

65. What is the possible outcome of chronic benzene intoxication:
   a) partial restoration  
b) complete clinical and hematological recovery  
c) stabilization of the process  
d) progression of the process

66. The optimal treatment for mild forms of benzene intoxication is the use of:
   a) stimulators of hemopoiesis  
b) sanatorium treatment  
c) vitamin therapy  
d) vasoconstrictive agents

67. Severe pancytopenia is treated by:
   a) transfusion of erythrocyte mass  
b) transfusion of thrombocytes  
c) administration of aminocapronic acid

68. Stimulators of hemopoiesis are:
   a) leukocytin  
b) pentoxyl  
c) prednisolone  
d) sodium nucleic acid

69. Hemorrhagic syndrome is treated with:
   a) ascorbinic acid
b) calcium chloride  
c) vikasol  
d) aminocaproic acid  
e) prednisolone  

70. Hemorrhagic syndrome in chronic benzene poisoning can be manifested by:  
a) expressed hematomas  
b) hemorrhages in mucous and serous membranes  
c) gastrointestinal bleeding  
d) gingivaleeding  

71. Amino-benzene compounds include:  
a) toluene  
b) hexachlorane  
c) aniline  
d) xylene  

72. Amido- and nitro compounds of benzene are poisons:  
a) forming pathological derivatives of hemoglobin  
b) violating the synthesis of heme  
c) violating globin synthesis  
d) depressing processes of hematopoiesis  
e) all of the above  

73. Amido- and nitro compounds of benzene are used:  
a) in the production of synthetic dyes  
b) in the production of plastics  
c) in the production of medicines  
d) in the production of explosives  

74. What is the result of aniline exposure  
a) carboxyhemoglobin formation  
b) methemoglobiniformation  
c) delta-aminolevulinic acidformation  
d) coproporphyrinsformation  

75. The appearance of sulfhemoglobin in the blood means:
76. Nervous system affection by amido- and nitro compounds of benzene can be manifested as:
   a) a light narcotic effect
   b) tonic and clonic seizures
   c) coma
   d) agitation

77. The Heinz's body is:
   a) product of arachidonic acid oxidation
   b) result of destruction of myoglobin
   c) product of hemoglobin denaturation and precipitation
   d) all of the above

78. Blood color in case of methemoglobin formation is:
   a) dark cherry
   b) bright scarlet
   c) chocolate brown
   e) yellowish

79. For the treatment of methemoglobinemia, the following applies:
   a) amplipulse
   b) darsonvalization
   c) hyperbaric oxygenation
   d) inductothermy
   e) all of the above

80. To stimuli the recovery of methemoglobin into hemoglobin is used:
   a) unitiol
   b) pentacin
   c) succimer
   d) methylene blue
   e) all of the above
81. Prolonged contact with aromatic amino compounds can lead to:
   a) urolithiasis
   b) papillomas of the bladder
   c) hypernephroma
   c) polycystic kidney disease

82. Porphyrins play role into process of:
   a) energy processes in the cell
   b) neutralization of toxic substances for the cell
   c) heme synthesis
   d) urea synthesis

83. In which enzyme are porphyrins included?
   a) cytochrome oxidase
   b) alanine aminotransferase
   c) monoamine oxidase
   d) cholinesterase

84. Which enzyme is one of the key in the heme synthesis?
   a) catalase
   b) cytochrome B
   c) dehydratase delta-ALA
   d) phospholipase

85. What occupation is at risk of lead contact?
   a) battery
   b) gas welder
   c) plasterer
   d) chopper

86. What is the ratio of stable and exchangeable fraction of lead present in the body?
   a) 50 : 50
   b) 10 : 90
   c) 90 : 10
   d) 40 : 60
   e) 70 : 30
87. Where is the lead of a stable faction contained?
   a) blood
   b) liver
   c) the spleen
   d) the brain
   e) bones

88. What is observed due to the lead inhibition on hemsynthetase?
   a) increased level of free protoporphyrin in erythrocytes
   b) increased level of delta-ALA in urine
   c) increased excretion of coproporphyrin with urine
   d) increased indirect bilirubin in blood serum

89. What type of anemia due to lead intoxication?
   a) hyperchromic, hypersideremic, sideroahrestic, normoblastic
   b) hypochromic, hyposideremic, sideroahrestic, sideroblastic
   c) hypochromic, hypersideremic, sideroahrestic, sideroblastic

90. What symptoms are typical for the lead colic?
   a) diarrhea
   b) cramping pain in the abdomen
   c) decreased blood pressure
   d) hematuria

91. What are the symptoms of lead colic?
   a) dull pain in the abdomen
   b) urine red color
   c) symptoms of irritation of the peritoneum
   d) hyperemia of the skin

92. Indicate the signs observed in the initial form of lead intoxication:
   a) vegetative-sensitive polyneuropathy
   b) asthenic syndrome
   c) reticulocytosis
   d) decreased hemoglobin level
   e) the amount of basophilic granular erythrocytes is 87:10000.
93. Indicate the signs observed in the light form of the intoxication of lead:
   a) toxic hepatitis
   b) increased delta-ALA level
   c) asthenovegetative syndrome
   d) motor dyskinesia of the gastrointestinal tract

94. Indicate the signs of severe lead intoxication:
   a) anemic syndrome
   b) reticulocytosis
   c) increased coproporphyrins level
   d) basophilic-granular erythrocytes

95. What is the most specific indicator of lead intoxication?
   a) number of reticulocytes
   b) number of erythrocytes with basophilic granularity
   c) hemoglobin level
   d) level of coproporphyrins in urine

96. Acute alternating conductive porphyria is characterized by the following features:
   a) absence of urine of red color
   b) absence of polyneuropathy
   c) increased excretion of uroporphyrin
   d) an increase in the content of protoporphyrin erythrocytes
   e) microspherocytosis

97. Which symptom is typical for lead colic:
   a) symptom of Sitkovsky
   b) hypercoproporphyrinuria
   c) hematuria
   d) increased excretion of porphobilinogen

98. Which drug is a chelator agent?
   a) haemodes
   b) refortan
   c) pentacin
   d) salbutamol
99. In what dosage is D-PAM administered for monotherapy of the initial forms of saturnism?
   a) 600-900 mg per day;
   b) 1200-1500 mg per day;
   c) 450-600 mg per day;
   d) 150-300 mg per day.

100. What activities are contraindicated in case of lead colic?
   a) administration of complexons
   b) cold on the stomach
   c) aprotinin administration
   d) platyphylline administration
   e) glucose caffeine mixture administration
THE ANSWERS TO THE TESTS

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LIST OF ABBREVIATIONS

ALA – aminolevulinic acid
ATPase - adenosine triphosphatase
CBC - Complete Blood Count)
CNS – central nervous system
CP – coproporphyrine
CT - computed tomography
dB - decibel
DNA - Deoxyribonucleic acid
D-PAM – D-penicillamine
ECG - Electrocardiography
EchoCG - Echocardiography
ESR – erythrocytes sedimentation rate
FEV\textsubscript{1} – Forced expiratory volume in 1st second
GINA – Global initiative for asthma
GIT - gastrointestinal tract
HIV - Human immunodeficiency virus
MPC - maximum permissible concentration
NSAID - nonsteroidal anti-inflammatory drugs
OBA - occupational bronchial asthma
PP - protoporphyrine
TPE - toxic pulmonary edema
UV - ultraviolet
WHO - World Health Organization


