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FOREWORD

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MEDICAL SERVICE IN MASS ATTACK

Organizatsiya Meditsinskogo Obespecheniya pri Massovykh Porazheniyakh Naseleniya, Kiev, 1957, pp 50-91, 184-244, 245-341, 388-398, and 399-413

Military Radioactive Substances

A. Ye. Minenko (from Chapter 4)

Together with atomic and hydrogen bombs and chemical and bacteriological weapons, military radioactive substances (BRV) are likewise considered as a weapon of mass antihilation.

There have been published in the foreign literature a number of works dealing with problems of the production, effectiveness and methods of utilizing military radioactive substances.

In the book "The Effect of Atomic Weapons", S. Cohen, L. Donaldson, E. Gilfillen and other authors report that BRV can be obtained by two methods.

The first method is obtaining radioactive substances in nuclear reactors (boilers) as by-products in the process of producing plutonium for atomic bombs. These by-products are a complex radioactive mixture of various chemical substances.

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The second method – obtaining radioactive isotopes by irradiating certain chemical substances with neutrons. Such radioactive substances include strontium, yttrium, zirconium, niobium, rubidium, praseodymium, cerium, etc. The half-life of these substances is measured in tens of days, and their radiation has great penetrating capacity.

A characteristic feature of BRV is that they have no specific odor, color, taste or other outward characteristics. The presence of BRV is determined by special instruments, termed dosimeters. BRV are designed to contaminate localities, water, food and air with the purpose of destroying people and animals.

Foreign specialists, as is evident from the article by Jack de Ment published in the journal "Military Engineer", (March-April 1952), divide BRV into two groups: first group – substances which act through radioactive radiation, and second group – substances acting not only through radioactive radiation, but also by toxic action of the chemical substances themselves. The author includes among such substances ordinary chemical poisons to which radioactivity is imparted artificially or which are mixed with BRV. In addition BRV can be used in incendiary bombs as a smoke or fog, in high-explosive splinter bombs, torpedoes, mortar shells, land and sea mines.

The foreign press states that BRV can be used in the form of radioactive "sand", which would be some substance carrying BRV within it or upon it. Such "sand" can be given adhesive or magnetic properties, which will enable it to be retained on clothing, motor vehicles, various objects, etc., and to affect people.

American authors include among the disadvantages of BRV as a weapon of mass destruction, the relatively rapid reduction in destruction action (radioactive radiation) and the consequent extreme difficulty of stockpiling suitable reserves of BRV in peace-time.

BRV are unquestionably a dangerous type of weapon, but nevertheless they are not so dangerous as foreign authors attempt to represent them. There exist quite reliable means of defense against this type of weapon.

The Toxicology of Military Poisonous Substances

N. I. Luganskiy and G. A. Belonozhko

A General Characterization of Military Poisonous Substances and Classification of Them

Military poisonous substances [or chemical warfare agents] are chemical compounds which are used with the aim of depleting enemy personnel, and under certain conditions can put a considerable number of persons out of action at the front and rear.

Depending on the physico-chemical characteristics and influences of environmental conditions these poisonous substances remain at the place where used for a short time (unstable war gases) or for a longer time, exerting a toxic effect for a long period of time (persistent war gases).

These poisonous substances are liquid, solid or gaseous. Therefore, they can act on the organism in droplet, fog or smoke, or vapor or gaseous states. Even the direct contact of these poisons with living tissues can lead to the development of injury. Penetration of the substance into the organism occurs through the skin, wound surfaces, mucous membranes of the eyes, respiratory, gastro-intestinal tract, genitourinary passages and others.

After they enter the organism, the toxic substances penetrate into various organs and tissues and produce pathological changes in them. Afterwards, they usually undergo various transformations in the organism, in consequence of which they are partially detoxified and lose their toxic properties.

The intensity of the development of the toxic process depends on many environmental conditions and the conditions of the organism. Thus, the character of the injury is determined to a certain degree by the quantity and localization of the chemical warfare agent [henceforth to be abbreviated CWA], the concentration and exposure time, and also the routes of entrance of it into the organism. The condition of the organism at the time of injury and also the individual sensitivity of it to the CWA are no less important. Thus, for example, in persons with pronounced physical and mental overstrain, diminished reactivity of the organism, or various diseases the toxic process occurs in a more severe form than in completely healthy people. In its turn, injury by CWA can render manifest a latent disease.

It should be noted that quite frequently reports are encountered in the literature concerning a distinction between the local and general effects of the CWA. However, from the point of view of I. P. Pavlov's teaching of the integrity of the organism such a division is not correct, because even in the case of a slight "local" involvement phenomena of general character can be observed on the part of the nervous system, cardio-vascular system, etc. as a result of nerve-reflex reactions.

In the general characterization of the CWA the speed of their action on the organism is of definite importance. A whole series of chemical compounds exerts a toxic effect quickly, and sometimes only a brief contact with air containing the CWA is enough to cause a pathological process to develop. These are so-called rapid-acting agents. At the same time, there are CWA which act slowly, which do not show their toxic effects immediately. The pathological process develops gradually thereby. Such chemical compounds are spoken of as CWA having a definite latent period of action. The duration of the latter is quite variable and depends on many conditions. It would be incorrect to think that during the period of latency of the CWA no definite changes are occurring in the organism. Even during this period a series of disturbances of physiological equilibrium can be detected, but the pathological changes are expressed only slightly, and a determination of them through objective examination is difficult. Nevertheless, the diagnosis of injury during the latent period of the CWA (early diagnosis) is exceptionally important, because the giving of timely first-aid measures and, therefore, the course and outcome of the toxic process, depends on this.

The excretion or elimination of CWA from the organism occurs by various routes: through the skin, respiratory organs, kidneys, intestine, etc. The rate of elimination of chemical agents from the organism deoends on their physico-chemical characteristics as well as on the functional state of the organs of excretion. It should be taken into consideration that c tain CWA are capable of accumulating. This accumulation can be chemical (accumulation in the organism) or functional, when each successive entrance of the chemical agent into the organism leaves a definite trace in the form of a partial disturbance of the functional capacity of individual organs.

The Use of CWA. CWA can be used by various methods. The simplest is the spraying of the CWA by special devices from an altitude, and also by apparatuses on the ground. The use of chemical bombs, mines, shells containing various CWA and also smoke pots is possible.

Modern technics of using chemical weapons provide the possibility of simultaneous utilization of large quantities of CWA and in various mixtures, for example, yprite and lewisite, diphosgene with yprite [mustard gas, so-called because it was first used at Ypres]. This essentially complicates the nature of the injury, the diagnosis and the treatment of it. In its turn, the use of CWA in various mixtures confronts physicians with new problems in the matter of diagnosing the injury and in the treatment of the patient. In addition, at the present time the possibility arises of the simultaneous use of atomic and chemical weapons by an enemy. The possibility of such combined forms places a serious responsibility on the shoulders of medical workers. --the solution of new problems in the matter of prophylaxis, diagnosis, evacuation and therapy of injuries produced by radiation and chemical factors.

Classification of CWA. There have been many diverse attempts at dividing the CWA in accordance with their physico-chemical properties, physiological effects and other characteristics. However, to date none of the proposed classifications is perfect or fulfills all the requirements.

Below, the most convenient and accepted classification of CWA is presented, the basis of which is constituted by certain general symptoms occurring as the result of the effect of the individual CWA. According to this classification, the CWA are divisible into the following groups:

1. General-toxic: hydrocyanic acid, carbon monoxide, arsine, tabun [see below for description], and others.

2. Vesicant: mustard gas, lewisite, trichlortriethylamine and others.

3. Asphyxiant: phosgene, diphosgene, chlorpicrin, chlorine, phosgenoxime, etc.

4. Irritant:
   a) lachrymatory: chloracetophenone, brombenzylcyanide, chloracetone, and others.
   b) sternutatory: diphenylchlorarsine, diphenylcyan-

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arsine, phenarsazine hydrochloride, etc.

In the present chapter, in addition to a description of the CWA listed above, the clinic, pathology and therapy are given of intoxications by certain technical fluids (methyl alcohol, antifreeze, tetraethyl lead) and also of injuries from phosphorus, which may be encountered in peace and wartime.

CWA of General-Toxic Effect

Among the CWA possessing pronounced general-toxic effects are hydrocyanic acid, carbon monoxide, arsine and also organic phosphorus compounds (tabun). The characteristic feature of all the CWA listed above is their capacity of exerting a toxic effect only when they penetrate into the organism. Direct contact of them with the skin and mucous membranes, that is, with the routes through which they are absorbed into the blood, do not lead to the development of significant local reactions in the majority of cases.

The CWA of general-toxic effect injure the vital organs and systems (blood, cardio-vascular, nervous system and others). As a result of this, the oxidative processes in the tissues are disturbed (hydrocyanic acid), the transportation of oxygen by the blood is blocked (carbon monoxide), marked changes develop in the nervous system characterized by a convulsive-paralytic syndrome (tabun and others). The fact deserves attention that timely, early therapeutic measures can prevent the further development of the pathological process and, by the same token, save the life of the patient. Therefore, the pathological phenomena produced by the effect of these CWA are, for the most part, reversible.

Hydrocyanic acid. Hydrocyanic acid (HCN) is a transparent fluid which has a specific almond odor. At a temperature of 10° its specific gravity is 0.7; its boiling point is 26°, and freezing point is 15°. It dissolves rapidly and completely in chloroform, ether and other organic solvents, mixes readily with water. The vapors of HCN also dissolve readily in water.

Hydrocyanic acid and its compounds (cyanogen chloride and cyanogen bromide) are very toxic substances. During the First World War they were given special attention. However, in view of the low stability of hydrocyanic acid it did not become prevalent as a war gas. An attempt was made to use hydrocyanic acid with weighting compounds (stannic

chloride, arsenic tetrachloride and others), but no particular results were achieved. In any case, hydrocyanic acid, being a very toxic compound, can probably be used as a CWA under certain conditions.

Hydrocyanic acid intoxications are possible also in peacetime, particularly in children, through the excessive consumption of pits of apricots, cherries, plums, peaches, which contain hydrocyanic acid in the form of glucosides.

In view of the quite extensive use of hydrocyanic acid in a number of industries (galvanoplastics, dyeing) and also in view of the utilization of cyanide-containing compounds in agriculture (rat-elimination) the occurrence of accidental intoxications is possible.

Hydrocyanic acid and its compounds can penetrate into the organism by various routes: through the lungs on inhalation of air containing this CWA, the gastro-intestinal tract and also through the intact skin in cases of the effect of high HCN concentrations. The penetration of the hydrocyanic acid through the mucous membranes of the respiratory passages is of the greatest importance.

Mechanism of Action of Hydrocyanic Acid. Hydrocyanic acid is readily absorbed and penetrates very rapidly into the blood, and, thanks to its great solubility in lipoids, it enters the tissues, disturbing the normal course of the oxidative processes. As a result of this, the tissues lose the capacity of assimilating oxygen, in consequence of which anoxia develops, even though a considerable quantity of oxygen is contained in the blood.

Up to the present time, the essence of the effect of hydrocyanic acid has not been completely elucidated. The opinion exists that HCN exerts an influence on the system of hemin-containing enzymes, and reacts with the oxidized form of the enzyme cytochromoxidase, forming complex compounds with it, whereby cytochromoxidase is deprived of its catalytic function in the reaction between oxygen and the reduced form of cytochrome C. In consequence of this, the course of the main mechanism of cellular oxidation is disturbed. Hydrocyanic acid exerts a blocking effect on other enzymes also.

As a result of such an inhibitory effect of hydrocyanic acid on the oxidative processes in the tissues anoxia develops (tissue anoxia). The central nervous system, as the most sensitive, suffers primarily. This pertains, mainly, to such

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centers as the respiratory, vasomotor, and vagus nerves. The disturbance of activity of the vitally important centers is expressed in a certain excitation of them, and then by depression and paralysis of them. Also, changes occur in the blood. The arterial and venous blood are almost equally saturated with blood, in consequence of which the arterio-venous difference is slight. With the development of the toxic process the carbon dioxide content in the blood is reduced. As the result of the anoxia, the metabolic processes are also disturbed, and the acid-base equilibrium is changed.

Hydrocyanic acid in the organism is subjected to a partial detoxification because of the fact that it combines with sulfur-containing substances (cystine, cysteine, glutathione and others), thereby forming slightly toxic sulfocyanide compounds (HCNS) which are excreted through the kidneys.

Clinical Picture of Hydrocyanic Acid Injury. The degree of development of the toxic process in inhalation intoxication with vapors of hydrocyanic acid is determined by the concentration of the CWA in the environment, the duration of contact and the individual characteristics of the organism. In those cases where a person is exposed to the effect of hydrocyanic acid vapors in a concentration of 0.3 milligrams per liter, a severe degree of anoxia develops, which in the majority of cases leads to a fatal outcome in the course of the next few minutes. Death occurs as the result of failure of respiration and the cessation of cardiac activity.

The effect of lower concentrations of hydrocyanic acid vapors leads to the development of a characteristic clinical picture in which several successive periods may be arbitrarily distinguished.

The initial period (prodromal) is characterized by sudden malaise, headache, general weakness, taste of almonds in the mouth, salivation, decreased sensitivity of the oral mucosa, nausea, retching, shortness of breath and palpitation.

Elimination of the contact of the patient with the vapors of hydrocyanic acid during this period of intoxication leads to an elimination of the pathological phenomena and to complete recovery of the organism in short order.

If the effect of this substance continues, more pronounced signs develop characteristic of the given intoxication (dyspneic period). In this stage of intoxication considerable respiratory disturbances are added to the signs listed. At the beginning, the respiration is frequent, deep; afterwards, it is slow, assuming a superficial, irregular character. Consciousness is also gradually lost. The mucous membranes and the skin are bright because of the saturation of the blood with oxygen.

With the development of intoxication convulsions of clonic and tonic character (convulsive period) appear; the patient loses consciousness. Soon, paralytic signs develop; usually, the intoxicated person is completely prostrate and unconscious; the respiration and cardiac activity are severely impaired; involuntary urination and defection are noted. During this period, a fatal outcome usually occurs. First, a failure of respiration is noted with subsequent stoppage of the cardiac activity.

The death of the patient may occur during the hour following intoxication, and in some cases even much later.

Pathological Changes From Hydrocyanic Acid Intoxication--On external examination of the cadaver a scarlet coloration of the cadaveric mottling, of the mucous membranes and of the skin is found. On dissecting the cadaver, no particular changes are found in the individual organs and systems, just as in the case of carbon monoxide intoxication. The tissues are bright red, the blood is scarlet, and an odor of bitter almonds is perceived. Solitary hemorrhages are observed in various organs: in the pleura, endocardium, kidneys, liver, spleen. Somewhat greater changes are noted in the central nervous system. This is expressed in edema of the meninges as well as in solitary punctate hemorrhages. In addition, individual areas of degeneration may be seen in the brain.

Diagnosis of Hydrocyanic Acid Intoxication. The diagnosis of intoxication by hydrocyanic acid vapors usually presents no difficulties. However, sometimes such an intoxication has to be differentiated from the intoxication produced by carbon monoxide, tabun and arsine. However, considering the data of interrogation of the patients, "reconnaissance" findings, and the characteristics of the clinical picture of the intoxication the diagnosis may be made with confidence. In doubtful cases, the decisive factor in excluding carbon monoxide intoxication is the examination of the blood for carboxyhemoglobin. It is not hard to exclude tabun and arsine intoxications, which are accompanied by other characteristic signs.

First-Aid and Treatment in Hydrocyanic Acid Intoxication

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--The outcome of hydrocyanic acid intoxication depends on timely and proper rendering of first aid. In cases of even more severe intoxication, properly organized therapeutic measures can save the patient's life. First of all, the patient should be removed from the contaminated area, after first putting on a gas mask. In cases where respiration has stopped, artificial respiration is indicated. Without losing time, a wad containing amyl nitrite (0.5 cubic centimeter) is put under the gas mask for the purpose of forming methemoglobib rapidly in the blood; this combines with the poison. Care should be taken that the wad or tampon placed under the mask does not slip down into the respiratory passages. In parallel with the inhalation of amyl nitrite, an intravenous injection of one percent methylene blue and 25 percent glucose solution (50 cubic centimeters) are given with the aim of forming methemoglobin and binding the toxic substance. Here, the injected glucose also reacts with the hydrocyanic acid, as a result of which almost non-toxic compounds are formed (cyanhydrins) which are rapidly eliminated by the organism. Sodium hyposulfite (50 cubic centimeters) in the form of the 30 percent aqueous solution is also used. Harmless sulfocyanide compounds are formed through the hyposulfite injection; they are eliminated in the urine, whereby the organism is detoxified. Therefore, the therapeutic agents listed may be regarded as antidotes.

Giving of this treatment does not exclude the use of agents which stimulate the respiratory center, cardiac agents, oxygen, etc. Afterwards, in case of need, various symptomatic measures are used.

Carbon monoxide (CO)--A gaseous substance without an odor, taste or color. Its specific gravity is 0.97. CO burns with a bluish flame. Carbon monoxide may be formed in consequence of the partial combustion of carbon-containing substances in the presence of a limited supply of oxygen. A gas mask without special adaptations does not keep out the carbon monoxide.

Carbon monoxide was not used as a war gas in consequence of its physico-chemical characteristics. However, during war carbon monoxide intoxications are possible, especially during mass firing from semi-enclosed positions (blindages, tanks, bilges), during artillery fire, etc. Carbon monoxide intoxications are possible also in peacetime, for example, as the result of lack of observance of the rules of utilization of gas apparatus, premature closure of flues and also in industry from improper ventilation systems.

Mechanism of Action of Carbon Monoxide--Carbon monoxide intoxification develops only when it enters the organism through the respiratory organs, whereby the patient may be exposed to the effect of carbon monoxide gas without being aware of it. After penetrating through the pulmonary membrane into the blood stream, the carbon monoxide readily combines with the hemoglobin, which leads to the formation of carboxyhemoglobin. In connection with this, the blood loses the capacity of carrying oxygen from the lungs into the tissues in the quantity needed by the organism; an anoxic syndrome develops with its consequences. It should be emphasized that the formation of carboxyhemoglobin occurs very actively by virtue of the great activity of carbon monoxide. However, even after breathing air with the usual oxygen content the carbon monoxide quite readily separates from the hemoglobin, which leads to the recovery of the normal blood functions. Therefore, carboxyhemoglobin is not a stable compound and dissociates readily. Carbon monoxide is excreted through the respiratory passages. The quantity of carboxyhemoglobin formed in the blood determines the intensity of the anoxic syndrome. If the content of carboxyhemoglobin in the blood does not exceed 25-30 percent, the signs of intoxication are not pronounced. With increase in the carboxyhemoglobin content the severity of the pathological signs increases. The formation of 60-70 percent carboxyhemoglobin can lead to the development of a severe toxic process with pronounced changes on the part of the central nervous system. In such cases the blood usually contains a much reduced oxygen content; the level of carbon dioxide is also reduced, which has an unfavorable influence on the activity of the respiratory and vasomotor centers. A disorder of the metabolic processes occurs; with the development of pathological changes in the blood various insufficiently oxidized products accumulate, and the acid-base equilibrium is disturbed.

Clinical Picture of Carbon Monoxide Intoxication. The character of development of the clinical picture of carbon monoxide intoxication is determined by its concentration in the surrounding air, by the intensity of formation of carboxyhemoglobin in the blood and by the state of the organism. Such a concentration of the gas as 0.15-0.2 milligrams per liter does not cause the development of any special pathological symptoms. The increase in the concentration of CO to four to five milligrams per liter and more leads to the development of serious toxic reactions.

The acute form of carbon monoxide intoxication is characterized by the appearance of a whole series of symptoms

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attesting to the developing anoxia. These symptoms are the following: dizziness, headache, ringing in the ears, sensation of pulsation of the temporal and cervical vessels, increase in frequency of the pulse and respiration, general weakness, sometimes nausea and vomiting. If the patient is brought out of the area into the fresh air, that is, if the contact with the carbon monoxide is removed, all the pathological signs gradually decrease and disappear without leaving any sequelae.

In those cases where the person is exposed to the continuing effect of carbon monoxide, the pathological signs progress.

The patients show sleepiness, adynamia develops with marked muscular weakness, chiefly in the legs. Afterwards, consciousness is impaired up to the development of a comatose state. The blood pressure is reduced very sharply at times, and the respiration and cardiac activity are considerably impaired (Cheyne-Syokes respiration develops). The pulse is usually of poor quality and hardly perceptible.

As a result of sphincter paralysis spontaneous defection and urination are often seen. In some of the patients clonic and tonic convulsions occur. The patients may remain in such a condition for several hours, and at times two or three days. Death of the patients usually occurs as the result of failure of respiration and cessation of cardiac activity. However, even in a serious condition the patient's life not uncommonly can be saved through proper organization of aid and treatment.

Recovery, particularly after severe intoxication, occurs gradually. The convalescents suffer from headache, general weakness, palpitation and an unsteady gait for a relatively long time.

The course of carbon monoxide intoxication is not always of the character described above. Atypical cases are possible where the development of the toxic process is accompanied by a sharp drop in blood pressure, rapid onset of a syncopal state, pallor of the visible skin and mucous membranes, and pronounced respiratory disorders. Here, the clinical picture of intoxication is reminiscent of the state of gray anoxia which develops in the severe forms of intoxication with the asphyxiant CWA. There are also other atypical cases of intoxication (euphoric form).

In mild cases of carbon monoxide intoxication the prognosis is usually favorable. In the more severe cases complications may be observed: hemipareses, paralyses, psychic disturbances in the form of hallucinations, depression, maniacal state as well as changes in other organs.

Pathological Changes in Carbon Monoxide Intoxication. On examination of the cadaver a bright coloration of the cadaveric spots and of the skin is seen as the result of intoxication by carbon monoxide. On autopsy of the cadaver, only solitary hemorrhages are found in the pleura, endocardium, gastro-intestinal tract, congestion of the brain and spinal cord. The blood is usually bright in color. If the patient's death occurs at later periods, degenerative changes are possible in the internal organs and in the central nervous system.

Diagnosis of Carbon Monoxide Intoxication. The diagnosis of carbon monoxide intoxication does not present any significant difficulty, particularly in those cases where there is a possibility of examining the blood for the presence of carboxyhemoglobin.

There are several methods of determining the presence of carboxyhemoglobin. The simplest of them is the qualitative method: formalin is added to blood taken from the patient; if carboxyhemoglobin is present, a raspberry-red color develops; in the control sample (blood of a healthy person) the addition of formalin gives a brown color.

Carboxyhemoglobin may be determined by means of the addition of a mixture consisting of two percent tannin and pyrogallic acid solution which, after interacting with the blood containing carbon monoxide, contributes to the formation of a bright red color; control blood taken from a healthy person and diluted with the mixture indicated takes on a grayish-brown color.

A better method for determining carboxyhemoglobin is the spectroscopic method: carboxyhemoglobin, like oxyhemoglobin, gives two absorption bands in the spectrum. However, when added to blood containing oxyhemoglobin and ammonium polysulfide, the two absorption bands fuse into one; this does not occur in the patient's blood.

First Aid and Treatment in Carbon Monoxide Intoxications. First of all, contact of the patient with the contaminated atmosphere should be eliminated. In the mild cases of in-

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volvement this measure leads to the quite rapid recovery of the impaired functions. With the more severe forms it is necessary to prescribe oxygen, best with an admixture of five percent carbon monoxide (carbogen). The carbon dioxide contributes to the stimulation of the respiratory center and to the improvement of respiration, which leads to a more rapid elimination of the carbon monoxide from the organism (Fig 80). The patient should be given rest. In very severe cases of intoxication, when a marked depression of the respiratory center occurs, artificial respiration should be used according to the Sylvester, Schaeffer or Howard methods. Artificial respiration sometimes needs to be carried out for several hours. For the purpose of stimulation of the respiratory center intravenous injections of lobeline solution or of cytitone in the usual doses are recommended. When there are disturbances of the heart the use of cardiac agents is indicated (caffeine, corasole [pentylenetetrazole]. In cases where the patients are in a state of coma for a long time, bleeding (150-300 cubic centimeters) may be recommended with the subsequent administration of blood-substitute fluids. Treatment of the complications or sequelae of intoxication is carried out according to general rules of therapy.

Fig 80. Dissociation of Carboxyhemoglobin of Blood of Animals Exposed to CO Where Oxygen Therapy is Used (according to A. I. Cherkes).

Arsine (AsH_3)--gaseous compound with indistinct garlic odor, combustible, much heavier than air. Its boiling point is -55°. Arsine dissolves slightly in water and alcohol; better, in fats. This may be obtained readily under laboratory conditions through the interaction of hydrogen with compounds containing arsenic.

Arsine, being a very toxic substance, has for a long time been attracting the attention of military chemists. However, arsine has not been used under military circumstances in consequence of its inadequate stability and of the difficulty in liquefying it. At the same time, arsine is of importance as an industrial poison, because it is encountered in many branches of industry (chemical, metal working and others).

Essence of the Effect of Arsine. In its toxic properties AsH_3 belongs to the group of toxins which possess a hemolytic effect.

Arsine penetrates into the organism through the respiratory organs, without producing any kind of signs of irritation. Arsine, readily absorbed by the respiratory mucosa enters the blood stream, is adsorbed by erythrocytes and leads to a hemolysis of them after a certain time (latent period of action). As a result of this, the oxygen capacity of the blood is reduced and an oxygen deficiency develops in the organism (anoxia). The possibility has not been excluded of a toxic effect of the arsenic itself on the organism; the arsenic is formed as a result of the decomposition of arsine.

Clinical Picture of Intoxication. Arsine even in insignificant concentrations can lead to the development of a severe toxic process. Thus, the inhalation of arsine in a concentration of 0,05 milligrams per liter for 30 minutes leads to the occurrence of a severe form of intoxication. It should be kept in mind that arsine possesses a definite latent period of action, which can last from several hours to days or more. Only at the end of the latent period does a more or less intense intoxication develop.

In the initial period of that intoxication the patients offer complaints of dizziness, headache, sluggishness, nausea, retching, epigastric pains, etc. With the development of the toxic process blood appears in the urine, the patients develop an icteric color of the skin, a rapid weak pulse, dyspnea, cyanosis, persistant vomiting with an admixture of bile, and sometimes also of blood.

Changes in the peripheral blood (Fig 81), which are expressed in the development of anemia with a reduction in the number of erythrocytes to 1,000,000 per cubic millimeter or less as well as neutrophilic leucocytosis, acceleration of the sedimentation rate, and the occurrence of biochemical changes in the blood (increase in bilirubin, sugar, NPN and others) are characteristic of all the forms of arsine intoxication. With a favorable course of the toxic process the symptoms of intoxication slowly and gradually disappear, and recovery of the patient occurs. In the severe cases of intoxication serious complications may develop on the part of the kidneys (oliguria, anuria, uremia), of the nervous system (disturbance of consciousness, delirium, comatose state), of the liver and other organs.

Fig 81. Content of Erythrocytes and Hemoglobin at Various Periods of Intoxication of Animals by Arsine.

Fatal outcomes in arsine intoxication are observed chiefly during the first two to four days, but death of the patient is possible even at later periods.

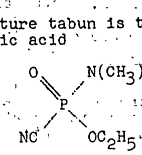
Pathological Changes in Arsine Intoxication. On autopsy of the cadaver the icteric coloration of the tissues, the hemolyzed blood, hemorrhages under the pleura, solitary hemorrhages in the heart muscle attract attention. The liver is enlarged and icteric. The gall bladder contains a considerable quantity of thick brown bile. The spleen is enlarged, edematous, soft to the touch. Changes in the kidneys are quite marked, and they appear somewhat enlarged, of daek-brown color, with different hues. The capsule is readily removed. On section, the surface of the kidneys is of dark brown color, and the markings are somewhat indistinct. The stroma of the kidneys is swollen. Hemorrhages into the mucous membrane of the kidneys and bladder are possible. Solitary hemorrhages are found in the mucosa of the gastro-intestinal tract. In the central nervous system, edema is noted in the meninges and solitary hemorrhages in various parts of the brain substance.

First Aid and Treatment of Arsine Intoxications. The patient should be removed from the contaminated area immediately. With the aim of the quickest possible elimination of arsine from the body, early bleeding (200-400 cubic centimeters) is recommended with the subsequent administration of physiological solution, glucose, and also of other blood-substitute fluids. In the presence of the appropriate indications cardiac agents (camphor, caffeine and others) are used; for combatting developing anoxia oxygen is used, and frequent drinking and diuretic agents are used for accelerating the elimination of arsenic. Afterwards, symptomatic treatment is given directed at restoration of the kidney function and stimulation of hematopoiesis. With this aim in view, the patient should be given intravenous glucose (up to 50 cubic centimeters), liver preparations, iron and other agents. In cases of uremia, bleedings are indicated with simultaneous administration of blood-substitutes. Also the use of general-tonic measures, vitamin and diet-therapy are recommended, and in the absence of the signs of hemolysis, blood transfusions.

Tabun--Considerable attention has been given in the post-war years to the study of organic phosphorus compounds which are highly toxic substances. A whole series of compounds have found application as active insecticides (parathion, tetraethylpyrophosphate and others), and certain substances

of this group (tabun and others) are potential CWA--Sartory, Holmstedt and others.

In its chemical structure tabun is the ethyl ether of dimethylamidcyanphosphoric acid



Tabun dissolves readily in a number of organic solvents (acetone, benzol and others). In water its solubility is slight. The reaction of hydrolysis proceeds slowly.

Tabun is an exceptionally toxic substance with a considerable absorptive effect. It should be noted that such compounds as tabun, parathione and others do not cause any pronounced inflammatory reactions after direct contact with the skin or mucosae and, after being absorbed, lead to the development of severe general symptoms. The effect of tabun in considerable concentrations and doses can lead to the death of the organism in the course of a few minutes.

Problems of pathology, clinic and therapy of the intoxications and also the mechanism of action of the organic phosphorus compounds have been presented in quite some detail in the foreign literature--Grob, Holmstedt, Rohwer and Heller, Koelle and Gilman, Krop and co-authors, and many others.

The intensity of the development of the toxic process in intoxication by organic phosphorus compounds depends on the dose or concentration of the CWA, the exposure time and also the individual characteristics of the organism.

In the mild form of intoxication with organic phosphorus compounds (tabun, parathione) the following are observed: dizziness, headache, restlessness, nausea, vomiting. However, the characteristic feature of the intoxication is the pupillary constriction (miosis). In addition, a disturbance of respiration is possible in connection with developing bronchospasm. In the case of a mild degree of intoxication the prognosis is favorable, and the pathological signs may disappear without trace in the course of the next few days.

In the more severe form of intoxication, aside from the pathological signs and symptoms listed above, which may be

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expressed to a much greater degree, the involvement of the central nervous system is most important. This is manifested in excitation, restlessness, disturbance in coordination, notable changes in the state of consciousness, up to loss of it as well as the occurrence of solitary muscular twitchings which may pass into a convulsive state. In such patients, the attacks of dyspnea are intensified, the cardiac and gastro-intestinal disturbances develop progressively, and glandular secretion increases (salivation, etc.). However, even in the severe cases of intoxication, with timely organization of first aid and treatment of the patients a favorable outcome is possible.

As has already been mentioned, a series of signs is observed in the clinical picture of intoxication by organic phosphorus compounds which give evidence of the involvement of the central nervous system in the toxic process. This is confirmed by the data of pathological examinations. In the cadavers an edema of the meninges, congestion of the cerebral vessels and hemorrhages are found. In addition, congestion and hemorrhages are noted in many organs. Spasm of the smooth musculature of the bronchi, intestine, and pupillary constriction is constantly noted.

Certain Problems in the Mechanism of Action--The problems of the mechanism of action of organic phosphorus compounds have not been completely studied to date.

Many research workers adhere to the view that the organic phosphorus compounds possess an anticholinesterase effect, that is, the basis of the toxic effect of the substances indicated is their capacity of blocking cholinesterase (an enzyme which destroys acetylcholine). In consequence of this, the acetylcholine content in the organism is increased, which to a considerable degree determines the characteristics of the toxic effect of the substances indicated on the organism. The fact that the application of such cholinolytic preparations as atropine eliminates the signs of bronchospasm and other symptoms associated with the disturbance of parasympathetic innervation of a number of organs may be used as proof of the correctness of this position. At the same time, not all the aspects of the toxic process developing in intoxication by organic phosphorus compounds can be explained simply by their anticholinesterase effect.

Prophylaxis and Treatment in Tabun Intoxications. Tabun intoxication can be prevented by the use of ordinary individual (gas mask, special suits and others) and group

(shelter) means of protection.

In cases where tabun gets on the clothes or skin, immediate processing of the area with alkaline solutions (10-15 percent ammonia solution), the liquid of the gas casualty first aid kit, organic solvents (dichlorethane, acetone, benzol and others) should be used.

An active therapeutic measure for tabun intoxication is atropine--an acetylcholine antagonist. The use of atropine (one to two milligrams or more) in the early period of the intoxication reduces the bronchospasm and the miosis. The therapeutic activity of atropine also effects an improvement in the general condition of those intoxicated. Therefore, atropine may be regarded as a specific measure to a certain degree. Atropine should be used along with symptomatic measures (in the case of considerable depression of respiration--lobeline or cytitone; with dyspnea--oxygen, cardiac agents; in the case of convulsions--barbiturates, magnesium salts, etc.). In cases of need, artificial respiration is indicated. Rest and proper diet are important in therapy.

VESICANT CWA

The group of chemical compounds of so-called vesicant nature is comprised by dichlordiethylsulfide (mustard gas), trichlortriethylamine (nitrogen mustard) and chlorvinyldichlorarsine (lewisite). Despite the fact that the substances named are called vesicants, their effects are not limited to the skin. Therefore, "local" signs which are noted during the effect of the CWA of this group should not be regarded as isolated from the considerable general-absorptive effects occurring as the result of their absorption by the organism.

Mustard gas--dichlordiethylsulfide $S\begin{smallmatrix} \nearrow CH_2CH_2Cl \\ \searrow CH_2CH_2Cl \end{smallmatrix}$ has not lost its military significance up to the present time because of certain properties and military-tactical characteristics.

As is well known, under battle conditions technical mustard gas was used, which represents a dark fluid possessing the odor of garlic, mustard or onions. Purified mustard gas is an oily, almost transparent fluid with a slight odor. The specific gravity of mustard gas is 1.3; its boiling point, 219°. Vapors of mustard gas are much heavier than air. Musttard gas dissolves slightly in water, but gradually undergoes hydrolysis. On heating the water and adding a small quantity of alkali, hydrolysis of the mustard gas proceeds more rapidly, as a result of which hydrochloric acid and thiodiglycol are formed; the latter has no toxic properties and dissolves readily in water.

$$S\begin{matrix} / CH_2CH_2Cl \\ \backslash CH_2CH_2Cl \end{matrix} + 2H_2O \rightarrow 2HCl + S\begin{matrix} / CH_2CH_2OH \\ \backslash CH_2CH_2OH \end{matrix}$$

Mustard gas dissolves readily in organic solvents (alcohol, gasoline, kerosine, carbon tetrachloride, etc.); the good solubility of mustard gas in fats and lipoids assures it a free penetration into the organism through the skin and particularly through the mucosae.

Mustard gas enters actively into a reaction with oxidants, like potassium permanganate, nitric acid, hydrogen peroxide, thereby forming compounds (dichlordiethylsulfoxide and others) which are less toxic. After reacting with chlorine and chlorine-containing substances (chloramine, hypochlorites), mustard gas loses its toxic properties.

Mustard gas possesses a high degree of toxicity and can act on the organism in droplet, vapor or fog states. Thus, inhalation of its vapors in a concentration not exceeding 0.05-0.07 milligrams per liter leads to the development of a severe toxic process in 30-40 minutes which terminates in a fatal outcome. However, the intensity of the toxic process depends not only on the concentration of mustard gas entering the body and the exposure time but also on the individual characteristics of the body (condition of the nervous system, individual sensitivity to mustard gas, etc.). In its effect on the organism mustard gas has a number of characteristic features whereby it is distinguished from other CWA of this group. Among such characteristics are a quite prolonged latent period, the gradual development of the toxic process and a prolonged course of it.

Clinical Picture of Mustard Gas Intoxication. Depending on a number of conditions (sensitivity, concentration, exposure time and others) various forms of mustard gas intoxication are observed.

In mild cases of intoxication with vapors of mustard gas

the duration of the latent period reaches two to eight hours, during the course of which the patient does not offer any particular complaints. Only at the end of this period of time do general weakness, headache, nausea, sometimes vomiting develop as well as a number of other pathological signs on the part of the eyes, respiratory passages and skin. This is expressed in a slight lachrymation, photophobia and blepharospasm, the occurrence of a tickling sensation in the throat, a non-productive cough, hoarseness of the voice, and the excretion of mucus from the nose.

Afterwards, signs of skin involvement develop: hyperemia of the face, particularly of the neck, in the axillary and inguinal areas, that is, in places which are exceptionally sensitive to this substance.

Mild degrees of intoxication usually end favorably in the course of the next seven to 15 days without leaving any sequelae except for a skin pigmentation which gradually disappears.

After the action of higher concentrations of mustard gas a severe form of toxic process is observed. In such cases the latent period is not so prolonged. All the pathological signs are more pronounced. Thus, in the eyes there are observed not only considerable degrees of conjunctivitis but also an involvement of the other membranes of the eye. In the lungs there is noted an inflammatory-necrotic process, bronchitis, broncho-pneumonia, and pulmonary edema is possible. The body temperature is elevated. Considerable skin afflictions develop: erythema and blisters (Fig 82) [Page 201 of Source]. The general-absorptive effect of mustard gas is expressed in pronounced fashion and is manifested in an involvement of the central nervous system, in blood changes, metabolic changes, etc. (see below).

Fig 82. Mustard-Gas Blisters Formed on the Skin After the Effect of High Concentrations of the CWA.

In severe cases of intoxication with mustard gas vapors death may occur at the end of the first or beginning of the second week against the background of pronounced general-toxic signs and a number of pulmonary complications.

In the event of death during the acute period of intoxication the greatest pathological changes of inflammatory-

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necrotic character are found in the respiratory passages. The lungs are somewhat enlarged, mottled in appearance because of the presence of emphysema, atelectasis and pneumonia. Abscesses and pulmonary edema are possible. The heart muscle is flabby. Degeneration of muscle fibers is observed. The parenchymatous organs are congested with blood and show changes of stasis; hemorrhages are found in some of them. Changes in the central nervous system are also pronounced (congestion of cerebral vessels, hemorrhages into the brain matter and other organic changes).

Involvement of the Skin by Mustard Gas. Mustard gas, after falling on the skin in the droplet state, leads to the development of erythema, blisters and ulcers after a latent period the average duration of which is equal to two to eight hours. The formation of erythema may not be limited to the site of localization of the mustard gas, and, become confluent, may spread along the periphery accompanied by an itch and a prickly feeling in the skin. Fifteen to twenty hours after mustard-gas intoxication small blisters develop along the borders of the erythema. Afterwards, they become confluent and are converted into a massive blister at first filled with a serous and then with an opalescent fluid which does not contain mustard gas.

In the milder cases of involvement of the skin the blister fluid is usually resorbed, and the blister shrivels up, forms a crust which later falls off, leaving only a pigmented spot.

The effect of large quantities of mustard gas on the skin leads to the development of a pronounced inflammatory-necrotic process as the result of which indolent ulcers are formed (Fig 83 [Page 202 of Source]). In such cases, secondary infection is readily superimposed, and this is in a good soil for its development, which complicates the course of the skin injury. As a result of marked pathobiosos of the tissues, the healing is extremely sluggish (one to three months) and terminates in the formation of a quite vulnerable scar surrounded by pigmentation.

Fig 83. Mustard-Gas Ulcer.

The effect of mustard gas in the vapor state also leads to the development of dermatitis; however, the latent period in such cases is more prolonged, and the signs of skin involvement are expressed to a lesser degree.

After the mustard gas falls on the wound surface it is rapidly absorbed into the blood and leads to the development of general intoxication (combined injury). The healing times of such wounds are considerably prolonged.

In diagnosing the mustard-gas skin involvements it should be kept in mind that other members of the persistent chemical agent group (lewisite and trichlortriethylamine) give very similar skin changes. Mustard-gas injuries of the skin sometimes have to be differentiated from certain conditions, like burns, frost-bites, erysipelas and others.

Involvement of the Respiratory Organs: The inhalation of mustard-gas vapors leads to quite considerable involvement of the respiratory organs, particularly the upper sections of the respiratory passages.

Clinically, this is manifested (after a latent period of two to six hours or more) by the appearance of a frequent cough, scratching in the throat, the excretion of mucus from the nose, hoarseness of the voice, and then by the development of aphonia. The involvement is not limited to signs of laryngitis and pharyngitis; the pulmonary parenchyma is also involved in the process. Pathological changes extend throughout the entire respiratory apparatus. Afterwards, the involvement acquires an inflammatory-necrotic character with the development of pseudocroup and the exfoliation of necrotic membranes. The possibility exists of the development of bronchopneumonia, abscesses and even of toxic pulmonary edema. Mustard-gas involvement of the respiratory organs is almost always accompanied by pronounced symptoms of general intoxication.

Mustard-Gas Involvement of the Eyes--may occur in various forms. The mild forms are usually observed after the effect of mustard gas in the vapor state and are most often limited to the signs of conjunctivitis, which disappear without trace in the next few days. Considerable mustard-gas concentrations can lead to serious afflictions of other eye tissues. A particularly severe eye condition is observed in the case of contact with [illegible] the form of drops. Here, the direct contact [illegible] not produce any unpleasant subjective sensations. [illegible] logical signs develop only after two-three hours. Not only the conjunctiva but also the cornea, iris and ciliary body are involved in the process. Superimposed infection often aggravates the condition. In extremely severe cases the development of panophthalmia is possible, which terminates in

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perforation of the cornea. Mustard gas is readily absorbed into the blood from the ocular mucosa and leads to the occurrence of general toxic signs.

Mustard-Gas Involvement of the Gastro-Intestinal Tract. The ingestion of food products or water containing mustard gas causes involvement of the digestive apparatus. The development of a toxic process is also possible as the result of swallowing saliva containing a mustard-gas admixture. As in the preceding cases, a latent period is observed, but here it is not so long (15-120 minutes). Afterwards, gastritis, salivation, nausea and vomiting develop. Sometimes, signs of enteritis and colitis are added. However, most often the process is limited to the esophagus and stomach. In the severe forms of intoxication the inflammatory process assumes a suppurative-necrotic character; sometimes, the development of ulcers and even perforation of them. Death of the patients has been noted in the next two or three days, and sometimes later as the result of a developing general intoxication of the organism.

General-Toxic Effect of Mustard Gas. Mustard gas possesses an absorptive effect. Hereby, a series of pathological changes is found in the blood, cardio-vascular and nervous systems, of metabolism, of the kidneys, liver and other organs. The signs on the part of the nervous system are expressed as headaches, marked depression, indifference to events occurring in the immediate area, and, in severe cases of intoxication, considerable excitation, impairment of memory, of sleep, and the development of hallucatinations and convulsions are possible.

Blood changes are observed chiefly in the more severe forms of intoxication and are expressed in a certain concentration of it with the subsequent development of anemia, which remains for a long time after recovery. A neutrophilia is almost noted with simultaneous eosinopenia. With the development of the toxic process the leucocyte count falls, leucopenia develops with the presence of toxic granulation in the leucocytes and degenerative changes in their nuclei. A sign which indicates a favorable turn in the course is the occurrence of eosinophiles, etc. in the peripheral blood. Severe mustard-gas intoxication usually is accompanied by a considerable drop in the blood pressure, up to the development of collapse.

In the milder cases of intoxication the cardio-vascular symptoms are limited to a certain drop in blood pressure, a

disturbance in the cardiac rhythm and muffling of the heart sound.

The kidneys are also involved in the process; albumen and blood appear in the urine with casts and other pathological elements; diuresis is markedly reduced.

Metabolism is significantly impaired, chiefly protein metabolism. There is an increased ammonia, total nitrogen, phosphorus, creatinine, etc. content in the urine. The body weight drops, and a cachectic condition develops.

Insufficiently oxidized products accumulate in the blood, and acidosis develops.

These involvements are usually associated with pronounced disturbances in heat-regulation.

Certain Problems in the Mechanism of Action of Mustard Gas. The mechanism of action of mustard gas cannot be considered completely clear at the present time. Several theories exist, according to which the toxic effect of the mustard gas is associated with the effect of the entire molecule of it, or else primary significance is given to the hydrochloric acid formed in the body as the result of hydrolysis in explaining the toxic effect. However, these theories, like many others, cannot be completely accepted, because they do not reflect the many and various changes in the body which are observed under the influence of mustard gas. Certain authors ascribe importance in the mechanism of action of mustard gas to its reaction with sulfhydryl groups of proteins, because of which the functional capacity of the latter is impaired. Works indicating the specific reactions of mustard gas with nucleoproteins occupy a definite place. Also, a similarity is noted between the biological effect of mustard gas and that of radiant energy, which indicates certain common features in the mechanism of action of both factors.

Prophylaxis, First Aid and Treatment of Mustard Gas Intoxications. Modern medicine has at its disposal a number of reliable agents for individual and group protection which can prevent the occurrence of large-scale intoxication under conditions of a chemical attack. Among them are gas masks, anti-mustard-gas suits, capes, impregnated underwear, rubber boots, gloves, stockings, and also the organization of special shelters.

The accomplishment of emergency measures should be begun with the evacuation of those affected from the contaminated area, after first putting gas masks on the patients. However, here it should be kept in mind that mustard gas is quite rapidly absorbed by the body. Therefore, the CWA should be removed from the surface of the skin or from the mucous membranes as soon as possible. If circumstances permit, the surface on which the CWA has fallen should be treated while still in the area of intoxication with agents capable of detoxifying the mustard gas, at least partially. As soon as possible, after carrying out the emergency measures, the patients should be treated in a medical processing station, and his clothes should be changed.

First aid consists basically of the neutralization and removal of the mustard gas which has fallen onto the skin and mucosae of the visual organs, organs of respiration, gastro-intestinal tract, etc.

In those cases where the mustard gas in the form of droplets or vapors has fallen simultaneously onto the mucous membrane of the eye and the surface of the skin, the eyes should be treated first by means of irrigating with a 0.5 percent aqueous solution of chloramine, with a weak (0.05 percent) solution of potassium permanganate, boric acid or sodium carbonate (two percent solution) and also water. Then, the skin is treated. Detoxification of the skin and removal of the mustard gas from its surface are accomplished in the following manner: if there are visible drops of mustard gas present, they should be removed mechanically (by pinching movements from the periphery toward the center) without rubbing them in or smearing them. Then, the contaminated surface of the skin is treated with solutions of neutralizers (contents of the gas casualty first aid kit, chloramine, calcium hypochlorite, chloride of lime, potassium permanganate or with a mixture of neutralizer and solvent--chloramine with carbon tetrachloride and others) for five to ten or more minutes. In the absence of neutralizers the affected skin is treated with solvents (kerosene, gasoline, alcohol, etc.) with subsequent careful washing around it with warm water and soap. Timely decontamination of the skin can prevent the development of a serious toxic process.

In cases where the mustard gas falls onto the mucous membranes of respiratory organs or enters the gastro-intestinal tract, the accomplishment of prompt measures is also necessary; these consist of the treatment of the oral cavity and pharynx with a weak aqueous chloramine solution. Careful

gargling with neutralizers and also irrigation of the nasal cavities with them at least partly prevents the absorption of mustard gas. Penetration of the CWA into the stomach requires an immediate washing of the stomach with a solution of sodium bicarbonate and potassium permanganate and also the use of adsorbents--carbolene (activated charcoal).

Through the timely use of prophylactic measures the development of local and general signs occurring from the effect of mustard gas may be prevented. Inadequately organized and conducted prophylactic measures and first aid as well as the use of the latter in later periods lead to the development of a toxic process.

Medical practice does not as yet have any agents which can neutralize mustard gas absorbed by the body; however, a series of therapeutic measures is taken the timely accomplishment of which can considerably reduce the toxic effect of the CWA and prevent the development of complications. Among such measures are: bleeding with the subsequent administration of blood-substitute solutions, the use of 30-40 percent glucose solution, 10 percent potassium chloride, 30 percent sodium hyposulfite solution and also cardiac agents. In the presence of symptoms indicating the development of a process of central nervous system stimulation, agents such as veronal, medinal and luminal should be prescribed in the usual doses. Oxygen therapy is of more than a little importance in the treatment of mustard gas intoxications. In cases where the activity of the respiratory center is impaired (marked depression), oxygen is used in a mixture with five percent carbon dioxide. With considerable depression of the respiratory center, lobeline or cytitone is recommended. For the prevention of the development of infectious complications the early use of sulfonamides and antibiotics (penicillin, streptomycin) is recommended.

During the recovery period efforts should be directed at increasing the immunobiological forces of the organism by means of the use of blood transfusions in small portions, protein therapy, autohemotherapy and general-tonic measures. Properly organized dietary and vitamin therapy contribute to the enhancement of the recovery process.

Treatment of various types of intoxication is carried out in the following way: in the initial stage of the development of the process on the skin (erythema) antiseptic solutions (chloramine, potassium permanganate, etc.) should be used; for itching, a two to five percent alcohol solution of menthol;

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for various large blisters following the preliminary antiseptic treatment their contents are absorbed with a sterile syringe, after which an antibiotic dressing is applied (penicillin, gramicidin) or antiseptic solutions.

In the case of diffuse involvement the open method of treatment is indicated. In order to avoid secondary infection it is recommended that the affected surface be irrigated with antiseptic solutions and that antibiotics and sulfonamides be widely used.

For superficial bullous forms and the presence of erosions the creation of a coagulation film is indicated by means of treatment of the affected area with three to five percent tannin solution, 0.5 percent silver nitrate solution or three to five percent potassium permanganate solution.

In the case of indolent ulcers and also in the stage of epithelialization thermoparaffin therapy gives good results.

During the period of healing, ointments consisting of vitamins and also physiotherapeutic measures, protein- and autohemotherapy and other measures stimulating the defensive reactions of the body should be used.

Pathological changes of the eye occurring as the result of the effect of mustard gas require special treatment. During the initial period treatment of the eyes with a weak aqueous solution of chloramine or with two to three percent sodium carbonate solution is recommended. If the patient is troubled by the pain, eye drops consisting of 0.5 percent dicaine solution or novocaine solution (two percent) with adrenalin is used. If the cornea is involved in the pathologic process, atropine treatment is necessary (one percent solution, one to two drops twice a day). In the event of photophobia, protective glasses should be used. The presence of a secondary infection requires the use of albucide [sulfacetamide] and penicillin. Afterwards, the patients need specialized treatment.

In case of involvement of the respiratory organs, as in diseases of the respiratory apparatus of other etiologies, symptomatic measures are used. In the case of signs of laryngopharyngitis, sodium carbonate or menthol inhalations are indicated, or gargling with emollient solutions. In cases where a diffuse tracheitis, bronchitis, bronchopneumonia or pulmonary abscess develops, streptomycin, penicillin and other antibiotics need to be prescribed, and in the presence

of the appropriate indications--oxygen, cardiac agents, mustard plasters, compresses, etc.

In the stage of resolution of the process, agents are recommended which contribute to the excretion of phlegm. With the aid of producing a better separation of the false membranes of the respiratory passages, such agents as menthol or guaiacol in oil should be introduced into the trachea. Further treatment of the patients is conducted according to the general rules of symptomatic therapy.

Treatment of gastro-intestinal involvements is also accomplished according to the rules of symptomatic therapy. Here, the observance of a diet is of great importance. Medicinal agents used are alkalis, bismuth and kaolin. To avoid the development of infections preparations of the sulfonamide, syntomycin and the penicillin group may be recommended.

Trichlortriethylamine--nitrogen mustard ($N(CH_2CH_2Cl)_3$) is a representative of the group of persistent CWA. Chemically pure trichlortriethylamine is an oily, liquid, almost transparent substance with a yellowish hue and a very slight odor. Its specific gravity is 1.23. It dissolves readily in alcohol, acetone, benzol, and slightly in water; on reaction with the latter, trichlortriethylamine gradually undergoes partial hydrolysis.

According to the data in the literature--A. I. Cherkes, Sartory, Anslow and Karnofsky, Friedenwald and co-authors, Gilman and Philips, Leder and others--trichlortriethylamine is a great deal similar to mustard gas in its toxic effect but has a whole series of distinguishing characteristics which will be brought out below.

Trichlortriethylamine possesses a toxic effect in different states of aggregation: liquid and vapor. Just like the other representatives of the persistent CWA group, trichlortriethylamine can penetrate into the organism through the skin, mucous membranes of the visual, respiratory, digestive and other organs. In case of direct contact with living tissues trichlortriethylamine produces more or less pronounced pathological reactions similar to those of mustard gas and lewisite, and absorption of it into the blood leads to the development of signs of general intoxication. It shc ld be noted that trichlortriethylamine compared with mustard gas produces somewhat less pronounced changes in the skin and in other organs. However, the general-toxic phenomena are greater in the case of trichlortriethylamine intoxication.

The intensity of the development of the toxic process in case of the effect of trichlortriethylamine is determined by a number of conditions (dose, concentration, exposure time, condition of the body, etc.).

The appearance of signs of intoxication at a certain latent interval after contact with the CWA rather than immediately is characteristic of trichlortriethylamine, just as it is of mustard gas.

Clinical Picture of Trichlortriethylamine Intoxication

Skin involvement. In the event trichlortriethylamine falls on the skin in the form of drops, hyperemia occurs after two or three or sometimes more hours, and then, edema od the skin. Also, unpleasant subjective sensations in the form of burning and itching appear. Further development of the toxic process depends on the quantity of the CWA which has fallen onto the skin and the reactivity of the organism. In cases of mild involvements the process is limited to the erythema stage.

In the case of more severe forms, solitary vesicles may develop. In favorable cases the contents of the blisters are resorbed, their membrane degenerates, and at the end of a week a crust is formed; after this falls off pigmentation remains. In the presence of infection the development of an ulcero-necrotic process is possible; however, it does not reach the intensity of that occurring from mustard gas. The intoxication occurring after entrance of trichlortriethylamine into a wound is much more severe. Here, the phenomena occurring as the result of absorption of the CWA are particularly pronounced. The effect of trichlortriethylamine in the form of vapors usually does not lead to the development of any considerable reaction on the part of the skin.

Involvement of the eyes. Trichlortriethylamine, after falling on the mucosa of the eye, produces an involvement of it and leads to the development of a general toxic process. The latent period of the effect thereby equals an average of two to three hours. At the end of this period the signs of conjunctivitis develop; lachrymation, photophobia and blepharospasm. Afterwards, keratitis occurs. In the more serious cases, particularly with the superimposition of a secondary infection, the other eye membranes are involved in the pathological process. The involvement occurs according to the type of suppurative-necrotic keratitis, which in a number of cases can terminate in atrophy of the eyeball.

Involvement of the Respiratory Organs. In its action on the respiratory organs, trichlortriethylamine, just like mustard gas, produces a series of pathological changes after a certain latent period. Afterwards, signs of rhinitis, laryngitis and tracheitis develop. In the more severe forms of intoxication the process spreads to the bronchi and the pulmonary parenchyma. The possibility exists of the development of bronchopneumonia and other complications. The general toxic symptoms resulting from the absorption of the CWA into the organism are quite pronounced.

Involvement of the Gastro-Intestinal Tract. Trichlortriethylamine involvements of the gastro-intestinal tract are in principle little different from the changes which are observed after the effect of mustard gas. Usually, after a latent period signs of gastroenteritis are observed: nausea, salivation, loss of appetite, vomiting, intestinal disorders. When the CWA enters in a larger quantity the occurrence of an ulcerative process is possible not only in the oral cavity but also on the mucosae of other sections of the gastro-intestinal tract. All these signs are accompanied by considerable general intoxication and by marked emaciation.

General-Toxic Effect of Trichlortriethylamine. Regardless of how trichlortriethylamine enters the organism, it can lead to the development of pronounced symptoms of general intoxication greater than after the action of mustard gas. Signs of general intoxication are characterized by involvement of the central nervous system, namely: the development of clonic and tonic convulsions and a disturbance in consciousness. In severe cases a comatose state develops. The circulation and respiration suffer considerably. Changes in the composition of the peripheral blood are characteristic: the occurrence of neutrophilic leucocytosis which is replaced by a marked reduction in the white blood corpuscles up to the development of aleukia with qualitative changes in the cytoplasm and nuclei of the cells. These changes resemble changes in the peripheral blood which are observed after the effect of ionizing radiation. In trichlortriethylamine intoxication, very frequently other organs and systems (heart, kidneys, liver) are involved in the pathologic process, and cachexia and marked general weakness develop. A fatal outcome occurs against the background of pronounced signs of a disturbance in the nervous system, hematopoiesis, circulation and respiration.

Mechanism of Action of Trichlortriethylamine. The mechanism of action of trichlortriethylamine is very complex and is not sufficiently clear at the present time. The viewpoint which has been most accepted is that trichlortriethylamine affects the nucleoproteins, particularly desoxyribonocleic acid, which is manifested by a disintegration of the nucleus and disturbances in the process of cell division, that is, of mitotic activity. These changes are particularly pronounced in cells with a high level of mitotic activity, particularly the formed elements of the blood, splenic cells, and cells of the bone marrow. At the same time, it is known that trichlortriethylamine is an enzyme poison with a broad range of action, which is manifested in the capacity of trichlortriethylamine of inactivating a series of vitally important enzyme systems (cholinesterase, etc.). It is possible that the disturbance in the nucleoprotein metabolism is conditioned by the enzymatic influence of trichlortriethylamine. However, this idea requires further confirmation.

Prophylaxis, First Aid and Treatment of Intoxications Produced by Trichlortriethylamine. The same measures recommended for the prophylaxis of mustard gas intoxication can be used for the prevention of trichlortriethylamine intoxications: the measures of individual and group protection (gas mask, protective clothing, shelters, etc.).

The methods of giving emergency aid and the subsequent treatment of skin involvements, involvements of the organs of respiration, vision, etc. which develop after direct contact with trichlortriethylamine are similar to those which are used in case of mustard gas involvement.

Concerning the measures directed at the fight against the signs of general intoxication produced by trichlortriethylamine, it should be kept in mind that the given CWA is an exceptionally toxic compound which affects many organs and systems, and therefore therapy should be combined, that is, directed at the recovery of the impaired physiological equilibrium of the organism as a whole. Thus, for example, for pronounced convulsions the use of soporific and sedative agents is recommended (barbiturates--luminal, amytal, etc.). Further, where necessary cardio-vascular agents should be used --camphor, caffeine, corasole [pentylenetetrazole], ephedrin, adrenaline, as well as glucose and other symptomatic methods of treatment. In cases of weakening of the respiration, substances should be prescribed which stimulate the respiratory center (carbogen [CO_2-O_2 mixture], cytitone).

Treatment of hematopoetic system changes deserves special attention. With this aim in view, blood transfusions and

other methods of stimulative therapy should be used.

Proper attention should be given to hygienic conditions, properly arranged diet, provision of the affected organism with an adequate quantity of vitamins.

Lewisite. Lewisite, chlorvinyldichlorarsine ($ClCH{=}CHAsCl_2$) is transparent liquid with a yellowish hue (chemically pure). Its specific gravity is 1.9; its boiling point is 190°. Lewisite possesses a characteristic geranium odor. The solubility of lewisite in water is slight; it dissolves much better in alcohol, benzine, benzol and other organic solvents; dissolves readily in fats and lipoids. As a result of the reaction with water, it hydrolyses with the formation of chlorvinylarsinoxide, which like lewisite itself, is a very toxic compound: $ClCH{=}CHAsCl_2 + H_2O \longrightarrow (ClCH{=}CH)AsO + 2HCl$.

Under the influence of such oxidants as potassium permangate, nitric acid and hydrogen peroxide, the arsenic atom is changed from a trivalent to a pentavalent condition; the compound formed is less toxic. Lewisite reacts actively with substances containing chlorine and also with strong bases, in consequence of which its toxicity is reduced.

In past wars lewisite was not used as a CWA; however, it is an exceptionally toxic compound, and in its toxicity it considerably exceeds the majority of the CWA previously used (with the exception of tabun and other CWA of similar type of action).

Lewisite is toxic for the organism in any state of aggregation: droplet, vapor, fog. Lewisite can penetrate into the body through the skin, gastro-intestinal tract, organs of respiration and others. An important characteristic of the effect of lewisite in contrast to other representatives of the group of persistent war gases is the particularly rapid absorption of it into the organism and the development of a general-toxic process, which under certain conditions can quite rapidly lead to a fatal outcome. It should be emphasized particularly that in the process of occurrence and development of toxic signs produced by lewisite the pathological changes occurring at the site of direct contact with the CWA (skin, mucosa of the respiratory tract, gastro-intestinal tract, eye) and the general-absorptive reactions of many organs and systems are interwoven.

The Effect of Absorption of Lewisite. An important charnot sufficiently clear at the present time. The viewpoint which has been most accepted is that trichlortriethylamine affects the nucleoproteins, particularly desoxyribonocleic acid, which is manifested by a disintegration of the nucleus and disturbances in the process of cell division, that is, of mitotic activity. These changes are particularly pronounced in cells with a high level of mitotic activity, particularly the formed elements of the blood, splenic cells, and cells of the bone marrow. At the same time, it is known that trichlortriethylamine is an enzyme poison with a broad range of action, which is manifested in the capacity of trichlortriethylamine of inactivating a series of vitally important enzyme systems (cholinesterase, etc.). It is possible that the disturbance in the nucleoprotein metabolism is conditioned by the enzymatic influence of trichlortriethylamine. However, this idea requires further confirmation.

Prophylaxis, First Aid and Treatment of Intoxications Produced by Trichlortriethylamine. The same measures recommended for the prophylaxis of mustard gas intoxication can be used for the prevention of trichlortriethylamine intoxications: the measures of individual and group protection (gas mask, protective clothing, shelters, etc.).

The methods of giving emergency aid and the subsequent treatment of skin involvements, involvements of the organs of respiration, vision, etc. which develop after direct contact with trichlortriethylamine are similar to those which are used in case of mustard gas involvement.

Concerning the measures directed at the fight against the signs of general intoxication produced by trichlortriethylamine, it should be kept in mind that the given CWA is an exceptionally toxic compound which affects many organs and systems, and therefore therapy should be combined, that is, directed at the recovery of the impaired physiological equilibrium of the organism as a whole. Thus, for example, for pronounced convulsions the use of soporific and sedative agents is recommended (barbiturates--luminal, amytal, etc,). Further, where necessary cardio-vascular agents should be used - camphor, caffeine, corasole [pentylenetetrazole], ephedrin, adrenaline, as well as glucose and other symptomatic methods of treatment. In cases of weakening of the respiration, substances should be prescribed which stimulate the respiratory center (carbogen [CO_2-O_2 mixture], cytitone).

Treatment of hematopoetic system changes deserves special attention. With this aim in view, blood transfusions and

other methods of stimulative therapy should be used.

Proper attention should be given to hygienic conditions, properly arranged diet, provision of the affected organism with an adequate quantity of vitamins.

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The Effect of Absorption of Lewisite. An important characteristic of lewisite is its capacity of penetrating rapidly from the site of application (skin, mucous membranes) into the blood and of exerting a general-toxic effect.

The intensity and rapidity of development of the general-toxic signs depend on a number of conditions (quantity of the CWA absorbed, the condition of the organism, etc.). Pathological changes of the central nervous system expressed in brief excitation with subsequent depression usually develop soon after the lewisite intoxication. The involvement of the cardio-vascular system with the gradual drop in blood pressure and the development of a pronounced state of collapse (Fig. 84) [Page 212 of Source] are characteristic.

Fig. 84. Blood Pressure in a Dog Exposed to the Effect of Arsenic.

The respiratory disorders are also considerable: at first, the respiratory rate is increased, and respiration remains quite deep for a certain time; afterwards, it assumes an irregular superficial character. In lewisite intoxication there are regular changes in the blood which are expressed in an increase in the number of erythrocytes and the quantity of hemoglobin (thickening of the blood), in leucocytosis which is replaced by leucopenia (Fig. 85) [Page 213 of Source]. Also, biochemical changes in the blood are observed, an increase in the content of lactic and pyruvic acids and of sugar; the excretion of considerable quantities of total nitrogen and urea nitrogen attests to the disturbances in the metabolic processes.

Fig. 85. Certain Indices of the Blood Composition in Lewisite Intoxication.

In the case of lewisite involvement a number of morphological changes occur in the internal organs: a dilatation of the cerebral vessels, marked congestion, hemorrhages particularly under the endocardium and in different parts of the cardiac muscle; degenerative changes are noted in the liver, kidneys and other organs. The picture of the general-toxic effect of lewisite is very similar to that of arsenic intoxication.

Lewisite Involvement of the Skin. Lewisite in the droplet form very rapidly produces a sensation of pain and burning when acting on the skin. After this, hyperemia appears (first stage of involvement), which is not confined to the site of contact with the CWA. Then, edema of the subcutaneous tissue develops, the pain increases, and itching occurs. With small quantities of lewisite the signs of inflammation are not pronounced and gradually disappear. With more severe skin involvements blisters develop (second stage of involvement). First, the blisters are solitary and small; afterwards (after 10-15 hours) they become confluent, and their serous contents acquire an opalescent character. At the end of approximately two days the edema begins to decrease, the contents of the blister are resorbed, crusts form; after these drop off there is no pigmentation. In cases where infection is superimposed the inflammatory process acquires an extensive ulcerative-necrotic character (third stage of involvement) with a considerable number of hemorrhages. The process of regeneration proceeds quite slowly and terminates in the formation of a scar.

The vapors of lewisite produce similar involvements on the skin; however, the intensity of their development is not so great. The latent period is also more prolonged (two to six hours). Penetration of the CWA into a wound surface markedly aggravates the course of the main process.

The skin changes described above which are observed after the effect of lewisite are similar to the involvements from mustard gas but have distinguishing features, specifically, a more vigorous development and a more rapid course of the reparative processes in the absence of infection.

Lewisite Involvement of the Respiratory Organs. With the penetration of lewisite into the respiratory passages the development of the pathological process considerably resembles the course of the similar process which occurs after the effect of lewisite and partly that following asphyxiant CWA. Lewisite vapors produce an irritation of the mucosa of the upper respiratory passages, which is accompanied by a number of symptoms (salivation, raspiness in the throat, cough, etc.), which appear as early as the period of inhalation of the CWA vapors in air.

Soon the toxic process spreads to other parts of the respiratory organs. After the inhalation of lewisite in high concentrations, and also in consequence of its absorption

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from the surface of the skin, more or less pronounced pulmonary edema may develop. During the late periods of intoxication the development of bronchopneumonia, pulmonary abscess, etc. is possible as the result of the superimposition of infection.

Lewisite Involvement of the Eyes. The direct contact of lewisite in vapor or liquid states with the sensory nerve endings of the ocular mucosa produces considerable pain. Then, inflammation develops, which with low concentrations may be limited to the signs of conjunctivitis. When large doses of lewisite enter into the pathological process, all the eye membranes are involved, and panophthalmia develops.

With involvement of the eyes by lewisite in a vapor form, the pathological signs are usually limited to conjunctivitis (lachrymation, photophobia, blepharospasm, etc.). Under these conditions, keratitis rarely develops.

Contact with a considerable quantity of lewisite in droplet form leads to the development of conjunctivitis, keratitis, iridocyclitis, and other tissues of the eye suffer as well. The development of a severe toxic process complicated by infection can lead to complete loss of vision.

Lewisite Involvement of the Gastro-Intestinal Tract. Lewisite can penetrate into the stomach in contaminated water, food products, or by means of the swallowing of saliva and phlegm containing the CWA. Here, the signs of gastritis usually develop promptly. Afterwards, enterocolitis is added. The intensity of the development of the pathological signs will depend on the quantity of lewisite entering the stomach.

Intoxication with large doses of lewisite is accompanied not only by changes on the part of the gastro-intestinal tract but also by the development of general-toxic signs (disorder of circulation, hemoconcentration, disturbance of metabolic processes).

Mechanism of Action of Lewisite. Regardless of how lewisite enters the organism, it is absorbed rapidly into the general circulation and spreads throughout the organs and tissues. On coming into contact with the tissue fluids, lewisite undergoes hydrolysis with the formation of hydrochloric acid and chlorvinylarsinoxide (ClCH·CHAsO), which is a very toxic substance. The toxic properties of lewisite and of its conversion products (arsinoxide) are produced by the effect of the trivalent arsenic in their structure.

According to modern concepts, the basis of the toxic effect of arsenic is its blocking effect on the sulfhydryl groups (SH) of a number of enzymes which carry out the most important physiological functions of the organism.

There are reports that arsenic compounds act selectively on the sulfhydryl groups of the protein component of the pyruvate-oxidase system which carries out the oxidation of pyruvic acid in the blood and tissues of animals. The latter leads to deep-seated disorders of carbohydrate metabolism as a whole.

The reaction of trivalent arsenic with the thiol groups of enzymes can occur in the following direction:

Such a concept of the mechanism of action of arsenic-containing compounds was the theoretical basis for the search for active antidote-therapeutic agents containing sulfhydryl groups, the therapeutic effect of which was based on competitive relations with the toxin. The dithiols (BAL, unithiol), compounds containing active sulfhydryl groups proved to be such substances.

Prophylaxis, First Aid and Treatment of Lewisite Intoxications. Emergency therapy and also measures of chemical protection used for chlorvinyldichlorarsine (lewisite) intoxication are similar to those which are recommended for mustard gas and nitrogen mustard.

After lewisite falls on the skin, the skin should be treated with a solution of the gas casualty first aid kit. Tincture of iodine (five percent solution) and a number of oxidizing agents (potassium permanganate), hydrogen peroxide and others others) also possess gas-decontaminating properties. Urea peroxide (hydroperite) is one of the agents which detoxify lewisite. Usually, a 40 percent aqueous solution of this preparation is used; the skin is treated with it no less than five minutes.

Timely treatment (five to 15 minutes after the contact with lewisite) with the substances named can completely prevent the absorption of the CWA.

Particularly prompt intervention is required for the entrance of lewisite into the respiratory organs, mucosa of the eye, etc. In such cases, the CWA should be removed as quickly as possible by irrigation of the eye or upper respiratory passages with aqueous solutions of soda and boric acid (two percent), potassium permanganate (0.05 percent), chloramine (0.5 percent) or simply with water.

Penetration of lewisite into the digestive tract requires the use of adsorbents, emetics, irrigation and also antidoti arsenici in a dose of one tablespoon repeatedly every 10-20 minutes.

Subsequent therapy of the involved skin, eyes, respiratory organs and gastro-intestinal tract is very little different from the therapeutic measures used for mustard gas intoxications.

In combatting the general-toxic signs resulting from lewisite intoxication, the antidotes of arsenic and of heavy metals may be recommended--preparations containing active sulfhydryl groups. The detoxification of arsenic and the most rapid elimination of it from the body are achieved by these substances.

The antidotes used do not exclude the use of other measures of pathogenetic and symptomatic therapy. Among them are substances which stimulate the function of the cardiovascular system (mesaton [meta-oxyphenyl methylaminoethanol hydrochloride: sympathominetic], ephedrin, adrenaline with blucose, corasole, etc.). In the event of developing hemoconcentrations, bleeding with the administration of a hypertonic solution of glucose is recommended. Magnesium preparations exert a favorable effect on the central nervous system.

The creation of good hygienic conditions, rest, appropriate diet and the administration of oxygen also contribute to recovery.

ASPHYXIANT CWA

Asphyxiant CWA (phosgene, diphosgene, chlorine, chlorpicrin, nitrous oxide and others) are characterized by the cap-

acity of producing pathological changes in the respiratory organs, as a result of which toxic pulmonary edema may develop. Certain of these substances (chlorine, chlorpicrin and others) produce considerable irritative phenomena on direct contact with the mucosa of the upper respiratory passages and of the eye. Chlorine and chlorpicrin lead to the development of a pronounced toxic process quite rapidly after contact with them; phosgene and diphosgene do not produce the whole complex of pathological signs characteristic of asphyxiant CWA immediately but rather have a definite latent period of action. Phosgene and diphosgene are of the greatest toxicological interest.

Phosgene and Diphosgene. Physico-Chemical Properties and Toxicity

Phosgene (carbon chloroxide, carbonyl chloride--$COCl_2$) is a colorless, volatile liquid. Its specific gravity is 1.4; its boiling point is 8.2°. With increase in the temperature, phosgene is converted into a gaseous substance which is more than 3.5 times as heavy as air. Phosgene possesses an odor of rotten hay or of moldy leaves. It dissolves slightly in water, but gradually hydrolyses on contact with it, as a result of which hydrogen chloride and carbon dioxide are given off. Phosgene dissolves readily in certain organic solvents, reacts actively with alkalis, thereby losing its toxicity.

Diphosgene (trichlormethyl ether of chlorocarbonic acid)-- $CO\langle^{OCCl_3}_{Cl}$ in chemically pure form is a colorless liquid. Its specific gravity is 1.65. Diphosgene boils at a temperature of 128°, and its temperature of fusion is -57°. In comparison with phosgene diphosgene is a more persistent substance, and its vapors are almost seven times heavier than air. On reacting with water disphosgene undergoes hydrolysis, but the reaction proceeds more sluggishly than with phosgene. Diphosgene is readily soluble in certain organic solvents, and like phosgene it reacts actively with bases and thereby loses its toxic properties.

Phosgene and diphosgene are very toxic substances. Inhalation of air containing 0.2-0.3 milligrams per liter of phosgene or diphosgene for a period of half an hour and in certain cases even for 15-20 minutes can produce a severe toxic process with a fatal outcome. The intensity of the involvement is determined not only by the concentration of CWA and by the exposure time but also by the condition of the body. Mild, moderate and severe clinical forms of intoxication are distinguished.

Clinical Picture of Intoxication. The effect of slight concentrations of phosgene and diphosgene can be unnoticed or can be detected in the form of slight and very transitory signs of irritation (dyspnea, mild lachrymation, slight salivation).

After the effect of higher concentrations the symptoms indicated appear in much more marked form; in addition, the development of malaise, general weakness, the occurrence of pain in the chest, sometimes headache, nausea, irritation of the mucous membrane of the eye are possible. Taking the patients out of the contaminated area leads to the disappearance of the signs of intoxication. For a certain time the patients usually do not offer any complaints--the latent period of action of the CWA occurs. However, the apparent state of well-being is only relative, because changes develop in the organism which are diagnosed with difficulty. On objective examination a certain increase in frequency of respiration and slowing of the pulse is observed. Many authors ascribe important diagnostic significance to this symptom. In a number of patients a slight reduction in arterial pressure, in temperature, and a hemodilution are noted. The duration of the latent period equals approximately four to seven hours; however, it can be much shorter, or, conversely, longer.

At the end of the latent period of the CWA suddenly, as though right during a state of complete well-being, the condition of those intoxicated by phosgene (diphosgene) deteriorates considerably; the respiration increases in frequency, becomes superficial, the dyspnea becomes progressively more intense, and cyanosis of the lips, nose and ears appears; marked general weakness, cough, at first dry and then with the expectoration of a frothy fluid (pulmonary edema) develop. With the development of the toxic pulmonary edema the quantity of sputum in individual patients reaches two liters a day. On examination of the lungs, considerable changes are found. On percussion, the lower borders of the lungs are found in a lower position with a considerable impairment of mobility, and a pronounced amphoric or tympanitic sound is noted which attests to the occurrence of emphysema and atelectasis of the lungs. On auscultation, a considerable number of moist rales of the most diverse calibers are noted. The

heart sounds are muffled; however, there are no data as yet indicating the considerable disturbance of function of the cardio-vascular system. On the part of the blood there is noted a neutrophilic leucocytosis with a simultaneous lymphopenia and eosinopenia. In consequence of the hemoconcentration the red blood count reaches seven to eight million, and the hemoglobin content, 100 percent or more. At the same time, the viscocity and coagulability of the blood are increased. In certain patients a state of depression, disturbance of consciousness, signs of enteritis, oliguria, etc. are observed.

The picture of phosgene (or diphosgene) intoxication presented above is characteristic of the cyanotic form of anoxemia, that is, of the condition in which severe dyspnea, cyanosis of the mucous membranes and skin predominate, but in which pronounced cardio-vascular disorders are absent. This condition may change into an even more threatening one (gray form of anoxemia) which is characterized not only by marked dyspnea but also by a considerable disorder of activity of the cardio-vascular system (drop in blood pressure, thready, arrhythmic pulse, etc.). The oxygen content drops markedly both in the arterial and in the venous blood. Here, the patients usually lose consciousness, and the color of the face and skin acquire an ocherous hue. This form of anoxemia is very dangerous and requires emergency measures.

The development of toxic pulmonary edema reaches a maximum after approximately 15-20 hours. If the patient does not die at the climax of the pulmonary edema with considerable signs of anoxia and a disorder of the cardio-vascular activity, then the process of resolution (recovery stage) occurs beginning with the third or fourth day. The pulmonary edema gradually decreases, the imparied gas exchange returns to normal, the cardiac activity improves as do also the functions of the other organs. At the same time, in certain patients an aggravation of the process may occur as a result of the superimposition of infection (development of bronchopneumonia, pleurisy and other complications). At later periods after the occurrence of the intoxication remote sequelae are possible in the form of bronchiectasis, bronchial stenosis, and pulmonary fibrosis which can lead to a loss of the ability to work.

Certain Problems in the Pathogenesis of Intoxication by Phosgene and Diphosgene

In the general complex of pathological phenomena occurring in phosgene or diphosgene intoxication chief importance is ascribed to the development of toxic pulmonary edema with all its sequelae (disturbance of gas exchange, hemoconcentration, cardio-vascular disorders, etc.). The mechanisms of development of these phenomena have not been finally clarified at the present time. The majority of research workers regard the toxic pulmonary edema as the result of a change in the regulation of the water balance between the blood and the tissues, of a disturbance in the permeability of the pulmonary capillaries as a result of which the liquid part of the blood exudes and fills the pulmonary alveoli.

With the development of the toxic pulmonary edema the normal gas-exchange conditions between the blood and the alveolar air are disturbed. With the filling of the alveoli with edema fluid the diffusion of alveolar oxygen becomes progressively more difficult, which leads to anoxemia. This is expressed in a progressive reduction in the oxygen saturation of the arterial and venous blood. Thus, the oxygen content in the arterial blood can reach 10 volumes percent or less compared with the normal of 17-20 volumes percent, while in venous blood it can go down still further. Because of this, the arterio-venous difference is increased. Signs of anoxemia can be increased in connection with the disorders of the cardio-vascular system which occur, stasis phenomena, etc.). With the progression of the process the content of carbon dioxide in the blood can increase, while in the terminal period it can decrease notably (Fig. 85 [Page 220 of Source]).

Fig. 86. Gas Content of Blood of Dog in Diphosgene Intoxication (according to A. I. Cherkes).

Certain Characteristics of the Effect of Chlorine and Chlorpicrin. The clinical picture which is observed from the effect of other asphyxiant CWA on the body, particularly of chlorine and chlorpicrin, to a great extent resembles the picture of the intoxication produced by phosgene (diphosgene). However, there are also a number of distinguishing features. First of all, chlorine and chlorpicrin possess more pronounced irritant effects on the sensory nerve endings of the respiratory passages. In addition, chlorpicrin produces a marked irritation of the eyes and can lead to the development of keratitis.

Chlorine and chlorpicrin intoxication very rapidly lead to the development of toxic pulmonary edema, but the intensity of it is less than after phosgene or diphosgene intoxication (Fig. 87 [Page 221 of Source]). It should be emphasized that the process here usually proceeds without any stage of false well being (latent period). Just as in the case of phosgene and diphosgene intoxication, chlorine and chlorpicrin produce acute anoxia and other pathological signs characteristic of the effect of this group of substances.

Fig. 87. Pulmonary Edema and Cardiac Dilatation in a Dog Exposed to the Effect of Chlorpicrin. (According to N. A. Soshestvenskiy).

Pathological Picture of Intoxication with Asphyxiant CWA. The most characteristic pathological changes after intoxication with asphyxiant CWA are observed in cases of death occurring during the course of the first two days. These changes are localized chiefly to the respiratory tract; in cases of phosgene (or diphosgene) intoxication they are chiefly in the lower sections of the respiratory tract (pulmonary edema -- Fig. 88 [Page 222 of Source]). Here, the lungs are usually three to five times larger than their normal volume. Their surfaces are mottled as a result of the presence of edema, atelectasis, emphysema and hemorrhages. On section, a large quantity of bloody-foamy fluid exudes from the parenchyma. No other changes are found in the upper and middle sections of the respiratory tract aside from hyperemia of the mucosa and solitary punctate hemorrhages.

Fig. 88. Toxic Pulmonary Edema in Diphosgene Intoxication. (According to M. I. Nemenov).

Significant inflammatory as well as necrotic changes in the trachea and bronchi are characteristic of chlorine and chlorpicrin. In cases of rapid death from chlorine intoxication, no pulmonary edema is found, but signs are observed which indicate a chemical burn of the lungs. The mucosa of the respiratory tract is usually necrotic, and the lung tissue is dry and friable.

In intoxication by asphyxiant CWA changes are observed in the heart (dilatation, particularly on the right), in the

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cardiac muscle (solitary hemorrhages), in the liver, kidney and spleen (congestion). On dissecting the skull, edema of the meninges is noted and a marked congestion of the cerebral vessels and possible hemorrhages.

On autopsy of cadavers of persons who died in the later periods of intoxication (10-14 days), pneumonia, pleurisy and other complications are found in the lungs.

Prophylaxis, First Aid and Treatment of Those Affected by Asphyxiant CWA. An important prophylactic measure which can prevent the entrance of CWA into the body is the use of a gas mask or refuge in a shelter. The rendering of first aid in cases involved by asphyxiant CWA amounts to the following: the patient should be removed (on a litter!) from the contaminated area, after first putting a gas mask on him; the patient should be given complete rest, because even slight physical strain contributes to an increase in the consumption of oxygen, a deficit of which already exists in the body in the initial stage of intoxication. Those intoxicated should be kept warm with hot water bottles, covered warmly, and given a hot drink at the first opportunity. The CWA can settle on the patient's clothing; therefore, it should be changed as quickly as possible. Rinsing with soda solution is recommended for reducing the signs of irritation of the respiratory passages and the ocular mucosa; in case of pronounced signs of irritation of the eyes, novocaine with adrenalin and other sedatives are indicated. The administration of oxygen by means of various apparatus -- oxygen inhaler (Fig. 89 [Page 223 of Source]) and others -- is indicated even in early periods of intoxication.

Fig. 89. Oxygen Inhaler (KN-3): 1--tank with compressed oxygen; 2--shut-off valve; 3--reducing valve connected to tank by means of a stem with a slip-over nut (4); 5--finimeter [?]; 6--injector screwed into the body of the reducer; 7--regulating disc; 8--breathing bag; 9--cross piece connected with the injector of the reducer by means of a rubber tube (10); 11--two corrugated hoses connected to the limbs (12) of the cross piece; 13--two masks connected with the free ends of the hoses.

After first aid is given, the patients should be sent to the hospital for further treatment.

Medical practice has at its disposal a number of measures for pathogenetic therapy which are effective, to a certain degree, in combatting toxic pulmonary edema, circulatory disturbances and other pathological changes developing in cases of asphyxiant CWA involvement. The patient should be given maximum rest, he should be kept warm and supplied with oxygen in order to combat the developing anoxia. Usually, inhalations of pure oxygen or air oxygen mixtures (40 to 60 percent) are used, and in cases of pronounced signs of the gray form of anoxia the oxygen should be given with five to seven percent carbon dioxide (carbogen). The duration of the use of oxygen depends on the condition of the patient. Properly organized oxygen therapy contributes to the restoration of respiration to normal and to an improvement in cardiac activity, and also eliminates a number of disturbances caused by the CWA asphyxiant effect.

In parallel with the measures directed at the elimination of signs of anoxia agents are used for preventing and combatting developing toxic edema of the lungs. Ten percent calcium chloride and 10 percent calcium gluconate solution are such agents. Intravenous injections of these solutions during the pre-edema period contribute to a condensation of the tissue colloids and reduce the permeability of the pulmonary vessels.

Among the measures directed at preventing and combatting toxic pulmonary edema mention may be made of bleeding with the subsequent administration of a hypertonic solution of glucose (25 percent, 50-100 cubic centimeters). In the initial stage of the intoxication the bleeding (up to 500 cubic centimeters depending on the condition) may readily be performed by means of venipuncture. With the development of pulmonary edema the removal of blood is usually accomplished by means of venesection. During the bleeding process the condition of the cardio-vascular system should be watched, and where needed one cubic centimeter of 20 percent camphor solution, caffeine or one cubic centimeter of 10 percent corasole solution should be injected subcutaneously. With considerable deterioration in the function of the heart active agents are prescribed which tonicize the cardiac activity. Bleeding performed in time usually gives a good therapeutic effect, because it contributes to bringing tissue fluid back into the circulation in consequence of which the quantity of circulating blood is increased, and its viscocity is reduced. Also, toxic products formed in the body are eliminated in the blood which is removed. Bleeding can not be

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used in all the periods of development of intoxication. Thus, in the stage of gray anoxemia, when, in addition to the toxic pulmonary edema, there are pronounced signs of cardio-vascular insufficiency (shock), bleeding cannot be performed. In such cases the intravenous administration of strophanthin needs to be used in addition to the cardiac agents mentioned above.

Glucose, which, by increasing the osmotic pressure of the blood, contributes to the return of fluid from the tissues to the blood stream, occupies a special place in the treatment of those affected by asphyxiant CWA. Glucose also improves metabolism, increases the blood pressure and diuresis.

In the event of the development of complications (bronchopneumonia, pleurisy), the use of antibiotics, sulfonamides, mustard plasters, and cardiac agents is recommended. During the period of resolution of the process, expectorant agents are prescribed. Treatment of other complications of the lungs as well as of the pathological signs of the nervous system and gastrointestinal tract is carried out according to the general rules of therapy. Properly organized hygienic conditions, general routine and diet are of importance in the success of treatment.

Phosgenoxime. In looking for new CWA, foreign military specialists have directed their attention to the oximes, which possess a certain toxic effect on the body. The addition of one of the halides (chlorine) to the oximes increases their toxic properties considerably.

Phosgenoxime (Cl_2=C=N=OH) is a white crystalline compound with quite an unpleasant, irritating odor; its boiling point is 129°. It dissolves in water without any particularly difficulty.

Phosgenoxime possesses a many-sided effect, uniting certain qualities of the asphyxiants, vesicants and general-toxic CWA; however, its toxic effect on the body is less pronounced than the effect of the CWA previously described.

Clinical Picture of Phosgenoxime Intoxication. Phosgenoxime exerts a toxic effect in the droplet and vapor states. After entering the body through the skin and mucosae, phosgenoxime produces a number of pathological changes in various organs and systems.

Direct contact of phosgenoxime drops with the skin leads to the development of an erythematous and sometimes also to a bullous form of dermatitis. The development of superficial necrosis is possible. The regeneration of the affected tissues proceeds sluggishly. Phosgenoxime does not possess any latent period of action: direct contact of it with the skin produces first pain and then itching. The development of a superficial necrosis is possible.

The effect of phosgenoxime in the vapor state does not usually lead to any significant skin changes. Even after a prolonged exposure the process, as a rule, is of a superficial nature; less often, a more deep-seated inflammation develops. In such cases, healing proceeds much more actively than after involvement with the liquid form of phosgenoxime. At the same time, the inhalation of phosgenoxime vapors markedly irritates the mucosa and can lead to the development of inflammatory signs not only in the upper parts of the respiratory passages but also in the lower parts. Not uncommonly, toxic pulmonary edema can develop. The eye is very sensitive to phosgenoxime.

The penetration of phosgenoxime into the gastro-intestinal tract is possible. In such cases gastroenteritis develops. In the very severe forms of involvement an ulcerative-necrotic process occurs.

Phosgenoxime is readily and rapidly absorbed into the body from the surface of the skin and mucosae and leads to the development of general-toxic signs: involvement of the nervous and cardio-vascular systems, kidneys and other organs.

Prophylaxis, First Aid and Treatment. Prophylaxis of phosgenoxime intoxications consists of the use of a gas mask and other known measures of protection.

Contact of phosgenoxime with the mucosa of the eye, respiratory organs or entrance into the gastro-intestinal tract, just as in the case of the other CWA, requires prompt intervention (see mustard gas).

In the case of developing pulmonary edema, bleeding is indicated with the subsequent administration of hypertonic glucose solution (25-40 percent, 50-100 cubic centimeters), rest, oxygen, active cardiac agents and other measures successfully used for intoxication by asphyxiant CWA.

In the event of contact of phosgenoxime in the form of drops with the skin the prompt treatment of the skin surface is necessary. For this purpose, chloramine and the contents of the gas casualty first aid kit may be used. Ammonia (10 percent solution) is an active gas-decontaminating agent. When the treatment is not timely and not sufficiently accurate skin involvements may develop which should be given treatment like that used for intoxication by other persistent CWA. Various symptomatic agents are used for combatting the signs of general intoxication.

IRRITANT CWA

The toxic effect of the irritant CWA consists principally of their influence on the sensory nerve endings of the ocular and respiratory tract mucosae. After being absorbed into the body, the irritants are capable of producing signs of general intoxication under certain conditions.

Usually, the irritant CWA in low concentrations which are, nevertheless, adequate to put an enemy out of commission, do not lead to any considerable changes in the body, and the process is limited to a reflex effect without pronounced organic disturbances. Nevertheless, the chemical compounds belonging in this group have not lost their significance as CWA in view of their capacity of rendering a considerable number of personnel unfit for duty. Most often, the irritant CWA are used in smoke or fog states.

Irritant CWA are customarily divided into two groups: chemical compounds which affect the nerve endings of the oscular--lachrymators--and substances which affect the nerve endings of the upper respiratory mucosa--the irritant arsines (sternutators).

Lacrimators

Among the CWA with a lacrimatory effect are chloracetophenone, brombenzylcyanide, bromacetone, chloracetone, benzyl bromide and benzyl chloride, etc. In their chemical structure they belong to the groups of the halide-substituted aliphatic hydrocarbons and of the halide-substituted aromatic hydrocarbons. The compounds named are solid or liquid. Their slight solubility in organic solvents and poor solubility in water are common to them. Brombenzylcyanide and chloracetophenone chiefly are of considerable practical interest.

Both substances lead to irritative signs in negligible concentrations (0.003 milligrams per liter).

Brombenzylcyanide ($C_6H_5CHBrCN$) in the pure form is a colorless crystalline substance. It has a special almond odor. Its specific gravity is 1.52. Brombenzylcyanide is a stable compound which can maintain its capacity of producing an irritating effect for many days.

Chloracetophenone ($C_6H_5COCH_2Cl$) in its purified form is a crystalline compound which possesses the odor of violets. Its boiling point is higher than that of brombenzylcyanide and is equal to 245°. Just as the other representatives of the group of lacrimators, brombenzylcyanide and chloracetophenone specifically dissolve poorly in water and slightly in many organic solvents.

Clinical Picture of Intoxication. The lacrimators do not have any latent period. After entering the eye they lead to considerable signs of irritation of the nerve endings (Fig. 90) located in the conjunctival and corneal membranes, which is expressed in marked pain and tearing, blepharospasm and other signs. When the effect of the lacrimators is brief and in low concentrations the pathological signs disappear after removal of the patients from the area of contamination; in the case of the more severe intoxications the signs of conjunctivitis may persist for several days, after which they gradually become quiescent. In particularly serious cases considerable changes are observed in the other ocular membranes also--the development of keratitis, etc., which can lead to a reduction in vision and invalidism of those affected. In the presence of high concentrations of the CWA in the air a number of pathological changes of the respiratory organs, skin and nervous system are added to the eye involvements. In individual cases, the development of pulmonary edema can be observed.

Fig. 90. Diagram of Winking Reflexes of Lids and of Lacrimation in Involvement by Lacrimators (according to Eder and Easton):

- - - -sensory pathways;
_______motor pathways.

First Aid and Treatment of Those Affected. Patients who

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have been exposed to the effect of lacrimators should be removed rapidly from the contaminated area, after first putting a gas mask on them. Emergency care consists of the immediate repeated treatment of the eyes with two percent aqueous soda solution, boric acid or pure water.

In order to reduce the unpleasant subjective sensations (photophobia, lacrimation, pain) the patients should use protective glasses and also should use various symptomatic agents: drops of atropine (one percent solution), dionine, dicaine (one percent solution) and others. In cases where there is a superimposed infection antibiotics, albucid [sulfacetamide], and systematic treatment of the eyes with antiseptic solutions are recommended. Further treatment is given by the oculist.

Irritant CWA (Sternutators)

This group of CWA includes a number of chemical compounds which contain chiefly trivalent arsenic. Depending on the chemical structure, the CWA of this group usually are divided into arsine derivatives of the aromatic series (diphenylchlorarsine, diphenylcyanarsine, phenarsazinehydrochloride) and of the aliphatic series (ethyldichlorarsine, methyldichlorarsine).

After falling on the mucosa of the upper respiratory tract in the form of vapors or smoke, the compounds mentioned produce a series of reflex changes (pain in the chest, cough, obstinate sneezing, etc.). In addition, these CWA, like other arsenic-containing substances, are capable of exerting a general absorptive effect. The arsines of the aromatic series possess the greatest irritant effects.

Diphenylchlorarsine--$(C_6H_5)_2AsCl$ consists of white crystals; its specific gravity is 1.4; its boiling point is over 320°. Like the other CWA of irritant effect it dissolves to an insignificant extent in water; on reacting with it, it gradually undergoes hydrolysis. Diphenylchlorarsine is soluble in many organic solvents.

Diphenylcyanarsine--$(C_6H_5)AsCN$--a crystalline compound possessing an almond odor. Its specific gravity is 1.45; its boiling point, 340°. The solubility of diphenylcyanarsine in water is negligible. It undergoes hydrolysis very slowly. The reaction of diphenylcyanarsine with active oxidizing agents leads to a considerable reduction in its toxic

properties.

Phenarsazinehydrochloride--$NH(C_6H_4)_2AsCl$--adamsite, consists of yellow crystals; its specific gravity is 1.65; its boiling point is over 400°. In water it is practically insoluble, and dissolves poorly even in organic solvents. In its effect on the living organism it resembles diphenylchlorarsine but possesses a more pronounced irritant effect.

Clinical Picture of Intoxication--The intensity of the development of the toxic process from the effect of irritant arsines on the body, like that of the other CWA, depends on the concentration of the substance, the time of its action and the condition of the body. Arsines, after coming into contact with the respiratory organs in the form of a smoke or fog, very rapidly lead to oppressive signs of irritation. This is expressed in raspiness in the throat, sneezing, the excretion of mucus from the nose, dry cough, headache and also in painful sensations in the retrosternal area, in the jaws and teeth. Therefore, both secretory and motor reflexes occur. These signs may be intensified even a certain time (half-hour) after removal of the patients from the contaminated atmosphere. Reflex respiratory changes in the form of slowing of respiration as well as disturbances of the cardiovascular system (Fig. 91 [Page 229 of Source]) are observed from the irritation of nerve endings of the upper respiratory tract and, particularly, of the trigeminal nerve. Afterwards, All the signs mentioned decrease, without leaving any aftereffects. In the severe forms of intoxication the signs of stimulation are more pronounced, and the process may also extend to the lower sections of the respiratory tract, leading to severe complications up to the development of pulmonary edema. Also, changes are observed in the central nervous system which are expressed in disorders of the psyche and of consciousness, in a disturbance of coordination of movement, development of anesthesia and others. The manifestations of intoxication enumerated above are of a reversible character in the majority of cases. It should be kept in mind that the arsines possess the capacity of exerting a toxic effect not only after coming into contact with the respiratory organs but also through their effect on the skin, eye and gastrointestinal tract. However, most often the pathological signs of the organs mentioned are limited to hyperemia, edema and skin itching, lacrimation as well as dyspeptic symptoms.

Fig. 91: Sensory-Motor Reflexes After Entrance of CWA into

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Respiratory Passages (according to Eder and Easton):

- - - -sensory pathways;
______motor pathways

First Aid and Treatment of Patients. In the case of intoxication by sternutators first aid amounts primarily to an evacuation of the patient from the contaminated area. For the purpose of reducing the symptoms of irritation of the upper sections of the respiratory tract repeated gargling with soda or water solutions is required. With this aim in view, the inhalation of the anti-smoke mixture of the following composition is recommended:

Rx Chloroformii
Spiritvi vini rectificati aa 40.0
Aetheris aethylici 20.0
Liq. Ammoniii caustici gtt V

The anti-smoke mixture should be inhaled for two to four minutes; if needed the inhalation of it may be repeated.

In halations of menthol, eucalyptus, etc. are not uncommonly used for pronounced signs of irritation. Irritation of the respiratory tract is often accompanied by quite severe headaches, unpleasant sensations in the chest, etc. These signs can be eliminated by analgesic agents--pyramidon, antipyrine, phenacetin and analgine [1-phenyl-2,3-dimethyl-5-pyrazolone-4-methylaminoethylene sodium sulfate]. Pathological signs produced by the absorptive effect of the CWA require special treatment, which is not much different from the therapy of intoxications with the arsenicals of the lewisite type.

TECHNICAL FLUIDS

Among the technical fluids are chemical compounds (methylalcohol, ethylene glycol, petraethyl lead and others), which are used very extensively both in war and peace time in various branches of industry and for various purposes. The technical fluids which are utilized in the capacity of agents possessing the capacity of lowering the temperature of the freezing of refrigerant mixtures in airplane radiators, tank radiators, etc., deserves special attention as does also the application of some of them as antiknock compounds. In view of the fact that alcohol is included in the composition of a

number of technical fluids (antifreezes and others), people have tried to use them instead of alcohol for drinking. As a result of this a more or less pronounced intoxication may develop which frequently terminates in a fatal outcome or in invalidism of the patient.

Methylalcohol (Alcohol methylicus)--CH_3OH (wood alcohol, methanol, carbinol). In pure form is a transparent colorless slightly volatile liquid with the specific odor of alcohol. Unpurified methylalcohol is distinguished by an unpleasant odor, which is produced by its content of by-products. Methylalcohol is inflammable and burns. Its boiling point is +64.7°; it solidifies at a temperature of -97.8°. Methylalcohol can be mixed readily with water, ethylalcohol, acetone and other organic solvents. It serves as a solvent for oils resins, rubber and dyes.

Methylalcohol has attained extensive application in various branches of industry. It is utilized as a solvent in the production of lacs, organic dyes, gum mastic, drying oils and is often used also to keep water from freezing in the radiators of internal combustion motors, because it is included in a number of antifreezes. Pure methylalcohol is of no less importance in the preparation of certain chemical-pharmaceutical preparations.

The toxicity of methylalcohol extends over a broad range and to a considerable degree depends on the individual sensitivity of the body. In certain people the consumption of even several milliliters (less than 10 ml.) of methylalcohol can lead to development of intoxication. The minimum quantity of methylalcohol which can produce death of a person is considered to be 100 milliliters. However, the use of an even greater portion of methylalcohol (400 to 500 ml.) in individual cases can be tolerated without serious toxic signs.

Methylalcohol can enter the body through the various routes: through the gastro-intestinal tract, respiratory organs and skin. Most frequently methylalcohol intoxications are observed when it is used in the capacity of an alcoholic beverage.

Clinical Picture of Acute Intoxication. Very shortly after the consumption of even a small portion of the poison nausea and vomiting can appear as well as signs characteristic of alcoholic intoxication. In the majority of cases the clinical signs of intoxication are found after a certain period of time (period of the latent effect; on the average, 10-

16 hours). During the period of the latent effect of methylalcohol the patient feels relatively good, but on objective examination a dilatation of the pupils, increase in frequency of the heart, etc., are noted. At the end of the latent period the patients' complaint usually amount to headache, dizziness, general weakness, sleepyness, nausea, vomiting, etc. Changes referable to the eye are particularly characteristic of methylalcohol intoxication. In mild cases of intoxication the eye involvement amounts to the sensation that everything around is seen through a fog or screen. Objectively only a certain dilatation of the pupils is found. The mild form of intoxication with methylalcohol usually ends favorably.

In the more serious cases of intoxication the same clinical signs are seen but manifested to a greater degree. Eye changes are particularly significant. Therefore, certain authors call this form of intoxication ophthalmic. Pathological signs of the eyes develop either gradually or in a stormy fashion; however, in both cases a marked decrease in visual acuity or a complete loss of it is observed as a result of atrophy of the optic nerve (Figs. 92, 93 [Page 233 of Source]).

Fig. 92. Inflammation of the Optic Nerve in Methylalcohol Intoxication.

Fig. 93. Atrophy of the Optic Nerve in Methylalcohol Intoxication.

In cases of severe intoxication with methylalcohol the initial clinical signs are similar to those described above. Then, signs of visual disturbance as well as data indicating the involvement of various organs and systems in the toxic process are superimposed. This pertains primarily to the involvement of the central nervous system, which is manifested as excitation and subsequent depression. Most often, the intoxication is accompanied by sleepyness, an unconscious state, a disorder of the respiratory function and of that of the cardio-vascular system. Gastro-intestinal symptoms are also possible (diarrhea or constipation, distention and unpleasant sensations in the abdomen); renal signs are also possible (albumen, erythrocytes, hyaline casts), as are also blood signs (neutrophilia, lymphopenia). In a prognostic sense the first three days are the most threatening. In subsequent days the

number of fatal results decrease considerably.

<u>Pathological Changes</u>. On external examination a pink color of the cadaveric spot and dilatation of the pupils are noted; at autopsy, congestion and edema of the meninges and brain matter as well as solitary hemorrhages in the pons, medulla, and other parts are noted in the central nervous system. At the same time there can be degenerative changes in various parts of the brain. Congestion and small punctate hemorrhages are observed in the lungs, heart, stomack and other organs. In all cases pathological changes are found in the eye: edema of the vascular layer of the retina, degenerative changes in the neural fibers of the optic nerve, hemorrhages, etc.

<u>Mechanism of Action</u>. Regardless of the routes of entrance of methylalcohol into the body, it is slowly oxidized, and forms toxic products (formaldehyde and formic acid) which are also considered to have decisive importance in the development of the pathology. It is believed that the toxic effect of formic acid is brought about by its very pronounced reducing properties, as a result of which the normal course of oxidative-reductive processes in the body are disturbed. It has also been established that under the influence of formaldehyde the course of enzymatic processes is disturbed, as a result of which formic acid cannot be oxidized to its end products (I. I. Kazas). Considering that methylalcohol circulates in the body for a certain time in a practically unchanged or unchanged condition while its toxic effect is obvious, certain authors have attempted to explain the mechanism of action of methylalcohol by the effect of its entire molecule.

The works of V. M. Rozhkov and A. T. Suprunov, which have expanded the existing concepts of the mechanism of action of methylalcohol, deserves special attention. They have shown that under conditions of oxidation of methylalcohol there is a disturbance in the metabolism of those vitamins which play an important part in the course of the toxidative processes (development of anoxia). Acidotic changes and a disturbance in the course of the oxidative processes in a direction of a decrease in their intensity are also found (Rozhkov).

<u>Prophylaxis, First Aid and Treatment of the Intoxication</u>. An essential condition for preventing the development of intoxication is the strict observance of rules and instructions concerning the keeping and the utilization of methylalcohol. The elimination of methylalcohol from a number of industries

and the replacement of it by other, less toxic compounds also is of important prophylactic significance.

One of the important measures in rendering first aid is washing out of the stomach which is indicated not only immediately after the intoxication but also subsequently. Adsorbent (activated charcoal-carbolene), emetics, laxatives, and also siphon enemas may be used. Bleeding with the subsequent administration of glucose or of physiological solution contribute to the elimination of the toxic substance and its conversion products from the body. When necessary the bleeding may be repeated.

In the treatment of those intoxicated by methylalcohol definite attention should be given to the matter of combatting possible acidosis and anoxia. With this aim in view the intravenous administration of alkali (sodium bicarbonate) and the use of oxygen therapy are indicated. It is also recommended that carbogen (oxygen-carbondioxide mixture) be used not only with the aim of stimulating the respiratory center in the event of its depression but also for the purpose of excellerating the elimination of methylalcohol through the lungs. An important place in the treatment of patients should be given to vitamin therapy (B_1 and C). There are reports in the literature concerning the favorable effect of tissue therapy in cases where there are still optic nerve fibers which have not atrophied. Various symptomatic agents are used for combating individual manifestations of intoxication.

Antifreezes. This group of compounds is constituted by chemical substances which freeze at a very low temperature and which are used chiefly as measures for preventing the freezing of liquid in the refrigeration system of internal combustion motors. In their chemical composition antifreezes are different. They are usually mixtures of ethyline glycol with glycerine or without it, or of methylalcohol with glycerine. Because of its properties ethyline glycol has an advantage over antifreezes of other compositions.

Ethyline Glycol (CH_2OH-CH_2OH) is a colorless, somewhat viscous liquid without any odor but which possesses a sweet taste. It dissolves readily in water, glycerine, alcohol, but poorly in ether, benzol and fats; specific gravity--1.130 (at 0^o); temperature of fusion, -15.6^o. It undergoes oxidation readily.

Acute intoxication is possible as a result of the ingestion of ethyline glycole; inhilation of its vapors usually present no danger. The majority of authors (S. Ya. Arbuzov, A. P. Astakhov and others) believe that 100-200 milliliters of ethyline glycol is the dose which can produce fatal intoxication. However, the development of serious intoxication is also possible after the ingestion of smaller quantities of ethyline glycol.

Clinical Picture of Intoxication. A brief euphoria is observed immediately after the ingestion of ethyline glycol. In the majority of cases the initial symptoms of intoxication develop after a certain asymptomatic period (2 to 13 or more hours) during the course of which the patients sometimes continue to engage in their usual occupations. Afterwards, depending on the degree of intoxication, the intoxication can be limited to an anesthetic effect of the toxic substance or else signs develop which attest to the involvement of the central nervous system, kidneys and other organs in the toxic process.

In mild cases of intoxication headache, dizziness, general weakness, nausea, repeated vomiting, as well as an excited state are observed. This form of intoxication usually ends in complete recovery of the patient.

In the more serious cases of intoxication a symptom-complex develops which is characteristic of central nervous system intoxication. Therefore, certain authors call this state of intoxication the stage cerebral signs. It is characterized by considerable headache, dizziness, sleepyness or excitation, by a decrease in auditory perception, dilatation of the pupils and a sluggish reaction of them to light, and shakiness of the gait. In favorable cases the signs noted pass in the course of several days without leaving any after effects.

In the severe forms of intoxication a more pronounced disorder of the nervous system is added to the signs described above. The memory suffers, poor orientation to the environment is noted, and from time to time consciousness is clouded. A considerable excitation or depression is observed.

In extremely severe intoxication the patients are unconscious, the pupils are dilated, pathological reflexes appear, spontaneous urination and suffocation and sometimes convulsions are possible. In addition to the characteristic signs of the nervous system, changes are also observed in the

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cardio-vascular system in respiration, in the gastro-intestinal tract, and others. In this form of intoxication the patients die during the first 24-48 hours. The outcome of the intoxication depends a great deal on the intensity of kidney involvement (stage of renal involvement). The disorders of the renal function are observed even in the stage of cerebral signs. Afterwards, oliguria develops, the urine acquires the color of gravy. In the very severe cases uremia is possible. During this period encephalopathy, bradycardia and other pathological signs in various organs are also observed. Death of the patients during this stage of intoxication occurs in the second to third week against the background of progressive signs of uremia and coma. In the process of recovery of the intoxicated patients the return to normal of the markedly impaired physiological equilibrium of the body occurs exceptionally slowly.

Pathological Changes. The following changes are characteristic of the central nervous system: considerable edema and congestion of the tia mater and dura mater and of the brain matter and punctate hemorrhages. Histological examination shows signs of stasis, considerable number of hemorrhages, destruction of the vascular walls, and also of the brain matter. In other organs, in the event of an early death, only hemorrhages in the serous membranes, congestion and a certain degeneration of the parenchymatous organs, catarrhal gastroenteris, pulmonary emphysema, and a serous myocarditous in the heart are found.

In the case of death occurring in later periods (10-15 days) pronounced changes are usually found in the kidneys: hydropic degeneration of the epithelium of the tubules with subsequent necrosis, the deposition of lime in them, etc. During this period changes in the liver--degeneration and necrosis--are quite characteristic.

Certain Problems in the Mechanism of Action of Ethyline Glycol. The mechanism of action of ethyline glycol has not as yet been completely studied. Considering that ethyline glycol is oxidized in the body with the formation of such atoxic substance as oxalic acid, the majority of research workers ascribe first-rate importance to it in the development of the pathological process. However, the entire symptom-complex characteristic of ethyline glycol intoxication cannot be explained merely by the toxic influence of the oxalic acid formed in the body. B. S. Fridlib distinguishes two phases in the toxic effect of ethyline glycol.

During the first phase changes are observed in the gaseous content of the blood, which leads to the development of anoxia and, therefore, also to a whole series of disorders associated with the anoxic syndrome. Serious disturbances of metabolism have also been established. The author explains the occurrence of the phenomena mentioned as an effect of the undissociated ethyline glycol molecule. In the second phase, organic changes are expressed in a number of organs and systems, primarily, in the central nervous system and kidneys. These disturbances are brought about, according to the data of B. S. Fridlib, through the effect of conversion products of ethyline glycol. N. V. Lazarev notes a definite effect of ethyline glycol as a vascular and protoplasmic poison, as a result of which edema, cloudy swelling and necrosis of the vessels develops. A. B. Reznikov and other authors, noting the disturbances in kidney function, attempt to explain these changes by the specific effect of the antifreeze on the vascular apparatus of the kidneys, thereby ascribing definite significance to the toxic effect of oxalic acid.

Prophylaxis, First Aid and Treatment of Intoxication. In order to eliminate ethyline glycol intoxication extensive educational work should be carried on with persons who deal with antifreezes. V. M. Rozhkov recommends adding substances to the antifreezes which possess unpleasant odors and tastes, making them unsuitable for internal use. Of the first aid measures for ethyline glycol intoxication early irrigation of the stomach, emetics, bleeding with subsequent administration of glucose or preserved blood may be recommended.

Based on the fact that great importance is ascribed to oxalic acid in the toxic effect of ethyline glycol, a number of authors recommend using calcium salts, which are almost always used in cases of oxalic acid intoxication, for therapeutic purposes. B. G. Motylyev recommends using calcium chloride, accompanying this treatment with the use of alkalies. As a measure capable of accelerating the detoxification of ethyline glycol in the body, certain authors use the intravenous administration of sodium sulfate in the form of 15-30 percent solution, in a dose of 50-60 milliliters. Lumbar puncture, the administration of glucose (30-40 percent, 30-50 milliliters), the use of cardiac agents and substances stimulating respiration are indicated in addition to bleeding for a developing comatose state and uremia. In the treatment of ethyline glycol intoxications oxygen therapy (oxygen, carbogen) deserves special attention. Diet (no salt

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and no-protein diet) and vitamin therapy are of great importance in the treatment of ethyline glycol intoxications.

Tetraethyl Lead. (TEL), $Pb(C_2H_5)_4$ is an organic lead compound, being a colorless oily liquid which possesses an odor which is not very characteristic and a sweetish taste. At a temperature of 20° its specific gravity is equal to 1.65; its boiling point is 200°.

Tetraethyl lead is very volatile, can evaporate at a temperature below 0° is resistant to alkalis, insoluble in water, but readily soluble in ether, chloroform, and fats; it readily combines with halides and concentrated acids. As a result of this reaction tetraethyl lead is decomposed in air and in the light it changes to lead oxide and triethyl lead. The latter compound is very toxic and is a dangerous industrial poison.

Tetraethyl lead has been well known for a long time; however, it began to be used extensively in industry only in connection with the discovery of its antiknock properties. It was established that the addition of tetraethyl lead to gasoline, even in very small quantities, contributes to a marked reduction in detonation in internal combustion motors. In addition, the addition of tetraethyl lead to gasoline creates conditions for the more prolonged operation of the motor and reduces the quantity of fuel used. Usually, tetraethyl lead is introduced into the fuel in the form of an "ethyl" fluid [TEL, ethylene bromide and chloride] of which it forms a part. Through the use of this "ethyl" fluid a lead gasoline is prepared, which is also used in internal combustion motors.

Tetraethyl lead intoxication is possible in all cases where there is direct contact with it (under conditions of tetraethyl lead production, in the preparation of the "ethyl" fluid and of lead gasoline, etc.). The use of food products contaminated with tetraethyl lead and also the ingestion of it as an alcoholic beverage can produce a severe toxicosis. The data which have been presented by far do not exhaust the number of conditions in which the development of tetraethyl lead intoxication is possible.

Tetraethyl lead, "ethyl" fluid and lead gasoline can penetrate into the body through the unbroken skin, through the respiratory organs (vapors) and also by means of ingestion of them as a drink. Being an exceptionally strong poison,

tetraethyl lead produces a severe toxic process in the body which often terminates in a fatal outcome.

Clinical Picture of the Acute and Chronic Intoxication. The effect of tetraethyl lead on the human body is characterized primarily by its specific effect on the central nervous system, regardless of the physical condition of the substance (liquid, vapor) or of the route of its penetration into the body (respiratory organs, gastro-intestinal tract, skin).

According to the nature of its course, the intoxication can be acute, under the conditions of large doses of substances containing tetraethyl lead, or chronic, from the prolonged effect of insignificant concentrations (cumulative effect). Some authors (B. I. Martsinkovskiy, M. F. Bogdanova and others) also distinguish a subacute form of intoxication.

The clinical signs of acute intoxication with tetraethyl lead usually develop a certain time after its entrance into the body. The existence of a latent period is characteristic of all cases of acute intoxication. The duration of this period is from several hours to ten or more days. Under conditions of penetration of tetraethyl lead *per os* the intoxication develops more rapidly. Forerunners of the state of intoxication are the following: nausea and vomiting, general weakness, rapid fatigability, loss of appetite, sleep disturbance, dizziness, weakening of the sexual capacity, etc.

Of the early signs of intoxication with tetraethyl lead note should be made of the vegetative disorders which are expressed in the occurrence of an increased tendency to perspiration, salivation, hypotension, hypothermia, bradicardia, and dermographia.

Quite often the patients feel as though there is a foreign body in the mouth and attempt to remove it by a movement of the tongue or by means of the hands. Data indicating psychopathological phenomena are particularly dangerous: the occurrence of anxiety, bad mood and fitful sleep with nitemares, and psychomotor excitation.

In the very severe forms of intoxication with tetraethyl lead the signs of intoxication assume a very pronounced character, which indicates organic involvement of the central

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nervous system: speech disorders, an unsteady gait, euphoria, an uncritical attitude toward one's own behavior, dysarthria, etc. are observed.

The toxic process which develops as a result of the action of tetraethyl lead can be limited merely to the initial stage of the intoxication. In the majority of cases of acute intoxication the process progresses rapidly assuming the character of a malignant course. Here, persistent central nervous system changes are particularly pronounced, leading to the development of an exogenous psychosis. The malignant forms of tetraethyl lead psychoses usually lead to the patients death in the course of the first few days. Intoxications with overt psychoses sometimes assume a prolonged course and in a certain percentage of cases can end in recovery but with residual signs of a more or less considerable psychic incompetency.

Chronic tetraethyl lead intoxication usually occurring as a result of the repeated effect of the poison or mixtures of it, develops slowly, the pathological signs increase gradually, the toxic process lasts for a long time (several months). The symptomatology of chronic intoxication is not much different from the signs which are observed in acute intoxication. In the chronic form of intoxication the most frequent complaints are general weakness, rapid fatigability, loss of appetite, salivation, tendency to perspiration, sleep disorder, weakening of sexual capacity. Objective examination shows a hypotension (90 over 60), hypothermia (35 to 36°), bradicardia (45-50 per minute), loss of weight, pallor of the skin, a slight inemia, slight leucopenia, lympho- and monocytosis are found in the blood (R. N. Vol'fovskaya). In some of the intoxicated patients psychosensory disturbances are observed and sometimes also hallucinations. Afterwards, slight euphoria, dysarthia, disorders of sleep, memory and even of the intellect may be added. In contrast to the acute intoxication the signs indicated show no tendency to progression and remain unchanged for a long time.

Pathological Picture of Intoxication. The most significant pathological changes are observed in the central nervous system. Usually, edema of the brain, hyperemia of the meninges and punctate hemorrhages are found. On microscopic examination small hemorrhages are found in the brain around the dilated blood vessels, and hemorrhages also exist in the cortex and white matter. Quite often, leucocytic stases are found in the blood vessels with perivascular hemorrhages in

the workers should take a shower, and the clothes should be given in for decontamination. An important condition for assuring the prevention of chronic intoxication is the giving of periodic medical examinations. Sanitary-education work is of great importance in the system of prophylactic measures.

Definite success of therapeutic measures in tetraethyl lead intoxication and intoxication by its mixtures depends on the early diagnosis of the intoxication and timely rendering of first aid. In these cases contact of the patient with tetraethyl lead should be eliminated first of all.

When tetraethyl lead or its mixtures fall on the skin it should be treated with kerosene, gasoline or alcohol immediately.

After such treatment an alcoholic soap solution containing cupric acetate is applied to the affected area (O. I. Glazova) or the contaminated site is washed with hot water and soap. Tetraethyl lead decontaminators consist of substances which contain chlorine in their molecules: chlorine water, chloride of lime, chloramines and the liquid from the gas casualty first aid kit. After the ingestion of tetraethyl lead vomiting should be induced, the stomach should be washed out with soda solution or by means of the administration of copious quantities of warm water. Bleeding is also indicated (N. V. Lazarev) with the aim of binding the lead in the body the intravenous administration of sodium hyposulfite together with glucose is recommended. It is believed that as a result of the reaction of sodium hyposulfite with inorganic lead circulating the body insoluble lead sulfide is formed. In addition, the capacity of sodium hyposulfite of increasing the antitoxic function of the liver and of favorably influencing the oxidative and metabolic processes is taken into account (V. M. Chernov).

In the cases where sympathetic nervous system symptoms are manifested to a considerable degree, stimulants are used (corasole, caffeine, phenamine [amphetamine sulfate]). Vitamin therapy is also indicated (ascorbic acid and vitamin B_1). In all stages of this condition the restoration of regular sleep (protective inhibition) is of special importance. With this aim in view, various members of the barbiturate group affecting chiefly the subcortical area (luminal, medinal [sodium barbital], nembutal, hexobarbital and sodium amytal) can be used. Magnesium sulfate (intravenously in a dose of the area of the third ventrical and basal ganglia. Destructive changes of necrobiotic character are possible. Perivascular hemorrhages are observed also in the area of the cerebral peduncles and pons. Similar changes are noted in the cerebellum and medulla. Considerable changes of destructive nature lead to a disturbance of the cortical connections with various parts of the central nervous system, which is responsible for the unusual nature of the symptomatology (A. A. Kevork'yan).

In addition, morphological changes are noted in the myocardium, kidneys and other organs.

Mechanism of Action of Tetraethyl Lead. The fate of tetraethyl lead in the body remains unclear at the present time.

It is well known that tetraethyl lead circulates in the body in an unchanged condition for a very long time, and then can undergo a transformation with the formation of inorganic lead. The greatest quantity of lead is found in various parts of the central nervous system: in the medulla, thalamus, red nucleus, cerebellum, etc.

Such a specificity in the distribution of tetraethyl lead is probably induced by its lipotrophic nature.

I. G. Ravkin notes that tetraethyl lead penetrates readily through the hematoencephalic barrier and involves primarily the cells of the brain. Somatic disturbances observed after the intoxication are considered by the author to be secondary and he associates them with a functional disorder of the central regulatory mechanisms. Disturbances in the cerebral cortical functions in various stages of the toxic process produced by tetraethyl lead have also been found by L. S. Gorshyelyeda.

Prophylaxis, Fist Aid and Treatment. Prophylactic measures and properly organized working conditions are of great importance in the prevention of tetraethyl lead intoxication. With this aim in view defects in the operation of apparatus used in the production of tetraethyl lead should not be permitted, the air conditioning system of the working rooms should be operated continuously, and all workers should be supplied with overalls and special clothing (gas mask, rubber gloves, boots, etc.) and with solvents (gasoline, alcahol, kerosene, and others) for washing their hands. After work

2 to 10 ml in the form of the 10-25 percent solution) exerts a favorable effect in the sense of reducing the excitability of the central nervous system. The use of glucose in combination with magnesium sulfate is desirable. Treatment of patients who are in a state of pronounced psychomotor excitation requires special attention, because they frequently refuse medicine and food. It is recommended that such patients be given hexobarbitol intramuscularly 10 percent, 10 milliliters, which produces sleep, during which the patients should be given magnesium sulfate, glucose, ascorbic acid and other symptomatic agents intravenously. When the patient awakens he should be fed; if he will not take food he should receive sodium chloride intravenously (10 percent, 10 milliliters) which increases the appetite and the thirst. With the aim of increasing the appetite and also of reducing the excitation insulin (5-10 units) may be given subcutaneously with the subsequent administration of glucose. A properly organized routine and diet are of great importance in the treatment of the patient.

PHOSPHORUS INTOXICATION

In military-chemical practice phosphorus is used as a smoke-forming and incendiary agent rather than as a CWA. Two varieties of phosphorus exist in nature, yellow and red. The yellow (white) phosphorus is of practical importance. Red phosphorus is sometimes simply added to the yellow phosphorus for the purpose of a more prolonged and uniform combustion.

Yellow Phosphorus, is a waxy substance of yellowish color, a specific gravity of 1.83, a boiling point of 280°, and a temperature of fusion of 44.5°. It is practically insoluble in water, but readily dissolves in carbon disulfide; it dissolves somewhat lesser extent in fats and lipoids and also in gasoline.

In air phosphorus reacts with oxygen, as a result of which it ignites, forming a yellowish-white smoke on burning (phosphorus pentoxide--P_2O_5). Later, the phosphorus pentoxide (phosphoric anhydride) is converted to phosphoric acid (H_3PO_4) through its combination with the moist atmosphere. Since it possesses the capacity of absorbing moisture, phosphoric acid gradually dissolves, as a result of which a fog is formed which consists of droplets of the acid in water (Yu. V. Drugov). This smoke does not exert any toxic effect on the body; only high concentrations of

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it can produce irritation of the respiratory tract.

In the vapor form phosphorus can exert a certain toxic effect on the body. However, the chief danger of the toxic effect of phosphorus is the possibility of its contact with open surfaces of the body or with the clothes in the form of hot particles, which leads to the development of thermal burns and for a general toxic effect.

When it comes into contact with the skin in the molten form or in a state of combustion phosphorus leads to charring of the skin. The effected area continues to smoke for a certain period of time (the oxidation of the still not entirely burned phosphorus). Afterwards, separation of the eschar occurs with the exposure of an ulcer which does not form a scar for a long time. Penetration of phosphorus into a wound surface complicates the course of the process and lengthens the healing periods of the wound. A fatal outcome can occur soon after involvement as a result of a burn of a considerable surface of the body and as a result of developing signs of general intoxication. The possibility of death exists even at a later time as a result of involvement of the liver, kidneys and other organs.

In the mild forms of involvement, the toxic effect of phosphorus is manifested in the occurrence of headache, dizziness, malaise and other disturbances. The symptoms mentioned disappear shortly.

In the severe cases of involvement, general intoxication is expressed to a much greater degree: pathological symptoms develop in the central nervous system (unconsciousness), in the cardio-vascular system (dilatation of the cardiac borders, muffled heart sounds, arrhythmia, drop in blood pressure).

General Information on the Biological Weapon and Principles of Anti-Epidemic Defence of the Population

I. N. Morgunov

Basic Information on the Biological Weapon and Methods of Using It

The problem of the possibility of using a new measure for mass attack against the population--the biological weapon--is being developed on progressively greater scales in the military plans of aggressive circles of certain foreign governments.

The term "biological weapon" is not new. Hitherto reference was made to the bacterialogical weapon, assuming that only pathogenic bacteria--the causal agents of infectious diseases of men and animals--would be used. With the development of the techniques of culturing various viruses and rackettsiae in massive quantities the more or less real possibility of utilizing these biological agents as instruments of attack has also arisen. Apart from man and animals, crops have been included among objects to be attacked with the aim of inflicting economic damage to the country under attack. In its turn this has involved the extension of attack measures to include the use of insect tests, (for example, the Colorado Beetle) fungi, etc. Naturally, the old terms--bacteriological weapon and bacteriological warfare--are no longer suitable and have been replaced by broader concepts: biological warfare and biological weapon.

The idea of artificial spread of infectious diseases among troups and population of an enemy for the purpose of attaining military results arose long ago, in the pre-bacteriological period, when nothing was known of the existence of causal agents of diseases but when the main property of the infectious diseases themselves was well known: that of spreading extensively and rapidly among the population. Thus, from the history of wars it is known that in 1346 during the siege of Kaffa by the Tagars the latter through the Cadavers of plague patients into the besieged city with the aim of causing a plague epidemic in the fortress and thereby breaking the resistance of its defenders. Plague which began in the city actually forced the besieged fortress to lay down its arms.

A similar example may be presented from the history of colonization of the territory which is now Mexico and Bolivia. In the year 1520 the Governor of Cuba, Diego Velksquez outfitted twelve ships with troops under the command of Panflio Norveza. There were cases of smallpox among the troops. The troops hung the infected clothes out in the woods which were stolen by the Indians and thereby an outbreak of Smallpox was provoked. According to the data of contemporaries about three million persons died from Smallpox. The data concerning the number of those who died can hardly be considered reliable. However, from the point of view of the possibility of provocation of an epidemic this fact is undoubtedly interesting.

The discovery of the causal agents of infectious diseases did not prevent attempt to spread epidemic diseases among enemy troops. Thus, during the Boer War the English troops during their retreat through the bodies of those who died from Cholera into wells dug along the main travel routes and which frequently were the only sources of water, with the aim of contaminating the water.

During the First World War the use of chemical warfare agents was tested for military purposes. Along with the use of gasses attempts were made also to use a bacteriological weapon mainly for diversionary purposes (the infection of forces of the Rumanian Cavalry and the infection of chocolate with botulism toxsin).

In 1915, the German spy Grägersen imported a culture of plague bacillus from the United States into Russia. This culture was brought from Arkhangel'sk to Saratov, where it was to multiply and then be used in Petrograd. This diversionary act was not completed, because the German spy Bler who had been put in charge of this operation was simultaneously working for Russian Intelligence.

In general, the use of the bacteriological weapon during the years of the First World War did not give any perceptable results because "the bacteriological experiments existing at that time were undertaken with insufficient means", as the German military theoretician, Klotz, appraised these attempts.

As a result of these unsuccessful attempts it became obvious that the utilization of biological agents as weapons requires the development of methods of using them and of

establishing the conditions under which this type of weapon is most effective. At the same time it was necessary to find new methods for the mass preparation (cultivation) of various species of pathogenic microbes.

During the period between the two World Wars many reports appeared in the foreign press concerning the study of various problems in the application of bacteria in the bacterial weapon. It was reported that microbes survive on the surface of a bullet when it is fired and in a shell after it explodes.

German intelligence workers established the possibility of spreading microbes by spraying them in the air of the Paris subway, etc. The fact attracted attention that there were no reports concerning works in this direction in the Japanese press. However, as the Khabarovsk trial of Japanese war crimes showed, the various aspects of waging bacteriological warfare were being studied most extensively in the Quangtung Army during these years. Two detachments were created in this army--number 731 (medical) and number 100 (veterinary). There were about 3,000 servicemen in detachment number 731 in addition to the various production rooms it had a special range for the purpose of testing various types of weapons, etc. As the investigation showed this detachment tried out the possibility of producing a plague epidemic in China among the population by dropping infected animals and fleas from airoplanes. An outbreak of plague confirmed the possibility of the mass artificial infection of people as a result of "the research work" of these detachments many technical problems were worked out: accelerated methods were proposed for the mass cultivation of microbes, multiplication of insects (particularly fleas) various rodents, and the most suitable types of bacteriological bombs, etc., were proposed. The rapid onslaught of the Soviet Army prevented the use of pathogenic microbes during the Second World War and saved mankind from the terrors of biological warfare.

Reports of the American Press attest to the exceptionally extensive scale which has been assumed for preparation for biological warfare in the United States. Thus, apart from a special large bacteriological institution in C mp Dietrich, structures have been built which require the construction and production of special equipment, namely: 1) a nursery and research station in the State of Maryland (April, 1943); 2) a field research station in the State of

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Mississippi (summer 1943); 3) experimental seats for practical research in the field of mass production in the State of Indianna (beginning of 1944) and 4) a field research station in the State of Utah (summer 1944). Therefore, at least five special institutions were organized designed for the development of new measures of mass attack against the population.

The application of biological weapons in Korea and in the northeastern regions of China are evidence of the extent of the work of these institutions. In a report of the International Scientific Commission on the Investigation of the Facts of Bacteriological Warfare in Korea and China published in 1952, information is contained to the effect that causal agents of plague, anthrax, cholera, typhoid and dysentery were attested in these regions. Many inhabited places were subjected to attack: attacks investigated by the Commission were described in which the plague microbe was used in seven inhabited places of Korea and four inhabited places in China; objects infected where the causal agent of anthrax were dropped on three inhabited places. In addition mention is made of the dropping of fleas and infected articles in the vicinity of military positions.

The causal agents of intestinal infections were used for contaminating water supply sources; in Dai-dong Molluscs infected with the cholera bibrio were used for infecting the water; these were thrown into the river at the water-intake area of the waterworks. The water-purification structures (but not the waterworks) were destroyed by preliminary bombardment with demolition bombs at this time.

Material concerning the use of bacteriological weapons in Korea and China show that the most effective methods of attack were not used in a single case. Conversely, the bacteriological weapons were used under unfavorable conditions, by means of infecting unusual objects, etc. This gave us the basis for the belief that the bacteriological weapon in Korea and China was used in the form of "an experiment" which was masked by the unusual methods of application. Such an appraisal of the events in Korea and China is confirmed by the reports of Prisoner-of-War Colonel Schwebl, who was in charge of problems of bacteriological warfare in the American Army Staff. In his report he wrote: "The fundamental aim at that time (October 1951, the beginning of bacteriological warfare--i.m.) consisted in trying out various elements of bacteriological warfare under military conditions and then gradually expanding these military tests so that they might become a part of the regular military operations depending on the results obtained and on the situation in Korea". Such an appraisal of events in Korea is also confirmed by a comparison with a research program in the field of bacteriological warfare given in a large special article by Roseverry, former director of the Bacteriological Institution in Camp Dietrich. The problems which were unclear to him were solved in practice in Korea.

The movement of various peoples for peace has not stopped the preparation for biological warfare, but has only concealed it further. Thus it is mentioned in a United Press report of November 1955: "A considerable part of the activity of the Chemical Corps (in charge of the development in problems of chemical and bacteriological warfare--i.m.) is considered horrible in its character and therefore does not find any support... Military circles have usually avoided discussing the question of chemical and bacteriological weapons in every possible way, partly for fear of international and internal psychological reaction". Nevertheless, according to a report of the Associated Press Agency, the Secretary of War of the United States, Bracker, ordered the Chemical Corps to carry on work in the field of creating "new types of bacteriological and chemical weapons which only the human mind can devise".

Evidently the moral evaluation of the idea of biological warfare expressed by the peoples of the world has not yet exerted a reliable effect on certain aggressive circles which want to make use of the characteristics and advantages of biological agents of warfare.

Characteristics and Advantages of the Biological Weapon

The biological and, particularly, the bacteriological weapon possesses the following characteristics which, at the same time, constitute its advantages.

1. The epidemic nature and the capacity of spread from a person directly affected to persons unaffected at the time of the attack. This characteristic is associated with the infectivity of microbes and the property of being transmitted from sick persons to healthy persons in the presence of conditions corresponding to the natural mechanisms of the transmission of the infection. Here, it is necessary

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to distinguish the time of infection during the attack, the time of artificial provocation of the epidemic outbreak from the further spread of the infection and the development of the epidemic itself. Artificial infection can be accomplished through routes not characteristic of the given cause of organism under natural conditions. Thus a number of viruses and rickettsiae can produce disease by entering the body through the lungs, although under natural conditions they are transmitted by blood-sucking insects. The development of the epidemic as such after a biological attack can be accomplished only in the presence of conditions corresponding to the mechanism of transmission of the given infection. Thus, in intestinal infection conditions are necessary which would contribute to the entrance of the infective material into the mouth (water, food, etc., factors); in the case of blood-borne infections, blood sucking insects--the natural vectors, etc.--should be present.

As an example of the fact that it is necessary to distinguish involvement at the time of the attack to further spread of the infection, one of the cases in North Korea may be related which was presented in the report of International Scientific Commission: One inhabited place with about 600 inhabitants was attacked at night. Animals infected with plague, on which fleas had fed which usually parasitize man (pulex irritants), were dropped. The nature of the attack was surmissed and prompt measures were taken in full volume. Only persons infected directly after the attack (50 persons) fell ill. As the result of the measures taken there was no further extension of plague. Therefore, there was an immediate infection but no further spread of the plague.

In a similar case in the Province of Han'man (Northeast China) the nature of the attack was guessed almost immediately and at midday the population had annilated all the field mice scattered over a territory of five by fifteen kilometers and also the dogs and cats which had caught the infected field mice. The attack was carried out in the winter and the animals dropped were either dead or half dead. This interfered with the rapid migration both of animals and insects. Under these conditions the measures taken rendered the attack unsuccessful. In both these cases the mechanisms of natural transmission of bubonic plague could not be realized, and the artificially provoked plague outbreak in one case did not spread, and in the other even the infection did not occur. It should be noted that in both cases a complex mechanism

of transmission of the infection was used for the biological attack. It is natural that the effectiveness of such methods of attack depend to a large extent on the alertness and the operational efficiency of the sanitary-epidemiological institutions, the medical community and the population which lives on the territory under attack.

It may be supposed that other methods of attack (which will be dealt with in detail below) particularly the use of infection through the respiratory track, will be able to produce a great direct effect: the number of those infected at the time of the attack would be considerable. However, further spread requires the participation of natural mechanisms of transmission for the majority of infections. The tremendous experience of laboratory work with various infections (viruses, rickettsia and others) shows that the infection of animals through the lungs leads to the infection of a specific pneumonia. By analogy, this may be also expected in man. In this case the artificially produced infection in man would proceed in a distorted manner: Involvement of the lungs would be added to the usual course of the infection. Apart from the difficulties in clinical diagnosis, the super imposition of the air-droplet the route of transmission may be expected, which is not inherent to this infection under natural conditions.

The epidemic nature of the biological weapon has been appraised by foreign authors as an indisputable advantage of it. Other forms of weapons are designed for their direct effect on man. All types of firearms have no effect immediately after the attainment of their goal. The biological weapon essentially just begins its effect after the primary infecting act: Further spread of the infection in the form of an epidemic may be added to the direct effect, which in itself can be considerable.

2. The Opportunity of Rapidly Obtaining Large Numbers of Microbes.

This feature is associated with the property of microbes of the rapid multiplication. The capacity for rapid multiplication is expressed in the bacteria. It is believed that division of the microbial cell occurs every thirty minutes. Therefore, theoretically, $4 \cdot 10^{14}$. Individuals may be obtained from one microbial cell in the course of twenty four hours. In practice, far fewer are obtained, which is associated with the particular rules and regulations of

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multiplication of microbes. Multiplication of microbes in a test tube proceeds irregularly. During the first few hours multiplication proceeds slowly (lag phase) and then a period of vigorous multiplication (logarthmic phase) occurs. After several hours of rapid increase in the number of cells a period occurs in which the number of microbial bodies in the nutritive medium remains at the same level (stationary phase), and then may even decrease somewhat. It has been shown that the relative equilibrium in the stationary phase occurs because of the dying-off of cells, by virtue of conditions unfavorable for microbes which are created in the culture fluid. Under ordinary cultural conditions accepted in laboratories (culture in test-tubes, flasks), microbes of the typhoid-paratyphoid and dysentery groups produce the suspensions containing concentrations of about two billion microbial bodies per milliliter of the nutritive medium. However, by changing the cultural conditions of the microbes it is possible to increase considerably the number of microbial bodies per milliliter of the medium (the so-called microbial mass yield). Thus, for example, by blowing air through the nutritive medium during multiplication of microbes in it, it is possible to shorten the time of the lag phase, and to lengthen the phase of logarithmic multiplication, and, by the same token, to establish the level of the stationary phase at a much higher point (30,000,000,000 to 60,000,000,000 microbial bodies per milliliter of medium). Here the total duration of the growth period of the bacteria may be short. It is not hard to imagine what figures may be obtained for the microbial mass. In very short periods of time under mass production conditions, it is known from the war crimes trial of the Quangtung Army that the productive capacity of detachment 731 made it possible to culture 30,000,000,000,000,000 plague of microbes in one cycle, and these microbes grow more slowly then microbes of the colln group. In practice, it may be considered that an unlimited number of microbes can be obtained in the course of a day or two.

The situation is somewhat different with regard to viruses and rickettsiae. By virtue of their purely parasitic nature they can be grown only in living cells, which is attained by infecting animals or chick embryos. This to a certain degree has limited the possibility of obtaining viruses on en masse. However, recently the technique of growing viruses and rickettsiae has been simplified considerably. Methods of growing them in tissue cultures in rotating vessels have been developed. This improves the growth conditions of the

tissues, as a result of which the multiplication of viruses proceeds much more rapidly (two to four days), and there is no difficulty in obtaining them in large numbers. As an example of this we may cite the practice of mass preparation of the vacine against poliomyelitis, the virus of which is one of those requiring the greatest exactions and which are most difficult to culture. In relatively short periods of time such numbers of it were obtained that the vacine prepared sufficed for the immunization of hundreds of thousands of children. Here it should be taken into consideration that the quantity of virus used for a preparation of the vacine for a single person exceeds by many times the known infective dose of it. In other words, far fewer virus bodies would be needed for infecting a person then for immunization.

Therefore, it is technically easy to obtain quickly the infectious material of viruses rickettsiae and particularly bacteria. This is not only a characteristic but is also an advantage of the biological weapon. Thus, as has been mentioned above, during one production cycle (maximum of three to four days) detachment 731 obtained 30,000,000,000,000,000 plague microbes. Theoretically this quantity can suffice for infecting a population of 15,000 planets like ours, if we assume that the infective dose is 1,000 plague baccilli, (actually, to be sure, a smaller number is required)

3. Cheapness of the Biological Weapon

This characteristic, although of economic nature, is still associated with the biological property of the causal organisms of multiplying on comparatively simple and cheap nutritive media. The cost of the dearest nutritive media (meat media) amounts in practice to the cost of meat, because the remaining expenditures are exceedingly small. At the same time, it is possible that the nutritive media made be made even cheaper by the application of plant proteins, etc. Thus, for example, the cost of a single productive cycle of detachment 731 obviously did not exceed 100,000 rubles.

The cost of viruses can hardly be much more, particularly if the growth is accomplished in tissue cultures. Thus, a total of about 2,000 eggs is required for obtaining one million doses of smallpox vacine from a chick embryos. Cultivation in tissue culture still further reduces the cost

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of such a quantity of vaccine virus.

The cheapness of the biological weapon from the point of view of certain foreign military workers is an exceptionally important advantage of it. Thus, the American newspaper "Stars and Stripes" (dated 27 January 1952) in an article with a characteristic title, "Bacteria and Gas--the Cheapest Weapon" reported that the Chief of the Research Division of the Chemical Corps of the Army of the United States, General Crissy had astated that this weapon, which can be created, makes it possible to achieve the greater effect with less expense then any otherof its forms.

4. Difficulties of Immediate Detection of the Type of Biological Weapon

Modern methods of laboratory diagnosis of infectious diseases are quite sufficiently developed so as to determine the type of causal organism of almost all diseases. However, they possess very essential short comings: First, comparatively considerable time is required to make a laboratory analysis, even an orientative one, and, secondly, the majority of methods provides for the examination of material taken from a patient and are unsuited to determining bacterial contamination of environmental objects (air, water, various articles, etc.). It is sufficient to point out only these two shortcomings in the modern methods of laboratory diagnosis in order to render obvious the difficulties in timely determination of the type of causal agent which has been used by an enemy. If we take into consideration the variety of species of causal agents of disease and differences in the methods of determining them, it becomes clear that the problem of the laboratory worker is a complicated one. This fundamentally distinguishes the biological weapon from the chemical and radiological weapons, the nature of which can be determined in a few minutes. The quickest methods of diagnosis of causal agents of disease require several hours, that is, a time more then sufficient for the purpose of infecting a person with certain methods of application of the causal agent as a weapon. (For example, in the form of an aerosol). Even in the case of a diversionary infection of water of a time required for the infection would be less then that required for making a bacteriological analysis.

This characteristic of the biological weapon is considered a great advantage.

not very strong and, in addition, is brief. There are no vacines against these infections. Therefore, the causal agents of two types of infections maybe used as a weapon: 1) those against which specific prophylactic agents exist and may be obtained, and 2) those against which it is impossible to immunize people beforehand. As an example of the first type mention may be made of practically a whole group of particularly dangerous infections (tularemia, brucellosis, plague, that is, aside from the pulmonary form, etc.). As an example of the second type of infection Roseberry mentions the virus of dengue fever and others.

It is important to consider this property of the biological weapon from the point of view that it expands the possibilities for using it by an enemy who knows what type of causal agent is going to be used and can therefore immunize the troops beforehand which are designed for occupation of the infected area. On the other hand, through the use of the biological weapon in the far rear or during a retreat, the enemy can utilize such infections for which it is impossible to create an inoculation immunity, which considerably complicates the matter of combatting them. The possibilities of regulating the species of causal agents used constitute an important advantage of the biological weapon.

7. The Possibility of Combined Application of Various Causal Agents

Existing classifications of pathogenic microbes group them according to definite biological features (morphological, cultural, biochemical and others) which are common to various numbers of the different species. Epidemiological classifications of infectious diseases at the same time group the causal agent in accordance with features important in an epidemiological connection. Thus, L. V. Gromashevskiy has made the mechanism of transmission of infection the basis for the most generally accepted epidemiological classification; this feature is closely associated with the localization of the infection. Here, in the same group there may be causal agents which are biologically completely unrelated to one another (for example, the diphtheria bacilus and the measles virus), but which are transmitted from person to person in the same way by the air-droplet route. The classification of microbes is extremely important and is necessary for practical work. It facilitates the identification of microbes or the determination of the nature of the anti-epidemic measures of general character (in connection with all the causal

5. The Presence of an Incubation Period

Diseases on a large scale and even individual cases do not appear immediately after the application of the weapon but rather a certain time interval later, which is equal to the average incubation period and lower limits of the incubation period characteristic of the causal agent used. This also applies to characteristics of the biological weapon. Depending on the problems pursued by the enemy, causal agents of diseases can be used which have various incubation periods. This characteristic of the biological weapon is the basis of two important facts: 1) in certain infectious diseases man is contagious even in the incubation period and can contribute to the spread of the infection if no isolating measures are taken and 2) during the incubation period, particularly with a long (several days) latent period, considerable movement and "mixing" of individual persons and even of groups from the area of contamination may occur with the healthy population which had not been exposed to the attack, and this may be included in the enemies plans. In other words, the presence of an incubation period can contribute to the manifestation of a fundamental characteristic of the biological weapon--its property of spreading among the population, its epidemic nature. In this sense, the presence of an incubation period is an advantage of the biological weapon. This fact should be kept in mind in determining the anti-epidemic measures to be taken in inhabited places where an attack has occurred.

It should not be overlooked that in many infections, the causal agents of which may be used, the incubation period may be shorter during infection en masse than it is when the disease occurs naturally. This possibility is particularly probable with the use of biological agents in the form of an aerosol thereby the causal agent will enter the body, missing the most powerful defensive barrier adaptations.

6. Possibility of Creation of Artificial Immunity

As the result of having had many infectious diseases a resistance (immunity) to a given causal agent occurs in the body. This protects against having the disease a second time. Immunity of greater or lesser duration can be created artificially by means of immunizing people with vacines or toxoids. A number of infections, including those the causal agents of which can be applied in biological warfare, either do not leave any immunity after them or else the latter is

Even though far from all of the causal agents can be utilized for the purpose of an attack, the advantage of the biological weapon is obvious in this connection.

8. As One of the Characteristics of the Biological Weapon associated with biological properties of the causal agent mention is made of retroactivity, that is, the capacity of spreading to involve the troops of the side which used the biological weapon. It was believed that this limits application of the weapon. What has been said above is sufficient to make clear how little this characteristic can influence the decision to use biological agents as weapons.

Possibility of preliminary immunization of troops, the existence of powerful disinfection technique, and the adoption of general preventive measures for the protection of troops in accordance with the type of causal agent which, to be sure, is well known to the side which used it considerably decreased the significance of this characteristic of the biological weapon.

9. The Biological Weapon Affects Only Persons who are Sensitive to it, without involving those who are resistant and without inflicting any damage on structures, industrial enterprises, routes of communications or on the means of communication, which can be utilized immediately by an enemy. This characteristic to a certain degree is inherent in poison gases and radioactive agents also if the use of the latter is not connected with the application of explosive bombs (atom, hydrogen). Great importance is ascribed to the absence of damage to the means of production in the agressive plans of certain circles. Thus, according to a report of the United Press Agency mentioned above, General Crisy "explained" that weapons containing pathogenic bacteria, poison gases or radioactive agents would make it possible to destroy enemy without destroying his economy. In a report of the Associated Press Agency it is mentioned that United States Secretary of War Bracker called for emphasis on the investigation "of the problem of how to suppress an enemy without destroying equipment which the victor might wish to keep".

10. The Powerful Psychological Effect Exerted on the Population by an Attack using Biological Weapons is also Highly Evaluated. According to an enemy's calculations, fear of infectious diseases leads to panic, to mass flight, which not only complicates the task of eliminating the after

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agents of various groups). However, various groupings of diseases do not mean that the individual species of microbes do not have their own specific characteristics which require special measures to be directed against them specifically. If we exclude the most general measures directed against some group of microbes in the epidemiological classification, it follows that a person can essentially be affected by any representative of this group even in the event protective measures are taken against one of them. For example such a general measure for air-droplet infections is the protection of the respiratory organs from entrance of the infective nidus into them (masks, gas masks, shelters). However, in the absence of this measure a person is guaranteed against only those diseases to which he has an immunity. In some cases, there are varieties (serologic types) within the limits of the same species of microbe, and immunity has to be created to each of these in order to prevent the disease completely. This characteristic of biological aliens brings about an extensive possibility of changing their sequence and combining them, substituting one species by another, one microbial association by another. Only the method of application can serve as a factor limiting the frequency of replacements and combinations of agents. Thus, there are certain causal agents with which it is impossible under any conditions to produce disease when used by mouth (for example, typhus). Evidently, the infection of food products or water with these causal agents would have no sense. We must consider that infection through the respiratory passages is not possible with all microbes either. In this case, spraying them into the air does not always achieve its purpose either. Therefore, each route of infection and every method of application will have its own group of causal agents within the limits of which changes in sequence and combinations can be accomplished. Such a grouping of causal agents cannot coincide with the usual epidemiological grouping in the form which has been adopted, for example, in L. V. Gromashevskiy's classification. Organisms which can produce infection after entering the body through various routes (for example, the organisms of tularemia, anthrax) constitute exceptions, and therefore, they can be used in combination with microbes of several groups.

In order to imagine what possibilities may be obtained from this characteristic of the biological weapon it is enough to say that in his expanded grouping L. V. Gromashevskiy lists more than 100 infections, and V. M. Zhdanov has listed 1,340 infectious diseases as nosologic entities.

The morbidity rate from the direct infection will be more or less depending on which of the objects mentioned is infected. Thus, when water-supply-line water is infected cases of disease will be found in larger numbers on territory which is supplied by water from water mains from the site of infection to the terminal water network.

A number of factors would limit the scale of involvement of the population when water is infected. Thus, the existence of residual chlorine in the water would to a certain degree disinfect the water, and in the event of infection of open water sources the normal operation of water-purification equipment would apparently completely prevent the entrance of infected water into the water-distributing network. Infection of the water in the large main lines (water conduits) with a small number of microbes would hardly give any significant effect by virtue of the great dilution of the infective material.

The infection of food products can also lead to a considerable morbidity rate, particularly in a system of community nutrition when mass consumption products are infected. However, the outbreaks from food infection are usually smaller (compared with those from water) for a number of reasons: difficulties in infecting a very large quantity of food products, death of the microbes in acid products, after thermal processing etc.

Naturally an enemy would take into consideration the conditions which would reduce the effectiveness of the attack. Particularly, utilizing the property of variability and ready adaptability of microbes, those microbes can be used in which an increased resistance to chlorine or to food product preservatives, etc., has been elaborated. Therefore, it is very important that under exceptional circumstances the population resort as much as possible to thermal processing of all food products and water used.

The possibility of infecting the air as a diversion method has been proved experimentally: German intelligence agents used the Bacillus prodigiosus for infecting the air of the Paris subway, through the currents of which the microbe was carried to neighboring subway stations. However, the impossibility of using large-volume apparatus, the danger of immediate detection, the comparatively small concentration of people in public buildings, where the air infection may be anticipated, limit the number of primary cases of

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effects of the attack and not only renders difficult the giving of aid to patients (administration of sera, antibiotics, etc.) but would also contribute to the spread of infection on the territory which had not been exposed to attack.

From the point of view of the proponents of biological warfare, the exceptional variety of means of using biological weapons, practically without the aid of explosive agents, and the possibility of spreading them among the population long after the attack determine the advantage of this method not only over the usual forms of weapons but also put it in first place compared with other forms of mass-attack weapons.

This is the evaluation of biological weapons given by aggressive circles of certain countries.

Methods of Attack and Methods of Application of the Biological Weapon. Of the characteristics of the biological weapon mentioned we are particularly interested in those properties which should be taken into consideration in the organization of defense of the population against attack. Since these measures are of different character, depending on the methods of use of biological weapons a description of the latter needs to be given if only in its general features.

Up to this point it has been useful to throw light on the probable methods of infecting a locality, that is, the methods of attack. These two concepts are not identical although they are often used as equivalent.

As methods of attack should be understood those technical measures and methods which an enemy can utilize for effecting a locality or individual objects on the territory of the side being exposed to attack.

The probable methods of attack may be judged on the basis of the history of bacteriological warfare, taking into consideration the sparse information which has penetrated into the general press concerning the "research" work in this field.

During the First World War the only method of bacteriological attack was diversionary. Evidently the application of this method will exist in the future. The diversion maybe accomplished by infecting either the water or the food products and fodder, or the air.

infection. Taking into consideration that for the purpose of the subsequent spread the air-droplet mechanism of infection is the most favorable one, the fact that only a small number of persons are initially infected does not exclude the possibility of application of this method of diversion.

During the period between the First and Second World Wars it was shown experimentally that even microbes that do not form resistant spores readily tolerate the conditions which are created from the use of firearms. Microbes have survived in an artillery shell, particularly of the shrapnel type, and even on the surface of a bullet. This has given us the basis for the expectation that biological agents can also be carried by artillery shells. At a comparatively short distance the ejection of microbes is possible by means of mortars. Recently long-range rockets have also been designed for this purpose.

It should be considered that only local and focal areas of infection can be created by this method. To be sure, with planned firing the number of these areas can be great and can extend over a comparatively large distance.

The use of special artillery shells, etc., very much complicates the rapid recognition of the fact of an attack, because these shells can constitute only a certain small portion of the shells ordinarily used which would mask the use of the biological weapon. However, with adequate alertness on the part of the observation service these shells can be detected rapidly by the character of their explosions, etc. The application of artillery weapons can be combined with such species of microbes the independent use of which would be senseless. Among these microbes are the entire group of causal agents of the wound infections. The infection of fragments formed from the explosion of shells containing the causal organisms of gas gangrene makes the latter suitable for application as a weapon. At least, such a combination has been considered in Japanese military circles to be completely acceptable, as was shown during the trials of the former Japanese soldiers (khabarovskiy trial).

Because of their large volume and other features, long-range rockets can be utilized for the carriage of any species of causal organism.

The use of artillery shells makes it possible also to combine chemical warfare agents with various causal organisms of disease.

As the events in Korea and North China have shown, the most common method of attack would obviously be from aircraft. The use of airplanes as means of attack has many advantages. First, the airplane can reach inhabited places which are located in the far rear. Secondly the airplane can transport any kind of causal agents. Thirdly, the carrying capacity of airplanes makes it possible to transport the infectious material in a quantity sufficient for infecting large areas. Fourthly, various methods of application of biological weapons can be realized by the use of an airplane, which will be considered below.

In principle, any bombing plane can be adapted for transporting biological weapons. However, by virtue of the characteristics of design, certain types of airplanes can be more convenient, and they would be used more often for these purposes. According to the American prisoner of war, Colonel Schwebel, during the war in Korea various types of airplanes were tested (VMF-513, B-26, AD, F4US, F7F, F9F, Panther, etc.) with the aim of determining those most suited to biological attack. Therefore, taking into consideration the types of enemy airplanes during an attack may very quickly reveal which of them are being used chiefly for purposes of biological warfare. Afterwards, these data may prove to be very useful as one of the features of application of biological warfare.

Airplanes may be utilized either for the direct spraying of infectious material from reservoirs, or for dropping various types of bombs and containers.

The possibilities of spraying an infectious mass from airplanes can be evaluated only by analogy with the practice of using toxic chemicals for combatting agricultural pests and the use of mineral fertilizers in agriculture. It is well known that this method has been widely used for combatting malarial mosquitoes where their breeding areas (marshes) were large. Up to one ton of infectious material can be sprayed during a single airplane flight.

It is hard to say which types of bombs and containers would be used. Undoubtedly there would be several of them depending on the nature of the infectious material. Incidentally, the possibility of application of biological weapons by means of the most diverse bombs and containers,

including those which have been designed for other purposes, has been appraised as one of the advantages of biological weapons in the foreign press. Thus, for example, containers used for carrying propaganda leaflets have proved to be quite suitable. Therefore, biological warfare in Korea has been designated by the term "super propaganda". A list issued according to the data of the International Scientific Commission on the investigation of the facts of bacteriological warfare in Korea and China gives us an idea of the variety of bombs and containers. From the description of eye-witnesses from preserved evidence and from the reports of captive fliers information is available concerning the following types of bombs and containers:

1. <u>Air-burst bomb for leaflets with a time fuze</u>. It has a length of 1.4 meters and a diameter of 40 centimeters. The shell casing is made of steel, three millimeters in thickness; the volume is 72 liters. Therefore, its dimensions are approximately the same as those of the 250-kilogram bomb, but its weight is equal to 75 kilograms. On explosion it covers an area of 200 x 100 meters.

2. <u>Air-burst bomb for leaflets supplied with a propeller</u>. After a definite number of revolutions of the latter an explosion occurs. This type of bomb was described by the captive fliers.

3. <u>Glazed-porcelain bombs 50-80 centimeters in length</u>. This type of bomb was developed in detachment No 731 of the Japanese army. They were designed for filling with microbe cultures.

4. <u>The bomb known by the name of "egg shell" is a variety of the preceding type</u>. It has very thin walls which after an explosion or even simply from the shock of hitting the ground smash into very small pieces which leave practically no trace at the site of hitting the ground.

5. <u>Bomb (container) for leaflets which has little doors and a propeller</u>. The latter actuates a mechanism which opens the doors. It was used for dropping insects. When supplied with a parachute it is suitable for dropping rodents.

6. <u>Bomb (container) for leaflets which opens from the shock of hitting the ground</u>. It is supplied with a parachute. Suitable for dropping insects and rodents.

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7. Non-explosive articles and paper containers of cylindrical shape (length 20 centimeters, diameter 10 centimeters) or in the form of packages (10 x 10 x 3 centimeters) for packing insects.

8. Paper or cardboard cylinder with a parachute. In its external appearance it is similar to an illuminating flare. Its length is 36 centimeters, its diameter is 13 centimeters. Diameter of the parachute is 70 centimeters. A container of this type has been used for dropping insects which cannot tolerate a strong impact (mosquitoes, etc.).

9. Paper container with paper parachute. It has ballast and a fuze which burns the container at the proper moment.

10. Other types of containers: Cylindrical containers made of wire netting, wooden boxes, etc. supplied with parachutes. Designed for dropping rodents.

It may be considered that this list does not exhaust the types of containers. However, it does give us an idea of their great variety, which should be taken into consideration in intelligence work.

Evidently, balloons can be used for carrying out an air attack; the movement of them is not regulated but their location is established by means of radio. The carrying capacity of the balloons is quite great (up to 600 kilograms), and they can be utilized for the transportation of bombs, containers, etc. It is not hard technically to drop these bombs on inhabited places over which the balloon is traveling. This method of attack is essentially no different from the use of airplanes, except for its lesser degree of accuracy in dropping the bombs.

The methods of application of the biological weapon can be various. They are determined by which route of infection is being used for attacking the population: the respiratory organs, gastro-intestinal tract or skin.

Infection through the respiratory organs is possible only by infecting the air. Infection of the air can be accomplished by spraying infectious material. In practice this can be achieved by the use of aerosols of a microbial mass. The spraying of a bacterial culture in large droplets, like rain, cannot produce any great effect, because these droplets rapidly settle. The characteristic feature of aerosols

is their comparatively long stay in the air. The stability of aerosols depends on the size of their particles. The maximum size of the aerosol particles does not exceed ten microns (one-hundredth of a millimeter). Larger particles rapidly settle, particles smaller than ten microns stay in the air the smaller they are. The size of the pathogenic microbes of various species ranges from 0.3 to 3 microns. Viruses constitute an exception; their maximum size is equal to 0.2 to 0.25 microns; the majority of viruses are much smaller.

Therefore, if aerosol particles consist of solitary microbes they will remain in the air for a long time. Particles containing virus are practically of the same size, because their mass includes tissues on which the virus has been grown.

Many other factors exert an influence on the length of stay of the aerosol in the air. Thus, movement of the air (wind) retards the settling of the aerosols. Air currents from heated ground also prevent sedimentation of the aerosols; if the air currents are great, for example, on a warm day, the particles of the aerosol can be carried upward. With a marked drop in the temperature, water vapor can condense on the aerosol particles on account of which an increase occurs in the size of the particles with a rapid sedimentation of them. In the absence of the effect of high temperature, movement of the air or condensation of moisture, the aerosol particles settle at a speed of several meters per second, depending on their size and the density of the mass, that is, on their weight.

A concentrated suspension of microbes and liquids (liquid nutritive media, buffer solutions, etc.) or desiccated microbial masses can be used for spraying the infectious material. In the former case, the aerosols have the appearance of a fog; in the latter case, of a smoke. Each of these materials has its own shortcomings and advantages. Thus, in the liquid culture the number of viable microbes is greater than in the desiccated material; however, the period of viability of it is limited. On the other hand, the desiccated microbial mass can be preserved for a comparatively long time and does not require such strict maintenance conditions as does the liquid culture, because in the desiccated state the microbes are much more resistant to the harmful effect of external factors (temperature, light, etc.) which is important also for the preservation of them in the environment after the attack. The

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fact that infection is more readily accomplished by droplets then by dust particles is one of the advantages of the liquid culture aerosols. This is very important. H wever, this advantage can be smoothed over by fine grinding of the dry mass, because the aerosol particles which are equal in size to microbes practically reach the alveoli with the inhaled air, and there infection occurs. The fact mentioned above can be of importance for larger particles (five to ten micrones or more) which settle in the bronchi and upper respiratory passages: Large particles of the dry mass would irritate the tissues, producing a cough, sneezing or would be expelled by the ciliated epithelium.

The desicated microbial mass, however, which can readily be converted into a powder has still another advantage: In this form the biological weapon can be used in all three methods of attack, whereas the use of an artillery weapon is obviously impossible for a liquid culture.

The use of the biological weapon in the form of aerosol would perhaps be most prevalent for a whole series of reasons.

First, infection through pulminary tissue is accomplished much more readily not only by causal agents which affect the respiratory organs naturally but also by the causal organisms of other infections. Thus, under experimental conditions mice are readily infected with a Rickettsia prowazeki through this route. Roseberry and Cabot, on the basis of an analysis of thirty-four laboratory cases of yellow fever infection (fatal in five cases) came to the conclusion that infection was accomplished most probably through the inhalation of desicated and pulverized virus. Mosquitoes could have participated in no more then a few cases.

Secondly through the use of aerosol it is possible simultaneously to infect the maximum number of persons who are in the area of infection. Practically everybody who doesn't use one of the various methods of protection who has breathed infected air can be infected.

Thirdly, infection through respiratory organs in certain infections is accomplished also in those cases where there is a considerable degree of immunity manifested to the other routes of infection. Thus, innoculations against plague protect against its bubonic form, are inaffective for an infection through the respiratory organs.

Fourthly not only the direct infection of people but also of everything which surrounds people is achieved by the use of aerosols. Thus, even if through the use of a mask a person has avoided direct infection, he is still threatened by infection from clothes on which aerosol particles has settled while he was in the contaminated area, and which were not disinfected in time; he is threatened by infection from objects in his apartment if the latter was not sealed off and if disinfective measures were not taken in it; and from food products and water which were not protected against the entrance of infectious material into them and which were not destroyed afterwards, etc.

Fifthly, not only people but also animals sensitive to the causal agent used can be affected by the aerosols and these latter can be, additional sources of infection. In the cases of certain infections (plague, tularemia) such animals may be rodents (rats, mice, etc.) which are reservoirs of the infection under natural conditions. If measures are not taken on time for their annihilation (complete deratization) the population of the involved locality will constantly be under a threat of occurrence of disease as the result of the previous attack.

Therefore, the use of the biological weapon in the form of an aerosol can activate additional sources of infectionof people which are characteristic of other methods of application of this form of weapon.

Infection through the gastonal intestinal tract may be accomplished first of all through the use of food products and water contaminated by pathogenic microbes for food or for drink. Other situations are possible: Swallowing sprayed infectious material with the saliva, that is, material which has settled on the nose and in the throat. Swallowing microbes which are on toys, fingers, etc., and which have been taken into the mouth. However, the latter cases would either be of exceptional rarity or else would be characteristic of special categories of the population, with respect to which an enemy would hardly orientate himself. For example, in order that infection occur by means of swallowing particles which have settled on the upper respiratory passages a causal agent would have to be used of one of the intestinal infections in the form of an aerosol with very large particles. Otherwise an infection would not occur by this route. The use of such aerosols is not expedient (rapid settling, poor penetration into quarters, etc.)

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In contrast to what has been mentioned for the respiratory organs, infection may be accomplished through the digestive tract only in the event causal agents are used which naturally affect man by this route. It is impossible to produce a disease through the enteral route by other causal agents.

All these considerations permit us to expect that the use of the biological weapon for infecting the population with intestinal infections is possible only by means of contaminating water and food products with pathogenic microbes. Evidently this method of application of the biological weapon is most readily conbined with the diversionary method of attack. The use of them in the form of aerosols might be expected in the case of certain infections, like, for example, tularemia, anthrax, Q-fever, that is, those which affect man by several routes. The existence of reports in the literature of the possibility of utilization of aerosols for infecting food products and water with microbes of the colon group causes us to take this method of attack into consideration also with the aim of infection through the digestive tract.

Naturally, such a situation obliges us to protect the water, provisions and fodder not only against a diversionist but also against possible contamination of them by aerosol particles of infectious material (sealing of storehouses, food enterprises, means of transportation, etc.). This pertains particularly to food products which are not subjected to thermoprocessing at home (bread, sugar, non-alcoholic beverages, etc.). The skin is the most powerful human barrier. Evidently the methods of application of the biological weapon described above would be inadequate for producing infection by this route.

Infection through the skin occurs in two groups of infections (according to the L. V. Gromashevskiy classification): In blood infections and infections of the skin. In the former case if the integrity of the skin is violated by blood sucking insects which are vectors of the infection, and the infective nidus enters the blood or lymph. In the latter case, the integrity of the skin is violated either mechanically (wounds) or as a result of animal bites, because of which the causal organisms miss the barrier and the further course of the infection can be most varied (is enough to compare the caurse of rabies, sodoku and gas gangarene).

The mechanisms of infection indicated above obviously pro-

vide methods of application of the biological weapon in the case of infecting people through the skin. At least, the information which has broken into the press concerning methods of waging biological warfare which are being developed give evidence of this specifically. Thus, it may be seen from the material of the Khabarobesk Trial that in Detachments No 731 and No 100, methods were being actively developed for artificial multiplication of fleas and infection of them under laboratory conditions. After that, an outbreak of plague in China was provoked by scattering infected fleas. In Detachment No 731 "experiments" were carried out in which people were infected through the combined use of fragmentation bombs and various causal organisms of disease. These "experiments" confirmed, so to speak, the possibility of combining artificial infection with mechanical injury of the skin.

According to the data of the International Scientific Commission on Investigation of Facts of Bacteriological Warfare on the territory of the Korean People's Democracy, a number of inhabited places were exposed to biological attack with the use of infected fleas or infected rats, and in which there were many human fleas (<u>Pulex irritans</u>), obviously with the aim of excelerating a transfer of the ecto-parasites to their natural biological host, man.

The possibility also exists of mass infection of the soil with spore-forming microbes and primarily with anthrax spores. Hereby, a double aim may be pursued: Infection of animals in pastures and infection of people during the performance of various agricultural duties associated with a large number of small traumata (thorn bricks, abrasions, etc.) which as a rule remain unnoticed.

Therefore, it may be supposed that both mechanisms of transmission of infection have been taken into consideration in the development of methods of application of the biological weapon. They would obviously be combined in a certain way with the methods of attack. Thus, the use of causal agents of infections of skin capable of producing disease after entering injured tissues (tetanus, gas gangrene, etc.) is readily conceived of only in combination with artillary fire. It would be senseless in an airplane attack. On the other hand, the use of infected insects is conceivable only from airplanes and then in special containers, but is impossible through artillary fire. The infection of large areas of earth in which the grass on it and the crops are to be preserved also determines the method of attack. Observance of these conditions is possible only through the use of airplanes.

In analyzing the question of the methods of application of the biological weapon the fact should not be overlooked that the use of combined methods of attack may be expected. The biological weapon permits the most varied combinations. First of all, combinations of various biological agents are possible, and these in combination can produce infections with a more severe course and with a greater mortality rate. In addition, the use of causal agents of infections using various mechanisms of transmission is possible, which makes the success of the attack more probable. Finally, the combined use of causal agents can be carried out for the purpose of deceiving the country being attacked, which leads to an incompleteness of the measures taken on account of the complexities of diagnosis, etc. The effectiveness of the attack, therefore, can be sharply increased thereby.

The combined application of various species of micro organisms should apparently be kept in mind always.

This by far does not exhaust the possibilities for the combined use of the biological weapon, however. Combinations of biological agents with various chemical warfare agents and radioactive substances are possible, that is, the combination of two or three various mass-attack agents.

A combination with chemical warfare agents can pursue the purpose of facilitating the penetration of microbes into the organism through the tissues entered thereby. To be sure, the course of infection would be complexified, thereby, which always occurs in a more severe form in persons who suffer from some other disease. Naturally, the combination of various microbes with chemical warfare agents is possible only under conditions where the latter do not destroy the microbes themselves.

The combination of biological agents with radioactive substances is no less probable. Radioactive emination, as investigations of recent years have shown, does not affect the growth, multiplication, or pathogenic properties of causal organisms of various infections. Microbes grow just as readily on media containing radioactive substances as on ordinary nutritive media. It has been shown that radioactive isotopes of chemical element are assimilated by the microbial cell and are included in the composition of the substance

of which the microbial body is constructed without stopping or altering its activity. At the same time, the radioactive emination has an essential influence on the bodies of animals and of man. Regardless of the manner in which the body is exposed to the affective radioactive substances, through external irradiation or through the entrance of these substances into the body, a marked decrease in the activity of the natural defence mechanisms is noted in both cases and obviously to the greatest extent with respect to their barrier functions. It has been noted that the most threatening complication of radiation sickness is the development of infection. As the result of involvement of barrier and apparently of the phagocytic mechanisms the disease can be produced even by ordinary microflora of the intestine which are not pathogenic to the adult person. When the pathogenic microbes are present in the surrounding medium, it may be expected that the infection would occur more rapidly. It is possible that a comparatively slight degree of involvement of the body by radiation is sufficient for making penetration of pathogenic microbes into the body easier.

In addition to the fact that radiation sickness is accompanied by involvement of the natural barrier mechanisms preventing the penetration of microbes into the internal milieu of the body, it almost completely paralyzes the immunological reactivity, as a result of which the body is deprived of the ability to elaborate an immunity. It has been shown experimentally that introduction of vaccines into animals affected by radiation sickness does not cause them to produce antibodies in full measure or to create a state of immunity. The possibility of disease in man through the penetration of saprophytic flora and a more severe cause of infection by a pathogenic microbe come about specifically for these reasons.

Such an effect of radioactive emanation on the body obviously excludes active immunization (vaccination) as a prophylactic measure in a focus which has been affected by the combined action of biological and radioactive weapons.

Therefore, the combined application of pathogenic microbes and of radioactive agents increases the affectiveness of both types of mass-attack agents. Radioactive emanation facilitates the infection of people, aggravates the course of the disease and eliminates the practicality of specific prophylaxis against the infections. The pathogenic biological agent complicates the course of the radiation sickness and thereby increases the affectiveness of the radioactive

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weapon.

Biological Warfare Agents

By biological warfare agents we mean the causal organisms of those infectious disease by which a population can be intentionally infected with the aim of mass-attack against it. At the present time, we can speak only conjuctually about the species of causal organisms which can be used by an enemy. In the description of infectious diseases which can be spread intentionally by mass artificial infection we have to orient ourselves first by the foreign literature, because the most probable warfare agents are named in it, and secondly, by the data concerning the properties of microbes, routes of spread of infection, etc., in comparison with the conditions under which the causal agent may enter the body when used by various methods.

The infections presented below do not exhaust the list of causal agents, which are regarded as the most probable biological warfare agents. Thus, such organisms as the influenza virus, the virus of Riff Valley Fever, the mumps virus, the vengue fever virus, the leptospiras, etc., have not been mentioned, the possibility of using which has been assumed by foreign workers. The description of these infections has been omitted, because the grounds for the possibility of using them are either inadequately convincing or else are simply doubtful. However, to be sure, in the future the list of infections may be changed.

In the description of causal agents and corresponding diseases we have not attempted to give complete information about them. Therefore, this chapter does not in any way claim to substitute for special textbooks on microbiology, epidemiology for infectious diseases in which the reader will find much more detailed information on the problems concerned. In this chapter they are being presented only in order to bring to mind certain properties of the causal organ, the clinic and epidemiology of diseases fundamentally for the purpose of laying a foundation under the ideas of methods of application of the given causal organism and also for the purpose of grounding certain measures of general and special nature in the focus of infection. Undoubtedly, a deeper study of the ediology, clinic, diagnosis and epidemiology of infections will require studying them according to the special literature.

The order of presentation of various infections is not

connected with any classification of infectious diseases. A grouping of them according to the method of artificial infection of the population (through the air, through water and food products, by means of insects, of vectors of infections, etc. (would be most correct, because definite measures would correspond to each group. However, such a grouping is as yet impossible, because the most frequent and effective methods of application for various infections would be demonstrated only in practical work with the biological weapon. At our present level of knowledge of this problem we may assume the possibility of application of several methods for the same species of causal organism, which complicates any kind of rational grouping which would be convenient for presentation and suitable for practical needs.

Based on this, we are describing first the bacterial infections and then the rickettsial diseases followed by virus infections and concluding with a solitary representative of the group of bacterial exotoxins.

Plague is an acute infectious disease occurring most often in two forms: The bubonic and the pulmonic. The great infectivity and the high mortality rate among the patients has aaused us to refer plague to the group of the particularly dangerous infections.

The causal organism of plague B. pestis, is seen microscopically as a small bacillus with pointed ends having an oval shape (coccobacterium). The same morphology is preserved in bouillon, but the formation of short chains is observed. In smears taken from agricultures of the bacillus-like shape of the microbe is more pronounced.

The plague bacillus is readily stained by all aniline dyes and is gram-negative. The ends of the bacillus are intensely stained; the central portion is practically not stained (bipolar staining), which is characteristic of the entire Pasteurella group to which the plague organism belongs.

The microbe of plague grows well on ordinary nutritive media.

Growth is improved by the addition of sodium sulfite to the blood media, which permits the detection of the plague bacillus when there is only a small number of them in the material under examination. In bouillon it grows in the form of a film, producing a flocculent sediment at the bottom of the test-tube leaving the bouillon clear. On agar it grows after twenty-four hours in the form of delicate colonies which are greyish-white with an azure hue. In the presence of a sparse growth of colonies they are of considerable size, round in shape, rough with a prominent center and a flat lacelike area along the periphery.

The consistency of the colonies is viscous when cultured at 37° centigrade and dry when cultured in an auto-clave at a low temperature (28 to 30° C).

Under environmental conditions the plague microbe possesses a considerable resistance compared with other vegetative forms. It is no different from others in its resistance to the effect of high temperature or to disinfectants.

On environmental objects the resistance of the plague bacillus fluctuates depending on the temperature, humidity, light, etc. The following data give an idea as to its resistance. In sputum the plague microbe can be preserved ten to thirty days; in darkness, up to 165 days; in dried sputum, 4 to 7 days. In puss from buboes it is preserved 20 to 30 days. In the desicated state on a towel the plague microbe remains viable at a temperature of 12 to 18° for 67 days. In human and animal cadavers, the plague microbe can be preserved at a very long time at temperatures below 0° C.: From several months to a year. At higher temperatures the plague bacillus dies more quickly. In decaying cadavers the microbe disappears in 4 to 5 days, being preserved for this period of time only in the bone marrow. The microbe is preserved up to three weeks at room temperature in the skin of rodents which died from plague.

In food products the plague bacillus is preserved for a long time: In black bread, for four days; in salted butter, 130 days; in fruits and vegetables, 6 to 11 days; in grain, 12 to 54 days. The possibility of infection from food products is confirmed by the fact that plague outbreaks have been observed among persons cutting up the meat of camels afflicted with plague. Therefore, we are dealing here with a peroral infection but rather with a mechanism similar to the natural one (through the skin). By analogy, infection may be expected through the respiratory tract in the reprocessing of grain.

The plague bacillus lives in water for 75 days. It is well preserved in the soil at low temperature (one month),

and at high temperature it dies quite quickly.

A sealed culture of plague bacillus at a temperature of 10° C preserves its viability and virulenze for nine years, which permits it to accumulate for a long time.

Various species of rodents are reservoirs of plague infection. Rats, susliks, sand-eels, and tarabagans play the greatest part in the epidemiology of plague. However, the number of species of animals susceptible to plague is very great. More then 150 species of rodents are known which are sensitive to the plague infection. Of the domestic animals, cats and camels are susceptible. It is possible to give pigs, goats, sheep a d dogs plague only by artificial infection with large doses of the culture. Horses and long-horned cattle are not susceptible to plague. Carnivora (except for skunks and weasels) and birds are not susceptible to the infection. Insects and arachnibes are slightly susceptible but can preserve the microbes in their bodies for a long time: Bedbugs, 147 days; ticks, 10 or 11 days (Tumanskiy).

A characteristic feature of the epidemiology of plague is the fact that the development of epizootics among rodents precedes the outbreak of cases among people, and from this the infection is transferred to people. Therefore, plague is a typical zoonotic infection. The transmission of the infection to man is accomplished, as a rule, by ectoparasites of the rodents. Cases are possible from contact with infected animals (hunting tarabagans, stripping the cadavers of camels, etc.) The bubonic form of plague always develops with this kind of mechanism of transmission. Further development of an epidemic can assume a more threatening course. A specific pneumonia can develop in a patient with the bubonic form of plague. The sputum excreted thereby contains a large number of plague microbes. Transmission of the plague infection in this case is accomplished by the droplet route, which in view of the absolute susceptibility of man leads to an exceptionally rapid spread of its most severe form. The pulminary form of plague determines the great epidemic tendency of the plague causal organism as an agent of biological attack.

This fact determined the most probable application of the plague bacillus in the form of a bacterial aerosol. However, this does not exclude the use of infected insects, because each patient with the bubonic form of plague is a potential puliminary form patient (secondary pneumonia), which, when it begins in one person, spreads rapidly to those around if appropriate measures have not been taken beforehand (separate hospitalization, observance of the routine of care of plague patients by the medical personnel, etc.).

The onset of the disease is acute in all forms (after incubation of one to three and, less often, more days) with a marked rise in temperature, a chill, headache and other signs of general intoxication. The patients are restless, excited and delirium with hallucinations is possible. The phase is hyperemic; the conjunctivae are injected. Later, cyanosis is noted, and the facial features are sharpened. The pulse increases in rate, is arrhythmic and thready. The heart sounds are muffled.

The chief symptom of the bubonic form of plague is the development of plague lymphadenitis which includes a group of lymph glands with the super imposition of a periadenitis called a bubo. The first signs of this form of plague are pains at the site of development of the future bubo. The first bubo is usually associated regionally with the portals of entry of the infection. Afterwards, the appearance of buboes is associated with the spread of the plague bacillus in the body. The buboes can be of different sizes, most often are the size of a hen's egg. Buboes are frequently observed in the inguinal areas, associated with infection through the lower extremities, and then most frequently in the axillery cervical and other areas. The latter are prognostically more dangerous and are complicated by the pulmonary form. The climax of the disease is noted on the fourth or fifth day, after which resolution of the infection occurs if phenumonia has not been superimposed (which occurs in 5-10 percent of the cases) or unless plague meningitis (rare) or non specific complications have occurred.

In the pulmonary form of plague, cutting pains in the chest, marked tachycardia, dyspnia, delirium with hallucinations and marked excitation (violence) are soon superimposed on the acute onset. Later, prostration is observed and prior to death, coma. A lobular phneumonia is established through oscultation and on precussion. A lack of correlation of objective signs to the severity of the course is characteristic of pulmonary plague. At first the sputum is foamy and clear (glassy), and then it becomes blood-tinged and even consists of pure blood. Microscopically, it is easy to find large numbers of plague bacilli in it. The total duration of the disease is five days.

The introduction of specific serum therapy into practice has markedly reduced the mortality rate from the bubonic form of plague, having practically no effect on the pulmonary form which usually ends in the death of the patient. Treatment with antibiotics (streptomycin and others) in combination with serum has reduced the mortality rate in pulmonary plague also.

The disease is followed by a strong immunity. A strong immunity also occurs after inoculations. Therefore, inoculations of live plague vaccine have become previlent as a prophylactic measure. Vaccination is carried out in the focus of involvement even in the event cases of the disease have already occurred, because post-vaccinal immunity increases the effectiveness of treatment.

Laboratory diagnosis is made by culturing suspected material on nutritive media and by infecting laboratory animals (biological tests). If the material contains considerable foreign flora (from the bodies of rodents) guinea pigs are infected by rubbing an emulsion of the material under examination into the skin (Austrian method). The animals are infected thereby and die from the more pathogenic plague bacillus. The results of the biological test are controlled by cultures on media.

The collection and delivery of material for examination is a responsible matter. The collection of material is accomplished by forceps or, in an extreme case, using rubber gloves which should be disinfected immediately after finishing the operation. The material is placed in a bipartite vessel, between the walls of which there is a thick layer of gauze moistened with five percent lysol. The bipartite vessel is also wrapped around with some kind of material moistened with disinfectant solution. Then, all this is put into a metal container or a tightly sealed box. Clinical-epidemiological data are given in an attached statement, and the presumptive diagnosis is indicated.

The principle of general anti-epidemic measures amounts, first, to complete individual isolation of all patients and persons who have in any way been in contact with them or with infected objects; secondly to combatting the source of infection and vectors of it (deratization and disinfection); and, thirdly, to the decontamination of the patient's surroundings (disinfection). In the event of the existence of large foci of infection, when the possibility of infections on a

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large scale has not been excluded, the measures indicated above are supplemented by the imposition of a quarantine on the entire affected area. In cases where plague bacillus has been used for the attack the quarantine is imposed immediately after the establishment of the species of organism, regardless of the number of cases or of the form of plague.

All kinds of work in the focus of plague and having to do with communication with patient, regardless of their duration, should be carried out in a special protective suite which assures protection of the body surface, respiratory organs (mask) and eyes (goggles).

Tularemia is an acute infectious disease which has several forms of clinical course (bubonic, generalized and pulmonary) and which is transmitted by all the possible routes.

The causal agent of tularemia, B. tularense, belongs to the Pasteurella group, like the causal organism of plague, although in its antigenic structure it is similar to the brucellae. The microbe of tularemia is a very small size (0.2-0.7 micron) often has the appearance of a coccus or coccobacterium, and is non-motile; it does not form spores, stains well with analine dyes; is gram-negative; is exclusive with respect to nutritive media and grows only on MacConnely's coagulated egg-yolk medium on blood agar containing cystine. Growth appears on the second to seventh day in the form of a delicate shagreen-like film or of delicate individual colonies.

Although the tularemic microbe does not form spores, still it possesses great resistance under environmental conditions. Direct sunlight kills it in 30 minutes; diffuse sunlight kills it in three days. It is not sensitive to low temperatures. Alternate freezing and thawing have little effect on its viability. It is preserved in frozen meat for 93 days; in salted meat, for a month; in cadavers undergoing incipient decay it dies in four to five days.

The microbe of tularemia is resistant to desiccation. In pelts taken from infected rodents it is preserved for 45 days. In rapidly desiccated pieces of tissue from sick animals the microbe can be preserved for a year. In the dry excrement of insects it is preserved for 20-25 days. In grain the tularemic microbe is preserved for 133 days; in baked bread, about three weeks; in water, three months.

The tularemic microbe is very sensitive to the effect of

ordinary disinfectants. In the usually accepted dosages they kill it very quickly--within several minutes.

Like plague, tularemia belongs to the group of zoonoses. The chief reservoir and source of infection are rodents. In various countries different species of rodents are sources of the infection (ground squirrels, hares, beavers, lemmings, etc.). In the Soviet Union mouse-like rodents, water rats and hares play the main part in the infection. The infection of cats is possible but under ordinary conditions they are not of epidemiological significance.

A characteristic of tularemia is the variety of routes of infection of men. Infection occurs through direct contact with infected material (the stripping of pelts, cutting of meat, etc.); through the consumption of infected water for drinking and domestic needs (washing, bathing) and the consumption of contaminated food products as food (bread, biscuits, etc.); through the bite of ectoparasites and certain flying blood-sucking insects (horseflys, mosquitoes, etc.); of rodents, by rubbing dust into the ocular mucosa or by inhaling dust in which the causal organisms of tularemia are present. The latter method of natural infection is doubted by some authors. However, in principle, no one disputes the possibility of tularemia infection through the respiratory passages.

In contrast to plague no transfer of the infection is observed in tularemia from ome person to another. Therefore, the tularemic microbe as an agent of biological attack does not possess great epidemic qualities. However, this means that it is also without retroactivity, which in certain cases can be a very important fact. The great infectivity of it for man and variety of the methods of infection compensate for its lack of an epidemic nature. Incidently, if a biological attack leads to the infection of rodents tularemia can also assume this property.

In accordance with the methods of infection (localization of the portals of entry of the infection) various kinds of clinical forms of tularemia develop. The incubation period lasts from several hours to three weeks; on the average it equals three to seven days. The onset of the disease is acute, with a chill, high temperature, headache, muscular pains, etc. The temperature curve is most often remittent or irregularly intermittent and sometimes undulant (two or more waves). The duration of the fever, on the average, is

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equal to 2-3 weeks (5-30 days). The fall in temperature is lytic with a long period of low-grade fever.

Clinical forms of tularemia (according to Rudnev): 1) bubonic (ulcerative-bubonic, pure bubonic, bubonic angina, ophthalmic-bubonic and abdominal with mesenteric buboes); 2) generalized (synonyms-typhoid, pseudotyphoid, septic); 3) pulmonary (bronchitic and phneumonic). The mortality rate in tularemia is low. Recovery proceeds slowly with loss of the ability to work for a long time.

Antibiotics (streptomycin) have recently been used successfully for treatment. In addition, serum is being used for therapeutic purposes. The rest of the treatment is symptomatic.

Laboratory diagnosis is made on the basis of the biological test (mainly for environmental objects, rodents and others), the agglutination tests with the patient's serum and the allergic test with tularin.

The collection of the infectious material and the delivery of it to the laboratory and the examination itself are carried on with observance of the same rules which apply to plague.

The comparatively high resistance of the causal organism and the variety of routes of infection of man makes its use possible by any means. However, not all the methods of attack can be equally effective, because the infection of a small number of persons does not lead to the occurrence of any great epidemic outbreak (absence of an epidemic quality). Apparently of all the methods of application of the organism of tularemia the one may be selected which leads either to a direct infection of a large number of persons or to the infection of rodents with the aim of creating an enzootic focus and an epidemic threat associated with it. The second method (infection of rodents) can constitute a hazard in a definite locality for a long time, but it can hardly lead to a single large-scale outbreak of the disease; this makes it possible to use sufficiently effective preventive measures in time.

Therefore, the application of those methods which lead to the large scale infection of the population would be most probable. This can be attained either by spraying cultures or by infecting the principle water mains of the water supply

system (pipelines and reservoirs). Through the use of the aerosol not only the infection of the population but also that of susceptible animals can be achieved (rodents).

A definite impediment to the use of the organism of tularemia as a biological weapon is the comparatively great selectiveness of the microbe with regard to nutritive media and the sparsity of its growth. However, these technical difficulties can hardly be insurmountable. They can be overcome through the expanded production of the microbial mass and by the accumulation of it in the desiccated state, because in this form the viability of the microbe is well preserved.

Tularemia leaves a strong immunity after it. Post-vaccinal immunity is also of adequate strength and therefore, vaccine-prophylaxis has an important part in the system of anti-epidemic measures.

General anti-epidemic measures are very similar to measures used in plague. They amount to hospitalization of patients with terminal disinfection of articles and of the room, of the observation of persons in the environment and of measures for the annihilation of rodents and vectors (deratization and insect elimination).

When there is suspicion that the causal agent of tularemia has been used in the form of an aerosol it is essential to resort to measures of individual protection (masks, goggles and clothes which cover the surface of the skin as much as possible).

<u>Anthrax</u>. The causal agent of anthrax, <u>B. anthracis</u>, is a <u>large bacillus</u> (five to seven microns), <u>non-motile</u>, forms a capsule and spores (pseudoanthrax bacilli are motile and do not form a capsule). In size the spores are much smaller than the vegetative forms. The ends of the bacilli, which have the appearance of being squared off, represent a morphological characteristic of the anthrax microbe.

The existence of spores for this microbe accounts for its very high degree of resistance to the effect of environmental conditions. In water, and in the earth the spores may remain viable for scores of years. Direct sunlight kills the spores in no less than four hours. Dry heat at a temperature of 120° kills them in two hours. Boiling kills the spores in 10-15 minutes. Solutions of chloride of lime (20 percent), formaldehyde (two percent), mercuric chloride (one percent) kill the spores in one to two hours. Salting, drying, tanning leather, etc. do not contribute to the death of the spores.

The vegetative forms of the microbe are much less resistant to the effects of physical and chemical factors.

The causal organism of anthrax does not possess any epidemic qualities in the literal sense of the word. Anthrax is a threat to personnel taking care of patients only when they do not observe the rule the precautionary measures in giving medical aid.

The group cases of anthrax which are observed are usually associated with a common source of infection (for example, the cutting and consumption of meat of a sick animal, etc.). Sporatic cases are often associated with occupational factors (infection of veterinary workers, shephards, workers in slaughter houses, persons engaged in the processing of leather, of bristles, etc.) and less often, with infection of the soil and transfer of the infection by blood sucking insects (horseflies and gadflies).

The lack of an epidemic quality in the case of the anthrax organism is completely compensated for by its unusually great resistance under natural conditions. In the opinion of Roseberry, herein lies its importance as an agent of biological attack. A locality once infected can continue to present a danger for a long time if account is taken of the difficulties of disinfecting the soil and the great resistance of anthrax spores.

The portals of entry of the anthrax infection can be the skin, intestine and organs of respiration. Therefore, methods of using the causal organism can be different. The possibility of using the spores of the microbe exists in the form of an aerosol (on account of their size the spores furnish stable aerosols) as a method which attains several purposes at once (direct infection of people, of the locality, of food products, etc.) and also as a diversionary infection of certain food products.

The clinical form of anthrax is determined by the portals of entry of the infection. Cutaneous, pulmonary, intestinal and septic forms are distinguished. The incubation period, on the average, is equal to two to three days with a range of

one to seven days. In the case of the cutaneous form, a reddish spot first appears at the site of the portal of entry of the infection which changes into a papule and then into a vesicle containing a serous and then a dark bloody content. Burning and itching at the site of the vesicle and of the pustule lead to scratching of them by the patient. A black eschar appears, it is surrounded by secondary vesicles which undergo the same development. On account of the secondary pustules growth of the black eschar occurs. The hard eschar is surrounded by an elevated blood-red infiltrate; the surrounding tissues are often edematous, particularly in places with a loose subcutaneous tissue and particularly in the area of the face. The sites involved are not painful in contrast to the cutaneous involvement in plague and tularemia. The following general features are noted: malaise, headache, fever (temperature of 39 to 39.5 degrees and higher). The drop in the temperature coincides with improvement of the local process. The cutaneous form can be complicated by a septic process with the appearance of secondary metastatic foci in the lungs, intestine and on the skin.

The intestinal form of anthrax begins with a chill and with sharp, cutting pains in the abdomen. Then, nausea and vomiting are added with the throwing up of bile and blood and also bloody diarrhea. The paresis of the intestine which sometimes develops produces a picture of acute obstruction. Intoxication is accompanied by a high fever, weakness of cardiac activity and progressive edema of the lungs.

The primary pulmonary form of anthrax is characterized by a short incubation period, pains in the chest, cough and the excretion of a foamy, liquid, bloody sputum in which many characteristic bacilli are found microscopically.

Aspirates of a pustule or ulcer, the contents of a carbuncle, vomitus, stool, urine, and sputum are subjected to laboratory examination. Pieces of the spleen are taken for autopsy. A final diagnosis is made on the basis of the biological test. Recourse is had to the thermoprecipitation test according to the Ascoli method for the examination of infected tissues, whether, etc.

Specific prophylaxis is accomplished by means of a vaccine. In the presence of a known infection, the prophylactic administration of anthrax therapeutic antiserum is possible.

General anti-epidemic measures should provide for the isolation of patients and the realization of measures of disinfection in the focus of involvement.

The observance of rules of burying of cadavers is of importance. Cadavers should be buried at a depth of no less than two meters and disinfectant solutions should be poured over them copiously. The burial sites should be fenced off.

An infected locality should be carefully disinfected and plowed under (depending on their conditions).

The use of anthrax spores may involve not only the infection of people but also that of cattle. This fact should be taken into consideration, and anti-epidemic measures should be supplemented by anti-etiozootic measures, for the performance of which the veterinary service is recruited.

Glanders is an infectious disease involving solid-ungulate animals (particularly horses) which are the sources of infection for man.

The causal agent of glanders, B. mallei, is a bacillus of comparatively large size (one to five microns), non-motile and non-spore-forming. Certain of its strains are polymorphic. It stains well with aniline dyes, particularly on the addition of phenol or alkali to the latter; it is decolorized by the Gram method. On staining with Loeffler's methyline blue, granulation is demonstrated in the body of the bacterial cell.

The bacillus of glanders grows well on potatoes, agar, and bouillon to which one to five percent glycerine has been added. On agar it produces greyish-white colonies with a mother-of-pearl sheen, slimy and viscous. Growth on potatoes is particularly characteristic: on the third day, a slimy film of amber-brown color resembling a copper film is formed which is dull or shiny; on the sixth to eighth day the amber color assumes a reddish hue. In bouillon containing two to four percent glycerine, the bacillus of glanders grows producing first a uniform turbidity, and then a slimy greyish-white sediment.

The causal agent of glanders possesses slight proteolytic properties, coagulates milk on the sixth to eighth day. With an acid reaction, gives off hydrogen sulfide and ammonia, ferments glucose and lactose without the formation of gas, and possesses reducing and catalasic properties.

The resistance of the glanders bacillus is comparatively

slight, like that of other vegetative forms of microbes, but is sufficient for infecting healthy animals from infected troughs, water, etc. Thus, the glanders organism is preserved 12 to 15 days in dung; it dies on the 7th to 15th day in the suppurative exudate of ulcers and in nasal mucus; it tolerates low temperature well. Direct sunlight kills the microbes in 24 hours. The causal agent of glanders has a high sensitivity to disinfectants.

A man is susceptible to glanders. Infection occurs under ordinary conditions during the care of sick animals and as a result of contact with objects contaminated by sick animals (straw, hay, harness, horse blanket, etc.); therefore, the cases show a pronounced occupational nature. Infection of man occurs through injured skin and mucosae. Certain research workers believe that cases of infection are possible through the respiratory passages.

The course of glanders in man can be acute or chronic. In acute glanders the incubation period last for two to five days. The onset of the disease is acute, with a chill, heat, headache and muscular aches; later, pains in the joints and swelling of them are superimposed. An ulcer develops gradually at the site of penetration of infection with undermined edges and a greasy base. In the process, the regional lymphatic vessels are involved (lymphangitis), and sometimes the lymph glands (lymphadenitis). After five to seven days, the fever shows an exacerbation. The appearance of secondary nodes is observed which change into ulcers in the muscles, in the nose and in the lungs. The ulcers are associated with greenish purulent exudates. Later, a suppurative involvement of the joints is added. The person dies with signs of progressive cardiac weakness. In the acute form death is practically inevitable.

In the chronic form, the inflammatory processes develop slowly and at times increase and at times slacken. In this form multiple ulcers and abscesses (like cold abscesses) are characteristic; these localize in the skin, in the muscles, in the lungs, and in the nose. The course of the disease is prolonged, up to several years. About 50 percent of those afflicted die.

The laboratory diagnosis of glanders amounts to the performance of a biological test, because cultures from the pus are rarely successful. The biological test is performed on male guinea pigs. After three to five days atypical

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orchitis (Strauss reaction) develops in intraperitoneally-infected animals. The glanders bacillus can be isolated very easily from the inflamed testicle.

For the purpose of making the diagnosis in chronic glanders in animals the complement fixation and the cutaneous tests (the eye test in animals), the latter being an allergic test with mallein are being used very successfully.

There are no agents for the specific therapy and prophylaxis of glanders.

The causal agent of glanders was one of the first microbes used as a bacteriological weapon for the infection of horses. For these purposes the feed of the horses was infected in cavelry units. No great damage was inflicted on the fighting capacity of these military units. Evidently, such diversions are completely senseless under modern conditions where the army is mechanized and the cavelry has lost its former significance.

The great severity of the infection (regardless of the form) and the high mortality rate in glanders, however, are attracting the attention of certain "pheoretichians" of biological warfare. In connection with this the problem is being discussed of the methods of producing a glanders infection. Since infection with this disease is possible only through damaged skin or mucosa, there is no particular sense in using the glanders bacillus, because it is impossible to carry out such a method of mass involvement of the population, and the disease itself does not possess any great epidemic quality. Roseberry, in discussing this problem, expresses doubt as to whether glanders can be transmitted by the air-droplet route under natural conditions. At the same time, he allows such a possibility in the case of artificial infection under conditions of biological warfare. Moreover, he believes that primary infection of the respiratory passages can give this infection an epidemic quality.

This gives us the basis for expecting the use of the organism of glanders in the form of aerosols.

For animals glanders is essentially an intestinal infection. The infection of people through the skin is used not because the alimentary method of introducing the causal agent cannot infect man but rather because this mechanism of transmission of glanders corresponds to the form of contact which

man has with the sick animal (L. V. Gromashevskiy). Therefore, with any method of application of the glanders bascillus as a bacteriological weapon all measures should be taken for the protection of food products and water because under certain conditions they can play a part of a factor transmitting the infection.

What has been said is sufficient to determine the system of measures to be used for the protection of the population against this infection in its general outlines. These measures should provide for the utilization of individual and group measures for the protection of respiratory organs and mucosae of the eyes (masks with protective goggles, shelters). In the event of use of aerosols of the causal agents of glanders, the protection of provisions and fodder from their contamination by particles of aerosol and from the diversionary infection of them.

Disinfection measures should be taken in the zone of infection. In the event of the presence of horses veterinary supervision should be established. The measures with respect to sick horses are regulated by veterinary legislation.

With the occurrence of cases among people, hospitalization and the establishment of medical supervision of the population of the affected area must be established for a two-week period.

Melioidosis, or pseudoglanders is an acute infectious disease of animals from which man can be infected. Therefore, melioidosis is a zoonosis. In its clinical picture it resembles glanders. Melioidosis is found in the Malayan archipelaeo in the southern part of Indo-China, in Burma and in southeastern India.

The causal agent of melioidosis, B. whitmori, is motile, large (2-6 microns) bacillus with rounded ends. It is arranged in pair-formation on smears; it forms capsules; it is aerobic.

The bacillus of melioidosis stains well with all analine dyes; it is gram-negative. In impressions taken from organs it stains well by the Romanowsky-Giemsa method. Staining is bipolar (the ends of the bacilli take the stain more intensely than the body of the microbe). The bipolar staining and the motility can be lost when it is cultivated on nutritive media.

The bacillus of melioidosis not selective with regard to nutritive media. It grows well on ordinary nutritive media at a temperature of 37 degrees Centigrade. The optimum pH=7, although the bacillus is not very sensitive to the reaction of the medium. The growth on five percent glycerine agar is most characteristic; on this, after 48 hours, it produces cream-colored rough colonies with a pinkish hue which somewhat resemble the colonies of the tubercle bacillus. On this medium the causal agent of melioidosis grows more rapidly than the glanders bacillus. Rough colonies of the microbe correspond to the more virulent form of the causal agent of pseudoglanders. On simple plate agar the colonies are round, slightly raised, opaque, cream-colored with irregular edges. The melioidosis bacillus can grow, forming slimy colonies which are larger than the typical ones. They are transparent or opalescent, have irregular contours and are surrounded by a slimy border. In cultures of sputum, the slimy colonies predominate (60 to 90 percent) over the typical ones. Biochemically, these colonies are no different from the typical ones. In bouillon they produce a uniform turbidity, and then a film can appear. On potato the melioidosis bacillus grows well producing a cream colored film. It possesses proteolytic enzymes: it decomposes gelatine moderately; and decomposes coagulated blood serum slowly. The melioidosis bacillus does not form indole. It ferments glucose, lactose, maltose, sucrose, mannitol and dulcite without the formation of gas. Cultures of the pseudoglanders bacillus have a distinctive odor.

The resistance of the pseudoglanders bacillus compared with other microbes which do not form spores is very great. A culture grown on glycerine agar preserves its pathogenicity for guinea pigs for eight years. It tolerates desiccation well even under conditions which as much as possible approach natural conditions. Thus, a freshly-isolated culture of pseudoglanders bacillus mixed with earth can put in a drier (at a temperature of 27° centigrade for 27 days) can infect guinea pigs by means of intranasal administration. In water the causal agent of melioidosis is preserved for 44 days; in stool for 27 days; urine, for 17 days; in a decaying cadaver, 8 days.

The pseudoglanders bacillus is relatively resistant to disinfectant: one percent phenol, 0.1 percent formalin kill it in less than 24 hours.

The causal agent of melioidosis is not sensitive to the

effect of penicillin, streptomycin or bacitracin even in the presence of high concentrations of them in the neutrative medium. Aureomycin, terramycin, neomycin and chlormycetine check the growth of the microbe, particularly the last-mentioned antibiotic. A combination of antibiotics does not increase their effect on the mellioidosis microbes. Therefore, although there are as yet no reports as to the testing of antibiotics on patients with melioidosis. The treatment of them is very promising.

The pseudoglanders bacillus produces the disease in guinea pigs, rabbits, rats, mice, cats, dogs, sheep, goats and monkeys. Guinea pigs, rabbits, and puppies are most susceptable to mellioidosis. Guinea pigs may be infected by any route or by any method. The most reliable method is the subcutaneous injection of the material. However, the disease occurs also from intranasal infection; through moistening the oral cavity with a culture; application of the material on to the scarified skin, etc. In the event of subcutaneous infection death occurs on the second to fourteenth day. At autopsy, solidary abscesses with regional lymphadenitis, splenolmegaly, hepatization of the lungs and the enlargement of the suprarenals are found. In rats melioidosis has a prolonged course, slowly leading to death. Horses are more resistant to mellioidosis than to glanders. Cold-blooded animals and birds are not at all susceptable to melioidosis.

Under natural conditions melioidosis afflict rats and mice. Epizootics have been observed among guinea pigs and rabbits in vivaria. Dogs and cats are infected through eating the cadavers of rats and horses. Hogs can be infected the same way, becoming chronic carriers.

The environment is infected by excretions of sick animals: mucopurulent excretions from the nose, purulent excretions from the skin, urine and feces. Human sputum may be added to this.

There are as yet no reliable data concerning the mechanism of transmission of melioidosis and the routes of spread of it. A peroral route of infection has been supposed, but Roseberry does not exclude the possibly of mellioidosis infection through the respiratory organs. Probably, the transmission of melioidosis is possible through blood sucking insects. In this connection, the findings of spontaneously infected rat fleas and mosquitoes (Aedes Aegypti) are interesting in this respect. The duration of the incubation period in melioidosis has not been established. The duration suggested is three or fourteen days. The desease occurs in three forms: acute, subacute and chronic.

The acute form of melioidosis is characterized by sudden onset, high temperature, severe headaches, shortness of breath, vomiting and diarrhea and muscle pains. In this form melioidosis has a course resembling sepsis or septicemia. This similarity is enhanced by the appearance of abscesses in the muscles and (parenchymatous organs, abscesses in the skin, etc.). A leucocytosis (15,000 leucocytes per cubic millimeter) are noted in the blood. The blood formula shows a neutrophilia with a considerable shift to the left (young forms). In the majority of cases the disease in the acute form leads to a fatal outcome in 5-10 days. In certain cases it begins with severe diarrhea resembling cholera. The disease occurs also in a lightening-like form, terminating in death of the patient within a day. Differential diagnosis should be made from pulmonary and septic plague, acute glanders, typhoid fever and the comatose form of malaria.

In the case of a subacute course of melioidoisis multiple purulent foci are observed in the form of pulmonary abscesses, purulent orchitides, myositides, osteomyelitides, etc. The meninges can be involved (according to the tuberculous meningitis type). The course is prolonged (three to four weeks) and, if the patient does not die, it passes into the chronic form.

Chronic melioidosis is characterized by the existance of multiple cutaneous ulcers and abscesses with fistulae particularly in the area of the buttocks. The course is very prolonged and te[illegible]inates frequently in death from cachexia. This form can resemble tertary syphilis, cutaneous tuberculosis, chronic glanders, brucellosis, mycoses of the skin and bones.

There is a high mortality rate in melioidosis.

Autopsy reveals cascous nodes surrounded by an area of acute inflammation which are characteristic of this disease in all organs. In the early periods these nodules are very small. The liver is enlarged and also contains numerous caseous nodules of irregular shape. The nodules can become confluent and are of considerable size. The spleen is also enlarged, and on its surface numberous yellowish-white caseous nodules of various sizes are seen. On section the same nod-

ules are found as well as abscesses. The presence of the caseous nodules and abscesses is noted also in the kidneys, bladder, gall bladder and lungs, in the subcutaneous tissue, muscles and bones.

Histological examination shows that the nodule represents a granuloma with polynuclear and mononuclear cells with necrotic centers. Small cellular element are arranged along the periphery of the granuloma. In the granuloma epithelioid cells are sometimes observed. Giant cells are not found in the granuloma.

The laboratory diagnosis is made by infecting guinea pigs with infected material and also by blood cultures and cultures of pus from abscesses of the patients and from pieces of organs and tissues of the spleen, liver, lungs, lymph glands and blood taken at the time of autopsy. A culture of the bacillus of pseudoglanders is most easily isolated from fresh pus taken from the dissection of abscesses.

The culture isolated, is used, in addition to studying its cultural characteristics, for infecting guinea pigs. As has been mentioned above the infection may be accomplished by any route. The application of the culture to the mucous membranes (eyes, nose, vagina) produces a suppurative process with the formation of ulcers and a high temperature. The regional lymph glands are involved in the process also. Death of the guinea pigs occurs approximately after a week. Subcutaneous injection of the culture produces first a dense infiltrate, which becomes necrotic on the second to third day and which changes into an indolent ulcer with undermined edges. The regional lymph nodes are enlarged and suppurate. Purulent foci are formed in various organs. The animals die at the end of the second to third week. Characteristic changes occur through the infection of guinea pigs (males) intraperitoneally. In addition to peritonitis with the formation of nodules [illegible] the omentum and internal organs, the male guinea pigs develop orchitis after two days (Strauss phenomenon). The bacillus of pseudoglanders can be isolated from the testicular exudate.

The melioidosis bacillus is agglutinated by the serum of animals which have been imunized against glanders and, vice versa, which speaks for their great serological similarity.

With patients' sera an agglutination test may be performed.

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A dilution of 1:100 is considered a diagnostic titer. The complement-fixation test is more sensitive and may be positive while the agglutination test is negative. Fresh antigens possess great specificity.

In patients with melioidosis the cutaneous allergic test with mallein can be positive.

Since the routes of spread of melioidosis are not known it is hard to speak of the most probable methods of using the pseudoglanders bacillus as agents of bacteriological attack. French authors, discussing problems of bacteriological warfare, believe the pseudoglanders bacillus to be a very probable agent for attack, because melioidosis is accompanied by a high mortality rate, and also because the physicians of European governments are not acquainted with this disease (and its causal organism). Roseberry (United States of America) shares this opinion.

The lack of information concerning the natural mechanisms of transmission of melioidosis cause us to suppose that the pseudoglanders bacillus, at least at first, would be used by all possible methods until the most effective of them is elucidated. Foreign research workers, discussing this problem, actively emphasize the ability of the causal organism to produce the disease by any route of penetration into the organisms of animals. Roseberry adds that the lack of proof of the droplet method of transmission should not be taken into consideration, because even the pulmonary form of plague is not encountered in localities with a hot climate. The same thing can occur with melioidosis. Objections may be raised to this research workers' interpretation of the pathogenesis of the pulmonary form of plague. However, undoubtedly, this speaks for a possible application of the causal organism of melioidosis in the form of an aerosol as the most universal method (inhalation of the causal organism, swallowing of microbes which have settled in the oral cavity, settling of the microbes on the mucous membranes of the nose and eyes).

Although the Soviet Sanitary Epidemiological Service has no experience in combatting melioidosis, nevertheless from what has been said above the general principles of prophylaxis of and combatting this disease can be marked out. Apparently, general measures for the protection of water and food products against bacterial contamination as well as measures for individual and group protection from aerosols (regardless of the species of causal organisms) should be extended to

melioidosis. Taking into consideration the role of rats and mice as possible sources of the infection general measures should be supplemented by the accomplishment of deratization and the protection of food products and water against the access of these rodents to them. With the appearance of cases the patients should of necessity be hospitalized, and their clothes and household objects should be disinfected.

Brucellosis is a wide-spread zoonosis which involves short- and long- horned cattle and hogs which are the sources of the infection. Brucellosis is one of the intestinal infections according to the mechanism of its transmission.

The properties of the causal agent of brucellosis, according to the prevalent opinion, are distinguished depending on which species of animal it adapts itself to. Therefore, at the present time it is customary to distinguish three species of brucellae: 1) *Brucella melitensis*, which produces a disease of sheep, goats, etc., 2) *Brucella abortus bovis*, which produces infectious abortion in long-horned cattle, and 3) *Brucella abortus suis*, which produces abortion in hogs. All species of brucella are very similar in their biological and serological characteristics. The differentiation of them presents considerable difficulties. This has given certain research workers the grounds for the belief that there is a single causal organism which changes certain of its properties when it passes from one species of animal to another. From this point of view, the greater infectivity of *B. melitensis* should be explained by the readier transmission of the infection rather than the properties of the causal organism.

Brucellae are small cocco bacteria which stain readily with analine dyes, and are gram-negative; non-motile and do not form spores or a capsule; they do not possess proteolytic or saccharolytic properties; they do not form indole. Hydrogen-sulfide is given off during growth on bouillon.

Brucellae are readily grown on ordinary neutrative media, grow well on liver bouillon. Colonies of brucellae on Petri dishes containing agar are colorless, convex, rounded, and with regular contours. In bouillon they produce a uniform turbidity.

Brucellae possess great resistance to the effect of various environmental factors, although they do not form

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spores. They are resistant to desication, to the effect of light, to low temperatures, and are preserved for a long time in water and soil (2-2-1/2 months). In urine, the brucellae are preserved for six days. In food products they are preserved for a much longer period of time: in milk, for several days, in butter and fresh cheese, for 15-45 days, in brynze (cheese made from ewe's milk) in the presence of high acidity (at 50° according to Turner), 72 days; with higher acidities, they die more quickly. In meat (salted or frozen) the brucellae are preserved for 15-30 days. Heating to 58 or 60° kills the microbes in 30 minutes. They are sensitive to generally used disinfectants in ordinary concentrations to the same degree as other microbes which do not form spores.

The fact that the culture of brucellae in sealed containers preserves its viability for several months is important.

Brucellae are pathogenic for many species of animals. All the representatives of the short- and long-horned cattle, hogs, horses, camels, dogs, and cats can be infected by them; rodents, including all laboratory animals, are susceptible to them. To be sure, the role of various animals as a reservoir of the infection is not the same. The part of rodents (susliks, mouse-like, and others) as sources of the infection under natural conditions is doubted by many research workers.

All species (variants) of brucellae are pathogenic for man. Infection of man under natural conditions is accomplished by the peroral route. The incubation period lasts, on the average from 12-20 days (from 7-30 days). The disease begins with a gradual rise in temperature. Fever is prolonged with periodic remissions (undulating fever), which is associated with a trenching sweat. Deviations from this typical form of fever are often observed along with it: brief temperature rises, typhoid-like fevers with very long remissions, with low-grade fever. Sometimes, there is no rise in temperature at all, and ~~only a positive~~ agglutination reaction (Wright) and an allergic cutaneous reaction attest to the previous infection. In febrile patients enlarged lymphnodes (polyadenitis), an enlarged spleen and liver are found. The pulse is of increased frequency (regardless of the temperature). The blood pressure is lowered. Leucopenia and monocytosis are noted. Involvement of the nervous (neuralgia, neuritis, polyneuritis), synovial and bone-joint systems (bursitides and tendovaginitives, arthritides, and coxitides) are characteristic of brucellosis. Orchitides and epididymitides are observed. Not uncommonly, secondary involvements of the respiratory organs (bronchitides, relapsing bronchopneumonias, etc.) are encountered. The complications of brucellosis are very diverse.

In brucellosis (not considering the ambulatory forms) the mortality rate is equal to approximately eight percent. A vaccine is used as a specific therapeutic measures. Recently, the use of chloromycetin, biomycin (aureomycin) and streptomycin have been recommended.

As has been mentioned above man is infected by the peroral route. Therefore, it is very easy to imagine that the brucellae can be used for diversionary infection of food products and possibly also of water. At least, the length of survival of the brucellae in them allows of such a possibility. The question of the possibility of producing a brucellosis infection through the respiratory organs under artificial conditions remains discussionable. Based on the great infectivity and on reports of cases of laboratory infection (particularly by <u>B. abortus bovis</u> suspended in air), Roseberry asserts that infection through the respiratory organs is quite probable. In this case it may be expected that the brucellae can be used in the form of aerosols.

It is very difficult to form an opinion concerning the epidemic quality of brucellae as agents of biological attack, because there are no reliable data concerning the infection of man by man. However, the morbidity rate for brucellosis is generally low compared with other intestinal infections. Therefore, this phenomenon may be explained by the relatively small number of patients as sources of infection. The possibility exists that mass artificial infections of people during a biological attack can bring about an increased contamination of environmental elements by the brucellae (for example, as a result of the excretion of brucellae in the urine) with the subsequent spread of brucellosis from man to man, that is, an epidemic proper.

In addition to this, the use of brucellae can lead to infection not only of man but also of animals which play a great part as sources of infection (sheep, goats, cows, hogs). Infection en masse of these animals undoubtedly would be accompanied by an increase in morbidity among people, but through routes characteristic of brucellosis (consumption of milk and milk products, contact with sick animals).

Laboratory methods of determining brucellae permit isolation of them not only from objects in which a few brucellae exist (blood, amniotic fluid, pieces of organs are taken at autopsy) but also in the event these objects contain many other microbes, as, for example, in urine, feces, etc. This makes it possible to examine various environmental objects (washings of various articles, food products, etc.). Such an examination is based on the fact that gentian violet solutions (1:200,000) inhibit the growth of the other microflora without involving the brucellae. In cases where a small number of microbes may be expected in the fluid, concentration of them is carried out (serum agglutination, centrifugation, filtration through membrane filters, etc.). Milk is centrifuged or is left in the cold and a culture is made from the cream which separates out.

The laboratory diagnosis of brucellosis in man and animals is based on a bacteriological examination (of blood, urine, stool, spinal fluid, pus, amniotic fluid, etc.), on serological analysis (Wright reaction) and on the intracutaneous allergic test (Burnet reaction).

A very reliable method of detection of the causal agent of brucellosis is the performance of the biological test. In the event the material being examined is contaminated with saprophytic flora or where the concentration of brucellae is small the infection of highly-susceptible laboratory animals (guinea pigs, white mice) should be accomplished along with the bacteriological method of examination.

A shortcoming of the methods of examination for brucellosis is the length of time needed for them, because brucellae grow very slowly when separated from the body. The first generation of brucellae in a culture, for example, of blood is sometimes obtained after several weeks of keeping it in a thermostat. In subsequent generations the growth of the brucellae excelerates considerably. Under these conditions serological and allergic reactions assume particularly great importance for making the diagnosis of the disease. However, they have no significance for the determination of the species of causal organism at the time of the attack. It may be considered that bacteriological examination under conditions of an attack would not require a prolonged cultivation of bacteria, because strains would be used inevitably which have already been grown for a long time on artificial neutrative media.

Specific prophylaxis of brucellosis can be carried out with a live brucellosis vaccine. In the event of an attack by means of aerosols consisting of brucellae the population should use such individual and group measures of protection as masks and shelters.

General measures for the safeguarding and protection of water and food products prevent infection of them by any pathogenic microbes, including brucellae.

For the purpose of protecting the population against this infection measures should be provided directed against the infection of cattle. The veterinary service of the MPVO [Local antiaircraft defense] should carry out a systematic observation for the existence of brucellosis infection in domestic animals. In the presence of any kind of report to the effect that an attack has been made an increase in the number of cattle affected by brucellosis (according to serologic and allergic tests) requires the adoption of special measures (intensification of the sanitary-veterinary routine on farms, transfer of cattle to stalls, etc.). In the event brucellae have been used in the form of aerosols the general system of sanitary-veterinary measures should be extended to include privately owned cattle on the territory which has been exposed to attack (in the area of inspection).

Naturally, disinfection measures should be carried out in the area of infection with consideration of the stability of brucellae in the environment. There are reports that in a large scale infection by brucellae the requirements made on disinfection conditions should be extended. If the cattle pastures have been exposed to infection they should be fenced off, and cattle should not be permitted to graze on them for three to four months. If conditions permit, such fields should be plowed under. After the period of time indicated it may be considered that the fields are free of brucellae as the result of their natural extinction.

In connection with people who have become sick ordinary anti-epidemic measures are used (hospitalization, disinfection of the focus, etc.). With the suspicion of a mass infection of people antibiotics may be used prophylactically.

Cholera. The causal agent of cholera is the vibrio cholerae asiaticae, which has the shape of a comma, is a curved bacillus, possesses great motility, does not form spores. The causal agent of cholera is a strict aerobe, stains well with all

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analine dyes, is gram-negative, is readily cultured on ordinary nutritive media. Culture of it on one percent peptone water, which is the first step in the bacteriological examination, is based on its consistent relationship to nutritive media and its pronounced aerobiosis.

The resistance of the cholera vibrio to the effect of physical and chemical factors is not great. On boiling, it dies in a moment; at a temperature of 80° centigrade it dies in five minutes, and at 56°, in a half-hour. The cholera vibrio is resistant to low temperatures. On objects contaminated with feces it survives for several days; in food products it is readily preserved if they are not acid; in milk (before souring) it can even multiply; in water it is preserved for a long time. It is very sensitive to acids: a solution of hydrochloric acid 1:10,000 kills it in several seconds. Chlorinating the water guarantees its safety.

Only man is a source of infection (patient or vibrio carrier). Infection of man is possible only by the oral route, that is, cholera is a typical intestinal infection. As in the case of the other intestinal infections the routes of spread are numerous. Water and food products can play an important epidemiological part.

Large outbreaks can be produced by the consumption of contaiminated water, particularly when there is a centralized water supply.

The infection of local water sources leads to the predominance of the disease in regions in which these water sources are utilized. Infected rivers can lead to the infection of inhabited places along them, particularly of rural localities, in which water is often utilized directly from the rivers. Further spread of cholera is effected by the same variety of routes as in the other intestinal infections. The role of the fly factor is important in the seasonal rise of the disease incidents. The great epidemic tendency of cholera is determined by this.

The use of the cholera vibrio as an agent of biological attack is determined by what has been stated above. Evidently, an attack can be effective only through the infection of the water supply. The system of purification and disinfection of water at community water supply centers completely eliminates the cholera vibrio from it. On this basis, Roseberry, in general, doubts the possibility of application

of it. However, in Korea (in Dai-dung) the water-purification equipment was destroyed by bombing prior to infection of the water source but the waterworks itself was not touched [the term "waterworks" is used here in the sense of water-distributing element in contrast to the water-purification element]. Under such conditions the infection of the water can lead to the occurrence of an outbreak if it is not recognized in time.

Infection of the water in the water supply system (auxiliary reservoirs, etc.) is possible if there is an insufficient quantity of residual chlorine in it. To be sure, this can be accomplished most readily by a diversionary method. The site of infection can be established by epidemiological examination with adequate accuracy: the great majority of cases will be in the area supplied by the infected water.

The clinical picture of cholera is characterized by diarrhea, vomiting, convulsions, hypothermia and in severe cases, by cynosis. The incubation period lasts from several hours to six days (on the average, one to three days).

In contrast to other diarrheal diseases the cholera diarrhea is not accompanied by tenesmus, the excretions are very copious, odorless and colorless, and are of a liquid consistency. Because of the desqumating epithelium of the intestine these stools resemble rice water. There are many vibrios in the excretions which are readily detectable on microscopy.

The excretion of a large quantity of fluid with the vomiting and in the diarrhea leads to marked dehydration of the body and demineralization of it. The occurrence of other clinical features are associated with this: marked sharpening of the facial features and cynosis of the face (<u>facies cholerica</u>), loss of the voice, intensification of convulsions, loss of skin turgor, etc.

There is no specific treatment. The use of antibiotics (streptomycin, terramycin and others) is possible.

Laboratory confirmation of the diagnosis of cholera is obligatory. A preliminary analysis is made on the basis of the microcopy of the excretion. At the same time, a culture is made on peptone water with subsequent plating out on alkaline agar, by the isolation of a pure culture and the performance of the agglutination test. An important differential feature is shown by culturing on blood agar.

Shipping of the material for examination is carried out using the same precautions as for other particularly dangerous infections. Specific prophylaxis is carried out by inoculations of a cholera monovaccine or by combined preparations in which the cholera vaccine constitutes a component part. Extensive phage prophylaxis, which includes the whole population without exception, is carried out in the focus of infection.

The general anti-epidemic measures are the same as for the other intestinal infections. The high degree of epidemicity of cholera makes it essential that these measures be conducted more carefully and in short order. Hospitalization of suspected patients should be carried out using isolation technique before clarification of the diagnosis; however, known cholera patients can be placed in general wards. Persons (clinically healthy) who have been in contact with patients are isolated in special institutions for the purpose of constant observation. They are carefully examined bacteriologically in order to detect vibrio carriers. The persons under observation are given bacteriophage (after material is taken for laboratory examination).

Requirements for the condition of the water supply, cleanliness of cities and the sanitary routine at food industries are made stricter. Constant special bacteriological examinations of water for the cholera vibrio are made.

The fight against flies should be carried out most vigorously.

The observance of the rules of personal hygiene by the population plays a tremendous part in the prophylaxis of cholera. Therefore, sanitary propaganda among the population should be markedly increased.

Typhoid and paratyphoid fevers. The causal agents of typhoid fever and paratyphoid fevers A and B are biologically related microorganisms which produce unitypical, clinically indistinguishable diseases which have common epidemiological rules and regulations.

Typhoid and paratyphoid fever microbes are bacilli of average size (1-3 microns). They do not form spores, are

motile; they stain well with all analine dyes, are gram-negative; grow well on ordinary media, producing a uniform turbidity on liquid media, while on plate agar (in Petri dishes) their colonies are clear, round, slightly convex, with smooth borders and two to three millimeters in diameter. They are biochemically active: they decompose glucose, maltose, mannitol, and certain other carbohydrates (except for lactose and sucrose) forming acid (the typhoid fever microbe), or acid and gas (the paratyphoid fever microbes). These properties of the typhoid-paratyphoid microbes are constant and can be used as a differentiating characteristic.

Microbes of the typhoid-paratyphoid group are quite resistant in the environment. They survive up to four days in tap water; in stagnant water, for about two weeks; in sewage and in soil of irrigation fields they are preserved for two weeks; in cadavers, up to a month. In pasteurized milk they live for four months, and in other food products, depending on the acidity, preservatives and other conditions, from several days to several months. Desiccation on various objects does not kill the microbes immediately: they survive for several days. When desiccated from the frozen state the microbes not only survive but also are well preserved.

Under natural conditions, a disease corresponding to the clinical picture of typhoid fever (which is produced by all three species of microbes) exists only in man. Such a disease cannot be produced in any species of animals even using experimental infection, although the administration of large enough doses of microbes causes the death of the animal from intoxication. Therefore, the only source of infection is man.

The infection occurs by the oral route. The incubation period in typhoid lasts for one to three weeks; in the paratyphoid fevers, from two to three to fourteen days. The clinical picture of typhoid fever is characterized by a very severe headache and depression during the first few days of the disease, by a slow increase in temperature (stadum incrementi), by prolonged fever (acme), by a general serious condition (typhoidal state), by a roseolar rash on the abdomen and chest, by a slow decrease in the temperature (stadium decrementi) and by a gradual improvement in the condition of the patient. Deviations from the typical clinical picture are possible in the direction of a milder course, particularly in those who have been inoculated. The idea that all cases of the disease with a mild course are paratyphoid fever

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is unconditionally erroneous: the severity of the course of the disease depends less on the species of causal organism than is customarily thought. Accurate diagnosis can be established only by laboratory means. In recent years, levomycetin (chloromycetin) and biomycin (aureomycin) have been used successfully for the treatment of typhoid fever.

As has been mentioned above, the only source of infection can be man, a patient or a bacterial carrier. Because the infection occurs through the oral route, the transmission factors can be either food products or water (including non-alcoholic beverages), which can be infected by the most varied means (flies, dirty hands, the access of contaminated sewage to reservoirs, etc.). The consumption of infected food products and drinks leads to the occurrence of new cases of the disease. The epidemic quality of typhoid fever, which under appropriate conditions can always become an epidemic outbreak, is determined by this factor. It exists when there is infection of water in watermains, of milk in dairy farms and creameries, of any dishes in large public dining rooms or factory kitchens, etc., that is, in those cases where infection of the water and food products occurs which are used on a large scale and which come from a single source. This determins the method of application of typhoid-paratyphoid microbes as agents of attack. Evidently a diversionary infection of the water and food products would be most probable.

Infection of water in reservoirs would hardly be effective in view of the existing system of purification and disinfection (chlorination) of it at the main structures of the public water supply. The penetration of a sufficient number of typhoid-paratyphoid microbes into the water supply network is possible only in the event the established sanitary-hygienic norms, which can be guaranteed only by strict observance of generally accepted methods of water purification, are violated. Naturally, under conditions of a possible attack the requirements for the observance of a routine of operation of the water supply systems should be made more rigid.

One of the violations of the sanitary-hygienic standards which can devaluate all the efforts of workers in public water supply systems is the combination of a water supply network used for drinking with an industrial water supply. When water is taken from an open reservoir it is not subjected to purification, because it is designed for technical purposes. In certain cases, when for various reasons there is not enough water, the industrial water supply network is combined with

the public water supply. As a result of an asynchronous change in the water pressure in the two water supply networks, the entrance of unpurified (so-called "crude") water is possible into the network of the public water supply system. Naturally, in such a case infection of the water in the reservoir can be effective. Some industrial administrators have been attempting to diverge from the requirements of the health agencies that the public water supply be kept unconditionally separate from the industrial water supply on the grounds that chlorination of the water is carried out in the latter. Such digressions should be stopped most decisively, because chlorination of unpurified water is not very effective because of the large amount of organic substance which combines with the active chlorine. Increasing the quantity of chlorine added cannot be unlimited, because it would have a marked effect on the quality of the water, which acquires the taste of phenol. In practice, this leads to the fact that chlorination is carried out with ordinary doses of chlorine, which does not assure the disinfection of the water. The considerations presented above permit us to believe that strict observance of sanitary-hygienic standards developed under ordinary conditions guarantees the disinfection of the water even under conditions of biological warfare. This is not a chance coincident. Sanitary-hygienic standards have not been worked out through speculation, but rather through the process of assuring disinfection of water from open reservoirs contaminated by sewage.

Therefore, a diversionary infection of open water sources cannot be effective if it is not combined with a destruction of the purification equipment.

The infection of water can be accomplished, however, in the water conduits and in the water distributing system. Depending on how the water distributing system branches off from the site of infection to its terminal points, the focus of involvement by the infection may be greater or smaller. The presumptive site of infection can be indicated with more or less accuracy by an epidemiological examination of the focus of infection. Factors contributing to the infection are marked variations in the water pressure in the distributing system. A fall in pressure in the system, up to a vacuum, renders infection of the water technically easy to accomplish. Poor maintenance of water towers, access of inspection pits to the water distributing network, and the absence of protection for auxiliary water reservoirs etc. also can contribute to this.

A diversionary infection of food products with typhoid-paratyphoid microbes can be expected first of all at industries the products of which are not afterwards subjected to thermal processing (bread, ice cream, certain confectioneries, hors d'oeuvres, etc.) or where thermal processing is not obligatory (milk). To a certain degree this also pertains to the large mercantile establishments, which extends the assortment of food products which can be exposed to infection (sausages and similar meat products, fruits, certain vegetables, etc.).

The question of the possibility of application of an aerosol of typhoid-paratyphoid microbes is being discussed in the press. It should be noted that there are no data in existence concerning the possibility of artificial infection by typhoid-paratyphoid microbes through the respiratory passages. However, it may be assumed that the existence of microbes in the air will lead to a settling of them in the oral cavity and in the nasopharynx, and they will be swallowed together with the saliva. The disease occuring thereby would be associated with the natural mechanism of infection rather than with any portals of entry which are not characteristic of the typhoid-paratyphoid microbes. In addition, the application of aerosols can lead to contamination of environmental objects (even aside from food products and water) with which man comes into contact, and then the microbes carried into the mouth by contaminated hands can be swallowed along with the food, etc. In other words, regardless of whether infection can occur through the respiratory passages or not, the use of typhoid-paratyphoid microbes in the form of aerosols cannot be eliminated as a possibility, although a priori. It would be difficult to determine the effectiveness of this method of application. These considerations pertain to a certain degree also to the cholera vibrio.

Everything stated above determins the system of preventive measures which need to be adopted before an attack occurs. Among them are a proper arrangement of the water supply system of inhabited places (observance of the technology of water purification, proper maintenance of the waterworks, a continuous operation of the pumping stations, etc.) and an appropriate routine for enterprises of the food industry and mercantile system (protection of food products from external contamination at all stages: from preparation to consumption). Diversionary acts can be prevented only through ineffective

protection of various objects. These measures should be supplemented by constant bacteriological control of the water: by determination of bacterial contamination with pathogenic microbes.

In the case of the use of aerosols protective individual and group measures should be used (masks and shelters) for the prevention of direct infection of man and also all the numerous measures for the protection of food products and water not only at the factories and mercantile points (sealing of storehouses, covering food products, etc.) but also of the food products and water existing among the population. Food products which have not been covered, and therefore which are possibly contaminated, should either be destroyed or subjected to thermal processing. All the measures for the protection of water and food products should preceed the advent of the aerosol cloud, that is, practically they should be carried out continuously, because it is impossible to determine the moment of attack beforehand. After the attack, access to food products can be permitted only after disinfection of all surrounding objects and rooms, etc. has been carried out. The food products should be unwrapped in such a way that they are not contaminated from the outside of the container or from the means of covering them before disinfection is carried out.

Prophylactic measures can be supplemented by immunization of the population with a vaccine prepared from a combination of all three causal organisms (triple vaccine).

After the occurrence of cases of the disease the measures taken are no different from the measures for combatting typhoid fever which have proved themselves. In connection with the fact that careful systematic medical observation should be carried out in the area of infection constantly, the early detection of febrile patients will be facilitated. Early hospitalization of patients and careful disinfection along with other measures (the cleaning of rubbish in the yards, the fight against flies, inoculations, etc.) when accomplished punctiliously and promptly can prevent the spread of infection among the population.

Bacterial dysentery. Dysentery is a general infectious disease with predominant involvement of the large intestine, which is manifested in frequent stool, usually with mucosanguineous excretions.

Dysentery is caused by several species of microbes: by the Grigor'yev-Shiga, by the Stutzer-Schmiez bacillus, and by microbes of the Flexner group, by the Sonne-Cruzi bacillis, etc. The causal organisms of dysentery are non-motile, do not form spores, are gram-negative. The Grigor'yev-Shiga and Stutzer-Schmiez microbes form a toxin. They grow well on ordinary nutritive media. The species listed are different in their biochemical and serological characteristics.

Under environmental conditions, the resistance of the causal agents of dysentery is less than that of microbes of the typhoid-paratyphoid group. In the stool of patients dysentery bacilli die in several hours. In impure water they die in two to four days, and in sunlight, in two and a half to three hours. The causal agents of dysentery survive for two months in ice. In food products they survive for several days.

Bacterial dysentery is a human disease. Spontaneous cases of dysentery are also observed in monkey houses. The disease can be produced in cats under laboratory conditions. When mice and rabbits are injected with dysentery microbes they die from intoxication by endotoxins. Therefore, the only source of dysentery is man.

The clinical course of dysentery has been discussed extensively in the special literature, and there is hardly any need to describe the entire well-known picture of dysentery. In this section mention should be made only of the great variability of the course of dysentery (from a severe toxicosis to the so-called "irritable bowl") which complicates its clinical diagnosis. In addition, the great frequency of the stool, which is associated with the excretion of a large quantity of infected material into the environment is important in an epidemiological connection, and to a certain degree this compensates for the low resistance of the microbe.

The routes of spread of dysentery are the same as for typhoid fever. However, the low resistance of the dysentery microbes limits the importance of such a factor as water. This, to be sure, does not mean that water-borne outbreaks of dysentery do not occur at all. When the causal organisms enter the drinking water large outbreaks develop. However, water-borne epidemic outbreaks in dysentery are much less common, obviously because massive infection of water sources is relatively rare on account of the low resistance of the

microbes and as the result of the rapid extinction of the microbes. The coincidence of a massive infection of the water with errors in the operation of the water supply system (inadequate purification and chlorination) are necessary for the occurrence of an outbreak. However, the effect of other epidemiological factors (flies, dirty hands, etc.) is so active that spread of dysentery proceeds very vigorously and generally involves more of the population than does typhoid fever.

Taking into consideration the characteristics of dysentery microbes and the epidemiology of dysentery it may be assumed that causal agents of this type of disease can be used as an agent of attack only by the diversionary method. Here the water supply network or rapidly-spoiling food products which are not subjected to thermal processing can be exposed to infection. Roseberry considers that dysentery causal organisms can be used for the infection of water reservoirs, food, milk, etc. during a retreat, which also to applies to the category of diversionary acts.

Therefore, the prophylaxis of infections amounts to the observance of the sanitary standards in the water supply system and possibly to an increase in the chlorine content in the water, and also to a protection of food products against infection. Sanitary propaganda among the population should play an important part (as in other cases): the consumption of boiled water and thermally processed (boiling, washing fruits and vegetables with hot water, etc.) of food products is a guarantee against infection by dysentery bacilli.

With the occurrence of cases of the disease the same measures are used which are taken in the fight against dysentery under ordinary conditions. These measures have been quite well worked out and are generally known.

Typhus. The causal organism of typhus, is the Rickettsia prowazeki. In smears the Rickettsia prowazeki has the appearance of cocci, bacilli, and sometimes of filaments which are often arranged in pairs and rarely in chains. Study by means of the electron microscope has shown that they possess a membrane and many inclusions in the cytoplasm. A bipolar structure is shown by means of the phase contrast microscope. After staining by the Romanowsky method brightly staining chromatin granules, which are arranged differently depending on the morphology of the cells (P. F. Zvrodovskiy), are found in the bodies of the Rickettsiae.

The Rickettsia prowazeki is a microorganism with little resistance, like the majority of intracellular parasites. However, this does not mean that they die instantly after coming out into the environment. Under some conditions, they are preserved for quite a long time. Thus, in the stools of lice under low temperature and low humidity conditions the Rickettsia prowazcki remain viable for several months. Under artificially created conditions (desiccation in the frozen state) the rickettsiae can be preserved for several years. This speaks for the possibility of prolonged preservation of the rickettsiae in the capacity of an agent of biological attack.

Modern methods of mass production of typhus rickettsiae have been quite well developed. They can be grown in lice, in the yolk sacs of chick embryos and in the lungs of rodents, maintaining their pathogenicity for man.

Man is absolutely susceptible to typhus. The epidemiology of typhus is quite well known. The only vector of the infection is the louse. In the complete absence of lice a patient does not constitute a danger to those around. However, this does not mean that a person cannot be infected artificially by another route. Cases of laboratory infection with typhus during the preparation of typhus vaccine in mice speak on behalf of such a possibility. The intranasal infection of mice produces sneezing in them, even though it is carried out under light anesthesia. This, in its turn, produces a dissemination of the infectious material in the air. Laboratory workers who are in the same and sometimes in the next room are infected by breathing the air contaminated with the rickettsiae. Therefore, the portals of entry for the typhus infection may be the respiratory organs. By comparing this with the possibility described above of keeping the Rickettsia prowazeki in a desiccated condition for a long time, the conclusion may be reached that the possibility exists of using the causal organism of typhus in the form of an aerosol as an agent of biological attack.

The clinical picture of typhus is characterized by an acute onset, by a rapid temperature rise (for two to three days), by a typhoidal state, disorder of activity of the cardiovascular system and by petechial rash which appears on the fourth or fifth day. The fever remains about two weeks, after which the temperature falls by crisis or by an abbreviated lysis. At the climax of the fever definite signs of intoxication develop in the central nervous system (typhoidal state, restlessness, delirium, hallucinations, etc.) and in the heart (degenerative changes of the muscle, involvement of the vessels).

The briefly described signs of typhus infection can be preceded by prodromal signs consisting of headaches and muscle aches, poor sleep, rapid fatigability, etc. The presence of such signs in cases of possible infection (in a focus of infection) should attract attention and should be considered to be incipient typhus, and the entire complex of anti-epidemic measures (hospitalization, insect elimination) should be taken with respect to the patient in the focus.

There is no reliable information as to how rapidly after an infection through the respiratory organs the signs of the disease appear. It is possible that the incubation period is of the usual duration (on the average, 14-15 days).

The <u>Rickettsiae prowazeki</u> when used as an agent of attack would not possess any epidemic tendency if participation of the only vector of the infection--the louse--iseliminated. Therefore, anti-epidemic measures in the area of infection should primarily provide the careful accomplishment of insect elimination. When a locality with a large number of inhabitants is affected, the citizens themselves may be brought into the work of insect elimination, providing them with insecticidal soap. Correctly and carefully performed measures can completely prevent the spread of typhus, limiting the number of cases to those directly infected.

Specific prophylaxis (vaccination) is possible but has not been adequately worked out as yet.

<u>"Q" Fever (pneumorickettsiosis)</u>. A particular species of rickettsiae, the <u>Rickettsia burneti</u>, is the causal organism of an unusual rickettsial disease which occurs in people in the form of an acute febrile disease, usually with the presence of pneumonia but in the absence of a rash, and which has been given the name "Q" fever. Rickettsiae represent small coccoid bodies; they can have the appearance of small or of large bacilli, and sometimes form filaments. The formation of filtrable forms is a characteristic feature of them.

The rickettsiae are readily cultured in laboratory animals. However, in mice the infection occurs asymptomatically, but a fatal infection develops when they are infected

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with a large dose. Guinea pigs are more susceptible and, therefore, more suitable for isolation and culture of the rickettsias. Rabbits are not suited to these purposes.

The causal agent of "Q" fever is very resistant both in moist and in dry substrates. In butter made from the milk of infected cows it remains very active for 41 days. It tolerates desiccation very well: it maintains its infectivity in the feces of ticks for 566 days. Dried urine and blood of infected animals preserves its infectivity for several weeks. Pasteurization of milk reduces the number of rickettsias but does not lead to complete disinfection.

On prolonged maintenance under laboratory conditions the causal agent of this disease preserves its infectivity for a long time. Thus, in blood of infected guinea pigs kept under a mixture of oil and vaseline the rickettsias preserve their infectivity for more than nine months.

The causal agent of "Q" fever is pathogenic for many species of animals: rodents (mouse-like, susliks), wild artiodactyls (Persian gazelles), domestic animals (short- and long-horned cattle, horses, asses, dogs, etc.). Its pathogenicity for birds (for example, field sparrows) has been established.

Man is also highly susceptible to the infection.

The incubation period in "Q" fever lasts from 19-20 days (14-26 days), on the average. The onset of the disease is acute, but is not severe. The fever begins with a chill, rapidly reaches a high level and lasts for four to 15 days. It is accompanied by headaches and muscle aches, and by general weakness. There is no rash, which distinguishes it from the majority of other rickettsial diseases. Pneumonia is very characteristic of "Q" fever, while it is comparatively rare in the other rickettsial diseases. Most often, the lower lobes of the lungs are affected. The pneumonia is accompanied by a dry cough, which is found on the fifth to sixth day of the disease, and by pains in the chest corresponding to the affected part of the lungs. The pneumonia itself has an atypical course: it is not demonstrable by auscultation or by percussion; it is mainly diagnosed roentgenographically. In individual cases, it shows the course of a severe bronchopneumonia with the excretion of sputum, or proceeds subacutely, resembling tuberculosis. There is a tendency to bradycardia noted in the heart. The course of

the disease is benign, but the period of convalescence is protracted (several weeks).

In addition to this typical form, "Q" fever can occur with the most varied clinical picture. In accordance with this, grippe-like, septic, pseudobrucellosis, nervous, low-grade febrile, latent and other forms of this disease are distinguished.

The disease leaves a strong immunity in its wake.

Successful treatment is given with aureomycin (biomycin) and levomycetin [chloromycetin].

The epidemiology of "Q" fever has not been adequately clarified. However, the main data concerning it are available. Rodents and ticks are the natural reservoirs of the infection; in ticks the infection is transmitted transovarially. Evidently, domestic animals are infected by the ticks (goats, sheep, cows), and these are frequently sources of the infection for man. Therefore, "Q" fever is a typical zoonosis. It is believed that man can be infected by the oral route by consuming milk and milk products from sick animals, through the skin, as a result of tick bites, through contact with infected articles, through the mucous membranes of the eyes, etc. and respiratory passages (inhalation of air containing infected particles). Particularly great significance is ascribed to the air-borne route of spread of the infection, particularly to the inhalation of dust (the causal agent of "Q" fever is found in the dust of farms which have sick animals).

There is no agreement on the question of whether or not the infection is transmitted from man to man. The majority of research workers deny this possibility. It should be mentioned that such an idea renders completely incomprehensible the assertion that the main route of infection of people is through the respiratory passages, on which many research workers insist. In all known infections the infection of man through the respiratory passages leads to the involvement of the latter and to the spread of the infection by the air-droplet mechanism. It is difficult to believe that "Q" fever is the only exception. Therefore, either we must accept the infectivity of man for those around, with the participation of the air-droplet mechanism of transmission, or deny the chief importance of the respiratory passages in the infection of man and regard the pneumonia which frequently develops as

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secondary.

This problem is exceptionally important for understanding the natural spread of "Q" fever, for an evaluation of the possible methods of using the causal agent of this disease and the spread of the infection in an artificially created epidemic focus (focus of infection). Therefore, this problem should be discussed in some detail.

From the recognition of rodents and ticks as natural reservoirs of the infection it follows that the infection of people can occur either as the result of the consumption of infected food products (with the possible participation of an additional epidemiological link--short- and long-horned cattle), or as the result of the bite of ticks (with the possible participation of them in the infection of agricultural animals). In both cases, infection through the organs of respiration is excluded, if we overlook, in general, the exquisite cases of the infection, for example, through dust from packing straw which had been sent into a locality where there were no other sources of the infection. Reports of the dust method of infection in foci of infection where other methods of infection are possible have, at least, not been proved.

Therefore, the chief method of infection of people should be considered to be either transmissive or oral, depending on the source of the infection. This is associated with the absence of infectivity of the sick persons, particularly those who are hospitalized, because in this case there are no conditions which would contribute to the transmission of the infection to those around.

There are other relationships in the infection of man through the respiratory passages. The developing pneumonia is accompanied by the excretion of sputum which is copiously seeded with rickettsias. Under these conditions the patient can be infective for those around, although the conditions under which hospitalized persons are kept do not contribute to the expression of this property. Thus, German authors have described an intrahospital outbreak of "Q" fever among patients and medical personnel. A laboratory worker was the source of it; he had been infected in the process of working with the causal organism of "Q" fever. In the course of two months he infected 38 persons in the hospital, evidently by the air-droplet route, because rickettsias were found in the sputum. Then, despite the fact that he continued to excrete the causal organisms in the sputum for another three months, the cases of the disease stopped. Undoubtedly, this was preceded by a change in the measures taken for the patient. It is interesting to note that the source of the outbreak was a man who had been infected in the laboratory, that is, not by the natural route. It is believed that in such cases the infection is brought about through the respiratory passages. Here, there is a primary involvement of the lungs, which is accompanied by the excretion of a large number of rickettsias. From this example it is seen that under certain conditions a sick person is highly contagious.

The conditions presented above permit us to suppose that under certain conditions (for example, in the event of primary involvement of the lungs, or in the acute bronchopneumonic form of the disease) a person can constitute an epidemiological danger.

The most probable method of using the causal organism of "Q" fever, in the form of an aerosol, is determined by the possibility of infection through the respiratory passages, by the great resistance of the causal agent, by the great probability of an increase in the epidemicity of this form of biological weapon in primary involvement of the lungs, and also by the fact that massiveness of infections can readily be produced by this route. The use of infected ticks cannot be very effective both because of their biological characteristics (number of blood-suckings, poor mobility, season of activity, etc.) and because of "the lengthiness" of the outbreak produced artificially by them, which permits the timely application of the entire system of measures for protection against attack. Food products (milk, etc.) can be infected for diversionary purposes.

The establishment of the use of rickettsias by the laboratory method can be based on the examinations of various environmental objects and on material from patients. In the former case, washings should be taken from articles onto which particles of the aerosol, suspected food products, and ticks may settle (if there are any indications that they have been dropped), etc. The examination proper should be carried out in the form of a biological test by the subcutaneous infection of guinea pigs in the area of the thigh. Disease of the latter (edema of the subcutaneous tissue and gangrene of the muscles) occurs on the third to tenth day; there are many rickettsias in the affected tissues. Therefore, reinoculations into fresh animals should be made at the height of the fever in the infected guinea pigs. The rickettsias can be reinoculated into the yolk sacs of chick embryos also.

Guinea pigs can be infected with material from patients by the method mentioned above or intratesticularly; the maximum accumulation of rickettsias is found in the tissues of the testicles (in the cytoplasm of the histiocytes) on the seventh or eighth day in the form of coccoid or diplococal forms. Chick embryos can be infected directly with this material.

Making the diagnosis in patients can be based on serological examinations (agglutination reaction of rickettsias and complement-fixation reaction) also.

The prophylactic measures are determined by the method of application of the rickettsias as a weapon. Such group measures of protection as shelters protect against rickettsias used in the form of an aerosol. Individual measures of protection of the type of masks, respirators, etc. can be supplemented by vaccination in this case. The vaccine which has been developed at the resent time does not constitute a complete safeguard against the disease during an infection en masse. However, in immunized persons the course of the fever is incomparably milder, without complications, etc. Naturally, the immunization is effective also for other routes of infection.

After an attack has been made, a careful supervision (no less than 21 days) is established of the inhabitants of the affected area. As a result of the high degree of resistance of the rickettsias, disinfection, insect elimination and deratization operations should be carried out extensively and very carefully. If it is established objectively that the rickettsias were used in the form of an aerosol, measures in the focus should be extended to include animals (sheep, goats, cows) in the form provided for by the veterinary-sanitary legislation for zoonotic infections. Milk of these animals should, of necessity, be boiled, because pasteurization is inadequate.

With the occurrence of cases of the disease, the same measures should be taken as for other infections (hospitalization, terminal disinfection). The prophylactic use of antibiotics is possible.

In the hospitals the medical personnel should wear at least masks.

When the rickettsias are used by other methods, appropriate measures are taken with respect to food products (when there is a diversionary infection of them) or ticks (insect elimination).

Virus Encephalitides. Cerebral afflictions are caused by several species of viruses. However, not all the viral encephalitides have been sufficiently studied. The epidemiology and etiology of some of them are not known to date. Among these are Economo's encephalitis [encephalitis lethargica] and Australian encephalitis (X-disease). Among those which have been adequately studied are tick-borne spring-summer encephalitis, Japanese, or summer-autumn encephalitis, St. Louis encephalitis, and equine encephalomyelitis.

Tick-Borne Spring-Summer Encephalitis. The etiology of this disease and the epidemiology of it have been studied by Soviet scientists. The causal agent is a virus which is pathogenic not only for man but also for other species of animals and birds, which are infected under natural conditions. The vector of the infection and chronic carriers of the virus are ticks of the genera Ixodes, Dermacentor and Haemaphysalis. The virus concentrates chiefly in the salivary glands of the ticks and enters the bodies of man and animals with the saliva of the tick during a bite. Evidently, the virus enters the genital organs of the tick also, because it is transmitted to the tick progeny transovarially.

The virus is cultured in susceptible animals (mice) and on chick embryos (on the chorioallantoic membrane). When dried from the frozen state the virus is resistant. The virus can be preserved for 25 days in a suspension of brain in physiological solution. The possibility of laboratory infections without the participation of vectors permits us to suspect infection by other routes, for example, by the airborne route. Therefore, the possibility exists of application of the virus as a biological weapon, at least in the form of aerosols.

The events in Korea have shown the attempts at using the biological weapon are possible by means of scattering insect vectors. However, the dropping of ticks can create localized foci of infection. We must consider also that ticks can be used during definite seasons of the year--during the per-

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iod of their greatest activity.

The season of the greatest activity of ticks is found from April to June. After a certain delay (incubation period) the activity curve of the tick factor is repeated by the tick-borne spring-summer encephalitis morbidity rate. In the western regions of the USSR the maximum number of cases are observed in June-July.

The incubation period lasts two weeks, on the average (eight to 23 days). The disease begins acutely, with a rapid temperature rise (to 40°), very severe headache, nausea, vomiting and general hyperesthesia. The psyche is impaired. The disease affects the gray matter of the spinal cord, most often of the superior cervical segments, as a result of which flaccid, atrophic paralyses of the muscles of the neck and shoulder girdle develop. The paralyses are observed in more than 20 percent of cases. The recovery period is prolonged. A strong immunity remains after the disease. Therapeutic serum and convalescent serum can be used for treatment.

The vaccine which has been proposed for purposes of specific prophylaxis represents a suspension of the brains of infected mice, in which the virus has been killed by the prolonged effect of small doses of formalin.

Anti-epidemic measures should be directed against the vectors of the infection (insect elimination). The individual measures of protection are appropriate clothes and insect repellents. Patients should be hospitalized immediately, not so much because of their epidemiological threat as in the interests of the patient himself.

Japanese, Summer-Autumn Encephalitis [Japanese "B" Encephalitis]. Cases of this infection are observed in Japan, Korea, in the Philippines, in the western regions of China, in Manchuria, and in the southern regions of the Primorskiy Kray. The regions affected by encephalitis are strictly outlined, and cases have been observed in them for many years (natural focalization according to Pavlovskiy).

The causal agent of Japanese encephalitis is a filtrable virus, to which, in addition to man, monkeys, certain species of rodents, sheep and goats are susceptible. Because the encephalitis has been observed for many years in poorly inhabited localities it must be considered that certain species of animals (possibly also birds) are the reservoirs of the in-

fection, as in the case of tick spring-summer encephalitis, becoming sick from it under natural conditions. Therefore, Japanese encephalitis should be regarded as a zoonosis.

Mosquitoes are the vectors of the Japanese encephalitis virus: Culex pipiens, Culex tritaeniorhynchus, Aedes togoi, Aedes albopticus and Aedes japonicus. Culex tritaeniorhynchus and Aedes togoi are infected spontaneously. The virus reaches its maximum concentration in the bodies of the mosquitoes 15-20 days after the infection.

In its remaining properties the virus of Japanese encephalitis is similar to the virus of spring-summer encephalitis.

The methods of using the virus of Japanese encephalitis as an agent of attack can evidently be analogous to those described above. It should be taken into consideration that mosquitoes are more active as vectors but they cannot be bred in many localities. Therefore, in many regions it is impossible to create long-smoldering foci of Japanese encephalitis, the possibility of which would compensate to some degree for the lack of epidemicity.

The clinical picture of Japanese encephalitis is characterized by an acute onset. The incubation period lasts 10-12 days, and the prodromal signs are usually absent. The temperature rapidly reaches 39-41°. Vomiting occurs. Tonic and clonic convulsions develop which go into an epileptiform attack. The muscle tone is increased (fixed positions of the patients). Recovery is slow, with a prolonged mental impairment (weakening of memory, discrimination, etc.). There are no pareses, paralyses or similar phenomena. The mortality rate is high (40-50 percent).

The treatment and prophylactic measures are the same as for tick-borne encephalitis. Anti-mosquito nets should be added to the measures of individual protection. Naturally, in the focus of infection insect elimination should be widely used (when insects are dropped) as well as processing of the population (in the event aerosols are used).

St. Louis Encephalitis (American Encephalitis). Cases have been observed in the United States (in St. Louis and its environs and in the state of Illinois). The causal agent of encephalitis is a filtrable virus, which is similar in its properties to the virus of Japanese encephalitis. The virus is pathogenic for monkeys and mice, is not pathogenic

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for sheep and other animals. The vectors are several species of mosquitoes of the genera Culex, Aedes and Theobaldia. Culex torsalis mosquitoes have been found to be spontaneously infected. The morbidity is observed in August-September.

The clinical picture of American encephalitis is the same as that of Japanese encephalitis, but it is milder.

Treatment and prophylactic measures are the same as for Japanese encephalitis.

Equine Encephalomyelitis. Cases have been observed in America, Germany, and France. In the United States, two variants of the virus are known--western and eastern equine encephalomyelitis, which are capable of producing cases of the disease in persons. Equine encephalomyelitis observed in the USSR is obviously not transmitted to people, because no cases have been observed among people.

Many species of rodents, calves, goats, certain birds (with experimental infection) are susceptible to the viruses of eastern and western encephalomyelitis. Under natural conditions, mules, horses and man become sick with it. The cases of eastern encephalomyelitis are more severe.

The disease in people is characterized by a sudden onset (in the western variant prodromal signs are observed--headache, sleepiness, intestinal disorders). Fever with a temperature of 40-41° is accompanied by neurological symptoms: very severe headache, pronounced pain in the back muscles, sleepiness, confusion, speech disturbance, ataxia, nystagmus, convulsions. In eastern encephalomyelitis general rigidity of the muscles or opisthotonus, paralyses, pedal and facial edema and cyanosis are observed. In the eastern variant the disease passes through two phases: the initial general signs, of the prodromal type, pass without trace, and then, after a short period of apparent recovery, the complete, severe picture of the disease unfolds. Paralyses are observed in 15-20 percent of the cases. The mortality rate is high: about 15 percent in western and up to 74 percent in the eastern form of encephalomyelitis. Chiefly children are affected.

The virus of encephalomyelitis is readily cultured by all the methods known in virology: in tissue culture, on chick embryos, on animals. Large numbers of the virus are readily obtained by the infection of chick embryos. This

method, as well as passage through the brain of mice, is utilized for the purpose of obtaining virus during preparation of the vaccine. Vaccination creates a strong immunity to the disease.

In nature the reservoir of the virus is unknown. Evidently, neither horses nor man play the important part in preserving the virus in nature. The question of vectors of the infection has not been finally solved either. It is believed that two blood-sucking arthropods participate in the transmission of encephalomyelitis: the bird mite, which transmits the virus from bird to bird, maintaining it under natural conditions, and mosquitoes, which transmit the infection from birds to vertebrates, including horses and man.

The absence of cases of equine encephalomyelitis in the USSR can be explained either by the lack of susceptibility of man to the local virus or to the absence of an appropriate vector. Therefore, the use of the virus of American equine encephalomyelitis could have the aim only of directly infecting the population, which can be accomplished on a large scale only by means of aerosols. The use of infected vectors can produce a limited number of cases of the disease if there are no appropriate local vectors which are secondarily infected. In the event of the presence of vectors the infection can assume broader dimensions if we judge by the analogy to malaria. It may be supposed that the second possibility is excluded in the USSR, because the presence of appropriate vectors would have led to an adaptation of the local equine encephalomyelitis virus to the human body, as occurred in the United States.

These considerations, in accordance with the most probable method of attack (aerosols), permit us to recommend individual protective measures (masks and gogles for the protection of the mucosae of the eyes and respiratory organs) and processing of the focus and of people with the aim of eliminating aerosol particles which have settled in the event of an attack. If the attack is not recognized in time, there is no need for these measures at the time cases of the disease occur, because by this time the virus would have died out. This evidently applies to all viruses described above.

Psittacosis is an infectious febrile disease produced by a filtrable virus and in the majority of cases it occurs with inflamation of the lungs.

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The virus of Psittacosis is one of the representatives of a group of viruses very similar to one another which cause diseases of birds and which are combined under the group of ornithoses. In their properties the virus of lymphodranuloma (a human of venereal disease) and viruses of various animal diseases are similar to the viruses of ornithoses.

The virus of psittacosis is one of the large (280 to 380 millimicrons) viruses but it passes through a seitz filter, through the Berkefeld filters and through large-pored Chamberlane candles in impressions or in sections from organs of the elementary bodies of the virus can be found by staining in the Romanowsky or Morozov methods. They are found in cells of the reticulo-endothelial system or intracellularly after rupture of the cells. In the event of an intracerebral infection the sections (smear-impressions) are made from the brain; in the event of an intraperitoneal infection, from the spleen and liver.

The virus of psittacosis is quite resistant. Heating to a temperature of 56° for thirty minutes does not inactivate it completely; it dies in ten minutes only at 60°. At low temperatures (minus 70°) it remains viable for one year and even for two years. When freed of tissue particles of the virus, suspended in a buffered physiological solution, is preserved for no less then three weeks. In sputum and in pieces of lungs placed in glycerine the virus is rapidly inactivated, which should be taken into consideration when collecting material for laboratory examinations.

The virus is pathogenic for mice and they are utilized for the isolation of it. Mice may be infected by any parenteral route. The virus can be isolated and cultured also by infecting chick embryos (in the Allantoic fluid or in the yolk sac).

Under natural conditions the virus of psittacosis and other ornithoses effects about thirty species of parrots, domestic pigeons, ducks, chickens, turkeys, egrets, etc. Guinea pigs and rabbits are susceptible to certain strains of the virus and are utilized for the isolation of it. Birds also may be utilized for the isolation of the virus if it can be ascertained that they were taken from healthy aviaries.

Man is infected with psittacosis and other ornithoses from parrots and other birds. The incubation period in man lasts from seven to fourteen days (on the average ten days).

The clinical course of the disease is different. In some cases, the onset is sudden, with a chill, fever, loss of appetite, pain in the throat, malaise, photophobia and a severe headache. In other cases the disease begins gradually and unnoticeably. The temperature at first is somewhat less then 38 to 39° C., and then increases. In severe cases, a high temperature of constant type persists for about two weeks; in mild cases, it drops on the seventh to eighth day. The temperature decreases gradually. Nasal hemmorhage is noted in 25 percent of the cases. A slight dry cough develops in the patients for several days. The sputum is never abundant; at first it is mucous and then mucopurulent. The physical changes in the lungs are poorly expressed: Sections of bullness to percussion are found at the bases of both lungs; rales can be heard, beginning with the fifth day. The degree of development of pneumonia is established by X-ray examination. Recovery proceeds slowly and there are often relapses. Residual signs in the form of "a network" of interstitial thickening with individual small foci are detected by roentgenological examination when it is impossible to detect any changes by ordinary examination.

The mortality rate in psittacosis is equal to nine to eleven percent, but in individual cases it can be higher. The mortality rate is reduced considerably by the use of antibiotics (penicillin, biomycin, etc.). Blood is taken from the patient for laboratory examination during the first few days of the disease and after two weeks. Blood taken during the first few days is utilized for isolation of the virus and for performing the compliment-fixation test. The complement-fixation test is performed using two specimens of syrum taken during the first few days and after two weeks in order to ascertain the occurrence or increase in the antibody project.

Befibrinated blood is used for isolation of the virus taking into consideration the fact that it is found in the blood during the first week of the disease. The virus may be isolated from the sputum at later periods: After two to three weeks, and in certain cases, even later. Therefore, this material can also be taken for examination. If the patient does not excreet any sputum, a washing is made from the bharynx with sterile physiological solution.

On autopsy of cadavers pieces of pulminary tissues should be taken from areas showing changes, and also pieces of spleen, and exudate from the plural cavity. Each type of material is put individually into test tubes which are covered with rubber stoppers. The test tubes are put into metal cases and during transportation the material is refrigerated (dry ice, by putting the cases into ice, etc.) A similar procedure is carried out with material taken from the bodies of birds. If the bodies of birds are being shipped they should be wrapped up in many-layered gauze, moistened with five percent lysol or phenol and placed in a canvas bag. Refrigeration of the material is obligatory.

The main source of psittacosis and ornithoses in general, as seen from the name, are birds, and particularly parrots. However, man to man infection is possible. Recently, more then twenty cases of infection of medical personnel (thirty persons) have been described where contact with birds had been completely excluded.

Infection obviously occurs through the respiratory passages. Intrahospital and intralaboratory infections attest to this. The latter cases also speak for the great susceptibility of man because infection is contracted very readily. The infection of laboratory animals by inhalation of the virus also indicates the fundamental importance of the air-droplet mechanism in the spread of the infection.

These data speak for the fact the use of the virus of psittacosis is possible only in the form of aerosols. True, reports of the possibility of infection from articles contaminated from virus (feathers of birds which have died, excreta, nasal excretions, etc., permit us to assume the possibility that infected articles can be dropped. However, in the best case such a method can produce only solitary cases of the disease. The application of aerosols makes it possible to infect not only people but also birds, creating, thereby, a powerful focus of infection with a long-lasting reservoir of infection in a given locality.

Apart from the usual measures of protection to which recourse is had in places where the use of aerosols is suspected.

Protective masks and goggles, gas masks, shelters) the prophylactic use of antibiotics is possible if it has been established that the virus of psittacosis was chosen as the agent for the attack. Vaccines made of psittacosis virus have been obtained and have been tried out on volunteers; however, their epidemiological effectiveness has not been established.

When cases of the disease occur among people measures should be taken in the area of infection taking into consideration also the possible infection of birds.

Continuous medical supervision is established of the population in the area of infection for two weeks during which temperatures are taken. At the first signs of the disease the patient is hospitalized and disinfection is carried out of his personal articles.

Observation of persons who have been in contact with patients is continued for two weeks after hospitalization of the patient. A careful examination of birds is carried out by the veterinary service in the area of infection with the aim of establishing the presence of cases of disease among them. On large farms sick birds and those suspected of being sick are killed and eviscerated on the spot. The meat can be used as food after thermalprocessing the down and feathers are carefully collected and burned. In individual farms in which cases of the disease are found the clinically healthy birds are killed with consumption of the meat as food. The feathers and down are burned. Sick birds are destroyed (burned). Careful disinfection (with a clarified solution of chloride of lime) is carried out in the aviaries. The eggs may be utilized as food in the cooked (hard-boiled) form. The sale of birds and eggs from the area of infection is prohibited. The quarantine is removed from farms six months after the last case of disease among the birds.

The medical and veterinary personnel carrying out the work on the elimination of the after-effects of the attack should use measures of individual protection (ordinary overalls, cotton-gauze masks, protective glasses). Medical supervision is established of them also.

Yellow Fever is an acute infectious disease of tropical and sub-tropical countries, of viral etiology, which is transmitted by mosquitoe bites.

The causal organism of yellow fever belongs to the group of small viruses (twelve to nineteen millimicrons); it readily passes through all the bacterial filters. Depending on the tissues that it accumulates in chiefly (affecting them) two types of virus strains are considered:. Neurotropic and Viscerotropic. However, different tropisms of the virus can be associated with the method of culturing it. The originally strains are evidently pantropic.

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The virus is readily cultured on animals (usually on mice), in tissue cultures and on chick embryos, that is, by all the methods known to virology.

The virus is sensitive to heat and antiseptics. It is well preserved in 50 percent glycerine solution, which is utilized for shipping the material for examination. The frozen infectious material preserves its activity for a long time. The virus desiccated in the frozen state when kept in the cold can remain viable for several years. The blood of patients looses its infectivity at a temperature of 24-30° centigrade in approximately two days; at 55°, in ten minutes.

The virus of yellow fever is pathogenic for mice, guinea pigs, hedge hogs, certain species of edentates (anteaters and others), certain species of rodents and all marsupials. Monkeys are readily infected by the virus of yellow fever. Rabbits and rats of the laboratory animals, carnivora, the majority of rodents, cold blooded animals and birds are resistant to the virus.

Man is very susceptible to the yellow fever virus.

The course of the disease in man is variable: from very mild to very severe, terminating in death in several days. The incubation period is equal to two to seven days, sometimes being drawn out to 12 days. The febrile period begins suddenly without any prodromal signs. The high temperature is accompanied by headache, pains in the back, and in the feet. A lack of correlation between the pulse and the temperature is characteristic of yellow fever. A remission is possible after which the temperature rises again, and jaundice develops. Hemorrhages are observed in the skin and mucous membranes. Nausea and vomiting (of changed blood) increases. In favorable cases, the temperature drops lytically. The mortality rate is considered to be various ranging from 5-25 to 30 percent if it is not taken into consideration that during the severe outbreaks it reaches 70-75 or even 94 percent. Possibly the latter figures pertain only to the most severe cases. There is no specific treatment.

At the very beginning of the present century it was shown by experiments on volunteers that yellow fever is transmitted only by blood-sucking mosquitoes. Attempts to infect people with underwear taken from patients or with underwear

contaminated with blood and vomitus of patients did not give any positive results. Thus, the opinion was confirmed that the only route of transmission of the infection is by the mosquito in the body of which the virus is capable of multiplying and reaching a high concentration on the twelfth day after infection.

From this point of view, the use of the yellow fever virus as an agent of biological attack is possible only by dropping infected mosquitoes. This, to be sure, can limit the effectiveness of the attack, because the inclusion of the natural mechanism of transmission of infection requires the presence of the <u>Aedes aegypti</u> mosquito in the given locality, and it is found only in a small section of the southern coast of the Caucasus (Batumi Poti, and Suahumi) where they were brought by ships. In other places of the Black Sea coast the mosquito of this species did not take route because of the unfavorable climatic conditions, since there is no basis for the belief that it was not imported into these frequently visited ports (Odessa and others). Therefore, on almost the entire territory of the Soviet Union the use of the yellow fever virus by dropping infected mosquitoes can be considered only from the point of view of the activity of the insects dropped. However, even in this case an adequately high night temperature is an obligatory condition: no less than 17-20°, at which the mosquitoes still attack man.

In connection with the discussion of the problem of the possibility of using the yellow fever virus as an agent of biological warfare the opinion has been expressed that artificial infection by this causal organism can be carried out by the air-borne route. Roseberry adheres to this view, basing his conclusion on an analysis of intralaboratory infections. Of 34 cases described (five cases fatal) only several of them were associated with mosquito infection, and in the tremendous majority of cases the work was being carried out without insects, and therefore, the infection was not accomplished by this method. Specifically, cases have been described where the patients had been assisting two laboratory workers in their work with desiccated and pulverized yellow fever virus. The work lasted a total of several minutes. The possibility exists that the virus was sprayed. Two other laboratory workers also became sick. Roseberry believes inhalation of the sprayed virus to be the most probable method of infection in the given case. Therein the yellow fever virus is distinguished from the epidemiologically similar dengue fever virus, which does not

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infect people when it enters the respiratory passages, being transmitted only by bites of Aedes aegypti mosquitoes.

Hence it follows that the yellow fever virus may be expected to be used in the form of an aerosol.

The laboratory diagnosis is based on the isolation of the virus and on the determination of antibodies in the patients' sera. The data of the histopathological examination may be utilized. Such examinations can be carried out in special (virological) laboratories. Blood should be taken from the patients for isolation of the virus during the first few days of the disease, because after the fifth day the virus disappears from the blood.

The system of measures for combatting yellow fever is determined by the method of application of the infective nidus.

Prophylactic methods in the use of aerosols, as in many other cases, amounts to a protection of the respiratory organs (masks, shelters). In the given case, individual measures of protection can be supplemented by vacination, which creates an immunity of adequate strength. In connection with the brief incubation period of yellow fever the immunization of persons known to be infected does not have any sense, because immunity cannot be developed. Nor does the disinfection of objects on to which particles of the aerosol have fallen or of patients' excretions have any particular sence, because during brief periods of time the virus is neutralized as the result of natural extinction. The fact that in the desiccated state it possesses a high resistance is very important for the accumulation and preservation of it, but does not make it necessary to carry out disinfection, because desiccated and pulverized biological preparations are very hygroscopic, and in the presence of moisture and warm weather conditions the virus is rapidly inactivated. If there should be any danger that the particles of aerosol which have settled will be carried upward into the air again, and if conditions have not contributed to their inactivation, pouring water over the soil and over the outside walls of buildings and damp cleaning in the house, etc. are sufficient. In practice, disinfection will be used in all cases of attack by aerosols, because all the protective measures should be taken in short order during those periods of time in which identification of the biological agent is impossible given the present state of science. Therefore, in practice, disinfection will be carried out when an enemy uses the yellow

fever virus.

The hospitalization of patients should be carried out in the interest of the patients themselves rather than because of the epidemiological threat of the patients. The absence of a vector makes the patient safe. In localities where there is a vector hospitalization is an anti-epidemic measure.

The use of mosquitoes infected with the yellow fever virus requires the accomplishment of measures with respect to the vector (insect elimination) and the application of measures of protection against attacks by them using netting, canopies, anti-mosquito nets, repellents. In other words, the same measures are taken against mosquitoes as in the case of malaria.

Botulinus Toxin. Among the agents of biological warfare mentioned in the foreign literature (Roseberry and Cabot) the toxin of the bacillus of botulism is listed.

The causal organism of botulism is an anaerobic bacillus, which is quite large (four to six microns), forming highly resistant spores. It is stained by all the aniline dyes. Young cultures are gram-positive; in old cultures there are many gram-negative individuals. A subterminal location of large (greater than the width of the cell) oval spores, which gives the bacillus the appearance of a tennis racket, is characteristic of the botulinus bacillus.

The bacillus of botulism possesses great proteolythic and saccharolytic activity; however, the property of splitting carbohydrates is not constant and cannot be used in the identification of the microbe or of its types.

Five types of the microbe of botulism are distinguished which are designated by the letters of the alphabet (A, B, C, D, E). They all form antigenically different toxins, that is, each of them is neutralized only by its own antitoxic serum. This property has been made the basis of the serological differentiation of the bacillus of botulism. The botulinus toxin is one of the most active. Its toxicity is exceptionally great. Thus, there are 220,000,000 minimum lethal doses for white mice per milligram of nitrogen of the crystalline type A botulism toxin. The toxicity of type B is approximately the same. It is hard to judge the activity of type E toxin, because it has not been isolated in the crystalline form; however, filtrates of cultures of type E

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bacilli are less toxic than filtrates of type B and particularly of type A.

The botulism toxin possesses a property which distinguishes it from other exotoxins: it is not destroyed in the acid medium of the stomach, and it is not split by digestive enzymes, and is readily absorbed from the digestive tract. Therefore, in contrast to other toxins it can cause a disease after entering the body in the food (enteral route). In addition, it is heat-resistant compared with other toxins: complete destruction is achieved by heat at 80° for about 30 minutes. The stability of the toxin is determined by the character of the medium in which the toxin is. A high carbohydrate content increases the resistance of the toxin to the effect of high temperature. In liquid medium (desolved toxin) in the presence of air, and under the effect of light the botulinus toxin weakens rapidly. It is inactivated very rapidly when there is an alkaline reaction of the medium. In the desiccated state in sealed ampoules or in an exsiccator over calcium chloride, sulfuric acid (protection against moisture), it can be preserved for several years without any significant changes in toxicity.

Man is very sensitive to type A, B and E toxins. The data of authors who have observed outbreaks of botulism speak for the high degree of susceptibility of man. Cases have been described in which the patients merely tasted the food product and spit it out without swallowing it. Nevertheless, this did not prevent the disease: negligible quantities of the toxin remaining in the mouth proved to be sufficient to cause a severe disease. The toxin may be absorbed from the ocular mucosae.

The first signs of the disease are thirst, dryness in the mouth and in the throat, visual disorders (disturbance of accomodation, double vision, ptosis, etc.) which stem from paralyses of the oculomotor muscles. Then, disorders of swallowing and of speech are added, the voice becomes hoarse, and there can be complete aphonia. The picture of botulism is also supplemented by a persistent constipation as the result of a disturbance of motor function of the intestine and meteorism. Consciousness is preserved until death. The mortality rate is high but is different in different outbreaks. It is believed that on the average it is equal to 66 percent. However, at the time of a large outbreak in the United States in 1936 it reached 82 percent.

A specific antitoxic serum is used for treatment.

The content of toxin in food products and in material taken at the time of autopsy (blood from the heart, pieces of liver, spleen, urine, contents of various sections of the intestine, taken separately in jars) is determined by a biological test on animals. With this aim in view, extracts from organs, food, etc. are poured out into five test-tubes. Antitoxic serum (A, B, E), each type in a single test-tube, is added to three test-tubes. A fourth tube is heated at a temperature of 100° C for five to ten minutes. Test-tubes containing a mixture of the material with serum are placed in a termostat for 20-30 minutes. Then, mice are injected with 0.5 milliliters of the liquid from all the test-tubes. An extract which was not subjected either to heating or to serum neutralization and which is in the fifth test-tube is injected into one mouse. The results of the test are correct if two mice die which have received the material under examination in a mixture with serum, and the mouse which received antiserum and another which received the heated extract remain alive. The type of botulism corresponds to the type of antitoxin which protects the mouse from death. To be sure, the course of the disease in the animals should be characteristic of botulism (flaccid paralysis). However, frequently the death of the animals occurs in the morning and the research worker doesn't have any opportunity to watch the development of botulism.

The properties of the botulinus toxin which have been briefly described and, primarily its exceptionally great toxicity have made it possible for foreign authors to list it among the agents of attack.

When botulinus toxin is used as a biological weapon only the direct involvement of the population can be taken into consideration, because for readily understandable reasons the toxin is completely devoid of epidemicity. American authors (Roseberry and Cabot) believe that the toxin can be used for poisoning water, food products and in the form of an aerosol.

This determins the prophylaxis of cases of botulism. Water and food products designed for individual usage should be subjected to thermal processing. Food products which are not subjected to thermal processing should be destroyed if they are known to be contaminated by the toxin.

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When the toxin is used in the form of an aerosol the protection of organs of respiration and of the eyes (masks, gas masks, protective glasses) and shelters are adequate for the protection of the people against the disease. The clothes of people who are in the aerosol cloud should be moistened with water and alkali. The use of disinfectants has no sense, because we are dealing here with a toxic substance and not with a living organism. Most practical is the use of substances which destroy the toxin. As far as the soil is concerned possibly it is sufficient to pour ordinary water copiously over it. Thereby the solution of the toxin occurs with absorption of it by the soil and acceleration of its destruction.

With the occurrence of cases of disease antitoxic serum should be injected, which can be used also prophylactically in the event of a probable entrance of the botulinus toxin into the body. Recently, a botulinus toxoid has been obtained with which people can be immunized. However, its effectiveness under epidemic circumstances has not as yet been clarified.

Measures for the Individual and Group Anti-Bacterial Protection of the Population

The fight against infectious diseases and primarily against those which have become prevalent and which have been associated with a high mortality rate (plague, cholera, small pox, leprosy, etc.) has been carried on for a long time, and the history of it is as old as the history of mankind. Naturally, the lack of information concerning the cause of the diseases in previous centuries lead to the fact that many of the measures taken were naive from a modern point of view (fumigation with letter incense during outbreaks of the plague etc.). However, certain of the measures in a modified form have been preserved up to the present time. The practicality of them was determined by the fact that they were directed against the most important properties of infectious diseases, viz., infectivity and a rapid diffusion among the population. Thus, such measures have been preserved up to the present time as hospitalization and isolation of patients, quarantine, protective suits and masks, etc. The idea of immunization of healthy people with the aim of protecting them against a severe disease has also been used for several centuries. The perfection of various prophylactic measures and agents proceeded on the development of the science of infectious diseases (bacteriology, immunology, virology, epidemiology, etc.)

and on the basis of the practical testing of them in anti-epidemic practice.

According to their character, prophylactic agents and measures can be directed against any definite infection, such, for example, as immunization against it, or in the case of a group of infections by acting on the routes of spread which are common to them. In connection with the fact that in the former case bacteriological preparations are most often used (vaccines, sera) which possess a great degree of specificity (in the immunological sense), the entire system of inoculations for prophylactic or therapeutic purposes has obtained the name of specific prophylaxis or therapy. In contrast to this, measures taken against the routes of spread, etc., are called measures of non-specific prophylaxis, although this is not altogether accurate in the epidemiological sense.

In addition to such a division of the various measures and agents of prophylaxis they are sometimes grouped in accordance with whether they are of an individual or group character. This division to a certain degree is arbitrary, because, for example, inoculations, which are essentially measures of individual prophylaxis, when used extensively lead to a reduction in the morbidity rate among the population (group) not only because of those who have been inoculated but also among the persons who have not been inoculated. Thus, smallpox was eliminated on the territory of the USSR before all of the population had been inoculated.

In a description of measures taken against the spread of infectious diseases among the population under conditions of application of a biological weapon a second grouping of them is accepted. That is, a differential consideration of individual and group measures of protection.

Among the individual measures of protection are the use of specific prophylaxis by means of vaccines and sera, the prophylactic use of antibiotics and various chemotherapeutic preparations, the utilization of protective clothing, gas masks or respirators, protective glasses, anti-mosquito nets, agents which repel insects, observance of the rules of personal hygiene, etc.

Among the group measures of protection are shelters and other structures which may be utilized simultaneously by groups of the population of different sizes. Various measures

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directed at decontamination of water, food products and soil or of the protection of them from contamination are also used for the protection of the group.

In our subsequent presentation each of these agents and measures will be examined individually.

Specific Prophylaxis. Specific prophylaxis is carried out by means of vaccines, toxoids and immune sera.

The vaccines are biological preparations in which the antigen, that is, the substance which produces the elaboration of immunity, is represented either by the entire microbe cell (bacteria, rickettsias, viruses) or by a substance extracted chemically from the whole microbial cell.

Vaccines may be living or killed. The liver vaccines are prepared from causal organisms of the corresponding diseases and attenuated by various methods. A live vaccinal strain is obtained as a result of various influences on causal organisms, which almost completely lose their virulence, preserving their immunogenic properties. The loss of the capacity of producing a general disease is preserved permanently by the vaccine strains, which assures their complete safety.

Plague, tulerimia, brucellosis, anthrax, tuberculosis (BCG vaccines), etc. may serve as examples of bacterial vaccines. Of the live virus vaccines, smallpox, rabies, influenzal vaccines and vaccines against yellow fever, poliomyelitis, etc. may be mentioned.

The killed vaccines are represented either by suspension of microbial bodies (bacteria, rickettsias, viruses) which have been killed by heat, formalin or phenol, etc. or are colloidal solutions of a glucide-protein-lipoid complex; the so-called complete antigen, extracted from bacterial cells by chemical means. Therefore, such vaccines are sometimes called chemical.

Of the killed vaccines mention may be made of cholera, typhoid, paratyphoid and dysentery vaccines. Complete antigens may be extracted from these microbes for the purpose of preparation of a chemical vaccine. An example of the latter is the NIISI [Scientific Research Institute of Vaccines and Sera] in which complete antigens of all the microbes listed above and tetanus toxoid are represented. Vaccines against typhus, "Q" fever, spring-summer encephalitis

and others are examples of chilled vaccines made of rickettsias and viruses.

So called toxoids, which may be obtained from bacterial toxins through the action of formalin on them (0.3-0.5 percent) at a temperature of 40° C, are widely used as agents of specific prophylaxis. These preparations, therefore, are prepared from the activity products of microbes--toxins which on entering the body produce disease, that is, which are the basic pathogenetic factors. Because they possess not only a toxic effect but also immunogenic properties, immunization with them is a protection against the disease. However, immunization with the toxins themselves is impossible on account of their high degree of toxicity. As a result of the processing of the toxin with formalin (at a temperature of 40° C) it completely loses its toxicity, preserving its immunogenic properties. The practice of combatting diphtheria and tetanus attest to the good prophylactic qualities of toxoids.

Diphtheria, tetanus, staphylococcus and botulinus toxoids may be named as examples of prophylactic agents of this group.

Not all the causal organisms of infections which have been mentioned in connection of preparations of vaccines against them will be used directly in the capacity of biological weapons. However, under conditions of application of radioactive weapons the significance of all causal organisms of infection can be enhanced, and therefore, active immunization of the population should provide for the use of all the known specific prophylactic agents.

The giving of inoculations under ordinary conditions is limited by established contraindications, among which are acute infectious diseases, kidney diseases, afflictions of the cardio-vascular system, diabetes, pregnancy in the second half, etc. When inoculations are given during a threatening period and particularly in the area of infection, the number of contraindications should be reduced as much as possible, giving the inoculation in all cases where injection of the vaccine is not a threat to the life of the person being inoculated.

Active immunization of the population should be carried out chiefly before an attack by the enemy for two reasons.

First, quite a long time is required for the development

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of an immunity after inoculation of the vaccine, which, as a rule, exceeds the duration of the incubation period. If we take into consideration the fact that the use of vaccines after an attack has been accomplished (in the area of infection) is possible only after the establishment of the species of microbe used, then the impossibility of creating an immunity in directly infected persons becomes obvious. The use of vaccines in the area of infection can provide only a limitation of the spread of the infection by a natural route and a certain reduction in the mortality rate among those infected. Only a preliminary immunization can reduce loses from direct infection significantly at the time of the attack.

Secondly, preliminary immunization (before the attack) of the population is more effective even in the event a combination of radioactive and biological agents of attack are used. Reports appearing in the press to the effect that active immunity elaborated before the development of radiation sickness is not weakened or is only slightly weakened by irradiation make it necessary to encompass the population as extensively as possible with active immunization before the attack. Active immunization of persons who have been exposed to the effect of radiological weapons would obviously be of little effect.

The need for preliminary immunization of the population, therefore, is obvious. However, there are a number of difficulties of objective and technical order. Among the latter are difficulties associated with the need for large quantities of vaccines, etc., inoculating instruments, large staffs of vaccinators, etc. Among the objective difficulties are the brevity of the immunity which can be created by certain types of vaccines, the inadequate scientific development of the preparation of effective combined vaccines for the immunization against a large number of infections simultaneously and, finally, the absence of vaccines against certain infections.

Therefore, along with the preparation for overcoming the difficulties mentioned (by increasing the productive capacity of institutions which manufacture vaccines, by the organization and training of inoculation detachments, by scientific research in the field of manufacture of vaccines, etc.), it is necessary to take into consideration the use of other biological preparations in the system of specific prophylaxis.

Specific prophylaxis, as has been mentioned above, can be carried out by the use of immune sera. The latter can be obtained from animals which have been immunized either by microbial cells (antimicrobial sera) or by their activity products (antitoxic sera). Blood sera of immunized animals contain ready immune bodies against the causal organisms with which the immunization was carried out. Antibodies introduced into a non-immune organism assist the latter in overcoming the pathogenic effect of the causal organisms.

In contrast to vaccines, the injection of antisera creates an immunity rapidly, over the course of several hours, but the duration of it does not exceed two or three weeks, that is, the time necessary for eliminating the foreign serum from the body.

As an example we should like to mention the serum against tetanus, diphtheria, botulism (types A B and E), anthrax, plague, spring-summer encephalitis, gas gangrene, dysentery (Grigor'yev-Shiga), etc.

The majority of antisera in ordinary practice is used for therapeutic purposes (specific therapy). Tetanus antiserum, the use of which gives practically no effect in tetanus which has already developed, constitutes an exception. The remaining sera also can be used for prophylactic purposes--for passive immunization of the population in the area of infection. To be sure, even in this case serum may be used only after the establishment of the species of the causal organism used. The use of polyvalent sera (against several infections) or of a mixture of several monovalent (against a single infection) sera is possible only in the event this is dictated by objective necessity (the established or suspected use of several causal organisms by an enemy).

Bacteriophage can also be used for prophylactic purposes. Bacteriophages are viruses which affect bacteria in the bodies of which the bacteriophage is a parasite and multiplies. Bacteriophages affect various species of microbes selectively. Thus, cholera, dysentery, typhoid, staphylococcic, proteus and other bacterial phages are known. Because of this they may be categorized as specific prophylactic agents. However, in contrast to vaccines and sera they are not in any sense connected with the antigenic stimulation and immune reaction of the body. Their specificity is brought about by the fact they destroy only those microbes to which they have been adapted. Bacteriophagy is essentially a virus

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disease of microbes. Therefore, for the effect of the bacteriophage its encounter with the microbe is obligatory, into which it penetrates and which it destroys. Naturally such an "encounter" in the case of the prophylactic oral use of bacteriophage can exist only in the case of those infections the causal organisms of which are localized in the intestine. Therefore, the prophylactic use of cholera and dysentery bacteriophage is the most likely. The prophylactic use of bacteriophage parenterally is completely excluded, because it possesses antigenic properties, and antibodies which destroy the bacteriophage are elaborated against it.

Still another type of biological preparation may be used as an agent of individual protection in the area of infection--antibiotics (penicillin, streptomycin, levomycetin [chloromycetin], biomycin [aureomycin], etc.). The establishment of the species of causal organism is also essential for their use. In addition, the sensitivity of the latter to various antibiotics should be established and depending on the results of testing various preparations should be prescribed. The need for the determinations indicated is dictated, on the one hand, by properties of antibiotics of acting on definite species of microbes (bactericidal or bacteriostatic action spectrum of antibiotics), and on the other hand, by the property of the microbes of increasing their resistance to the effect of antibiotics. The use of the latter in cases of infection by a microbe resistant to antibiotics can give no effect which can be anticipated.

The dosage of antibiotics which may be used in the focus of infection should be the same as when they are used therapeutically. The dosage of these preparations should not be reduced arbitrarely, because this may lead to the acquisition of resistance by the causal organisms.

In a completely similar way (to the antibiotics), chemotherapeutic preparations may be used also. Their use should also be correlated with the species of causal organism. Their dosage and systems of application have been quite well worked out.

Individual Measures of Protection Against the Entrance of Causal Organisms of Infection into the Body. Individual measures of protection which protect against the entrance of causal organisms of various infectious diseases into the body do not possess any specificity. Their character is determined by which of the possible routes of penetration of the

infection they protect. It is well known that infectious disease agents penetrate into the body through the skin, mucous membranes of the respiratory tract, mucous membranes of the intestinal tract, mucous membranes of the eye and mucous membranes of the genitourinary organs. In accordance with this various measures of individual protection are used.

Protection of the skin, respiratory organs and mucous membranes of the eye is accomplished by means of special clothing, gas masks (or its substitutes) and goggles. These protective measures against the acute infectious diseases have been used for a long time. As an example mention may be made of the anti-plague suit with a hood, worn over the usual clothing, and the triangular-bandage-nightcaps. The suit is supplemented by rubber boots and gloves. A medical gown of special style is worn over this suit. The respiratory organs are protected by gas mask or by a respirator or by cotton-gauze bandage. The mucous membranes of the eye are protected by goggles.

Such a suit protects against infection even upon entering a bacterial aerosol cloud.

Anti-chemical suits which protect against the effect of chemical warfare vesicands also completely protect the skin against infection by causal organisms of the particularly dangerous infections which are used in the form of an aerosol.

Other types of anti-chemical protective suits in combination with a gas mask or respirator and protective glasses make it possible to carry on different kinds of work in the focus of infection: reconnaissance, disinfection, insect elimination, neutralization of bombs and containers, the taking of samples for laboratory examination, etc.

Gas masks of the modern type protect the respiratory organs against infection completely.

The newly activated MPVO [Local Antiaircraft Defence] units, which are to be in the focus of infection for a long time, conducting its decontamination, should be equipped with special forms of protective clothing. The population, on the other hand, cannot always take advantage of the protective clothing and the gas masks. Therefore, it is important to know what can substitute for them if they are not at hand.

A gas mask can be successfully replaced by a respirator or even by a cotton-gauze bandage. The latter can be prepared by the general population. For this purpose gauze measuring 100 x 50 centimeters is used, and absorbent cotton measuring 25 x 15 centimeters and a thickness of two to three centimeters is placed in the middle of it. It is recommended that a layer of gray cotton, which retains dust particles more effectively be placed on the layer of absorbent cotton which effectively checks droplets (N. N. Zhukov-Verezhnikov). In folding the gauze the cotton is covered with two layers of it, above and below. A long strip of cotton and gauze in three layers is obtained. The ends of gauze free of the cotton are cut down to the cotton in order to obtain two strips of gauze on each size for the purpose of tying. This dressing (of a fundiform type) is applied to the mouth and nose. The lower ends of the cut gauze are tied over the top of the head, and the other ones, at the occiput. The space between the alae of the nose and the dressing is covered with pieces of cotton. The eyes are protected by protective glasses.

If a cotton-gauze dressing is not at hand any uninfected tissue may be utilized (coat tails, towel, shirt, kerchief, etc.). Such tissues should be folded in six to eight layers. Gauze (without cotton) should be folded in 10-12 layers.

In the absence of any special suit any thick or sufficiently nappy fabric, sheets, coat, etc., may be used for the protection of the skin. The trouser legs should be tucked into the boots. If no boots are available the trouser legs should be tied around and a second pair of socks should be worn above them. Sleeves, gloves, etc., are put on the hands.

All articles which have been used in an area of infection by aerosol or sprayed microbes after the explosion of a shell should, of necessity, be disinfected. Of course, these measures are not required if no air infection occurred during the attack. The use of clothes without respirators or goggles, etc., is required only when insects are dropped.

Protection against insects and ticks is accomplished by clothing made of dense fabric, without any openings into which the insects or ticks might crawl. The clothes should be impregnated with insecticidal preparations (DDT, hexachlorane).

In addition, anti-mosquito nets should be used against flying insects, which cover parts of the face and neck. Protective nets devised by the Academician Pavlovskiy can be made

from silk mesh, a fishing net of the drag net type, etc. The net is dipped in repellents: 1) ten parts of pitch and 90 parts of five percent potassium hydroxide; 2) 15 parts of lysol, eight parts of turpentine, 77 parts of water; 3) 20 parts of naphthalysol, 10 parts of turpentine, 70 parts of water; 4) 30 parts of lysol, 10 parts of turpentine, 5 parts of odorless vegetable oil and 55 parts of water. The nets are wetted with these solutions for two or three hours, and then are wrung out and dried. The repellent effect of these substances is maintained for 10-12 days. The nets are put on over the head gear so that the ends of the net hang down freely. It is fixed in place by two ribbons sewn to it which are tied under the chin.

Dimethylphthalate, with which clothing, netting, etc. are impregnated, is also used as a repellent. It is used either in the pure form or in the form of a 15 percent solution in glycerine, vaseline and others. Dimethylphthalate can be applied directly onto the skin, which it does not irritate. However, contact of it with the mucous membranes of the eye should be avoided, because it produces severe pain. The repellent effect of dimethylphthalate is preserved for three to five hours. Dibutylphthalate (a similar preparation) preserves its effect for four to five hours.

Observance of the rules of personal hygiene at home and at work is of great importance during the period of the threat. The biological weapon is insidious; the use of it may not be accompanied by any visible signs; it is difficult to recognize the use of it at the time it is applied; it may makes its appearance at any moment and infect a large number of persons. However, it is completely ineffective if its road into the internal milieu of the body is blocked.

Protection of the skin and mucous membranes of the respiratory organs and eyes has been spoken of above. Infection by the oral route can be effected either by water or by food products. Observance of personal hygiene, thermal processing of food products and water, careful covering of them (which will be dealt with below), protection against flies, etc., are the measures which completely protect against intestinal infections in the presence of any method of application of the causal agents of them. The rules of personal hygiene should supplement all the measures of individual and group protection.

<u>Shelters as Measures of Group Protection</u>. The construction

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of shelters for the protection of the population against the effect of chemical warfare agents was based on the idea, like individual measures of protection, of protecting man against an attack against his skin, respiratory organs, etc., by measures of chemical attack. Because the shelter is based on the principle of complete isolation of a person from a contaminated medium it can be utilized completely also for the protection of the population against a biological weapon.

The shelters represent complete guarantees against infection only in the event they are properly utilized. The rules of utilization of shelters are presented in a special section. In general, they amount to the following directives (with respect to the biological weapon): 1) until special instructions are received from the chief of the shelter service concerning their utilization no one should be permitted to enter the shelter (with the aim of preventing a possible diversionary attack); 2) persons who have entered the shelter after being in a contaminated atmosphere are kept in isolation from persons who took advantage of the shelter before the contamination occurred. Articles of various fabrics which were utilized as substitutes for protective clothing (sheets, kerchiefs, etc.) should be handed in for disinfection upon entering the shelter. Shoes should be wiped on mats moistened with disinfectant solution in sections (or in special shelters). Where persons are quartered who have been in a contaminated atmosphere, the utilization of gas masks, respirators, etc. is obligatory; 3) in the event of a disturbance in the operation of the shelter's airconditioning-filtering system (nearby bomb explosions, etc.) the order is given immediately that individual measures of protection be used; 4) shelters or sections where persons are quartered who have been in a contaminated atmosphere should be carefully disinfected after the people leave; 5) exit from the shelter may be allowed only by special permission. Leaving the shelter is accomplished along special walks covered with disinfectant solutions and with observance of the orders established by persons directing the operation of disinfection and decontamination of the area of infection (chief of the medical service of the MPVO [Local Antiaricraft Defense], his deputy in the sanitary epidemiological service, by the chief epidemiologist, or by the chief of the mobile anti-epidemic detachment).

Chemical agents possess a greater penetrating power than do microbes. If it were completely possible to guarantee the impermeability of cracks in windows and doors to bacterial aerosols, it might be possible to use any room as a

shelter, because filtration of the air through the wall (natural ventilation) would eliminate the infection of it. However, it is hard to guarantee such an isolation. Therefore, any room other than a shelter type cannot be considered suitable for complete protection.

Nevertheless, if for any reason it is impossible to utilize the shelters, the population may be quartered in any room or quarters which are isolated as much as possible. Thereby, the protection of people against the effect of ordinary types of weapons (fragmentation bombs, artillery fire, etc.) is achieved as well as against the effect of radioactive emanations. Undoubtedly, with sufficiently careful preparation of such rooms the penetration of bacterial aerosols into them would be insignificant, that is, the concentration of microbes would be considerably less than in the outside air. This makes the protective effect which may be achieved by individual measures (respirators, cotton-gauze, bandages, etc.) more probable; these measures would have to be utilized in such quarters. Taking shelter in trenches, and in blindages of the simplest type protects people only against ordinary weapons and external radioactive emanation. It does not protect against biological weapons. Conversely, in some cases aerosol particles of microbes may be retained in them longer than in the surrounding open area.

<u>Protection of Provisions from Fodder and Water Against Contamination by Pathogenic Microbes</u>. The significance of water and food products in epidemiology is well known. It has been mentioned repeatedly above that the causal agents of intestinal infections can infect man, entering through the mouth either with the food or with the water. The role of water and of food is not the same in different intestinal infections. Thus, in cholera water plays a more important part; but in dysentery, food products are more important.

The greater part played by one factor or another, first of all, does not eliminate the participation of other factors (for example, of water in dysentery) and, secondly, is associated not only with the biology of the causal organism but also with the characteristics of transmission of the infection from its source to a susceptible person.

Other relations can be observed under conditions of biological warfare, where water or different kinds of food products are infected artificially. In this case, the part played by them will be determined not by ordinary routes of

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infection, which have already been quite well studied, but rather by the availability and expediency of infecting them, taking into the consideration the biology of the causal organism (resistance in the environment) and the character of the raw material, food products, etc. Thus, for example, there would hardly be any sense in infecting groats or potatoes with a typhoid bacillus, because under these conditions there would hardly be any massive infection of the population produced. At the same time, the infection of sugar, bread and other products with anthrax spores could evidently bring about the infection of people, although such a method of transmission of infection is not encountered under ordinary conditions.

Under modern conditions, when there are no reliable data concerning the methods and measures of biological attack which would be utilized by an enemy, we must take the position that the measures to be elaborated for the protection of water, provisions and fodder should be as extensive and generally applicable as possible. In other words, they should be extended to all types of provisions without exception, and in their character they should not depend on the individual peculiarities of various objects in which the food product is being manufactured or stored (food enterprise, store, etc.). This does not eliminate the need for developing individualized measures not only with respect to various branches of the food industry but also with respect to various types of enterprises in one and the same branch of industry. However, the presentation of individual measures to be taken is not part of the problem of the present text, in which only the most general measures of protection of water and provisions are to be described.

Measures for the protection of provisions should be based on the fact that the main method of infection may be diversionary, whereby the culture is introduced directly into the food product. Infection of the latter can also occur indirectly--through aerosols of pathogenic microbes penetrating into the processing site (site of manufacture) of the food raw materials, site of storage of the prepared products, etc.

The protection of provisions against diversionary attack should provide for the protection of food enterprises, storehouses, etc.

One of the measures for protecting food products against infection in the food enterprises is the use of special clothing as a replacement for the usual clothing.

Measures for preventing contact of microbes sprayed into the air with food products are more complex. Sealing off of rooms with the simultaneous use of ventilation, which creates an increased pressure in the rooms, is the most general measure. It goes without saying that such ventilation is permissible only in the event the filtration systems provide a complete elimination of microbes from the air supplied. Otherwise, the ventilation should be turned off, and the airshaft hermetically sealed.

It is very difficult to achieve an adequate sealing of the room. Moreover, it can be impaired readily by bomb explosions in the vacinity of the buildings in question. Therefore, sealing of the rooms should be supplemented by covering food products and apparatus with covers, mantles, thick paper in two layers, and canvas. The food products and apparatus can be uncovered and work can be started again only after careful disinfection of the rooms.

To be sure, the best method of protection of food products against aerosol infection (and also including by the diversionary method) at the food enterprises is the mechanization and automatization of all elements of food processing. The entire technological process of processing food should be carried out in such a way that not only is the food untouched by human hands but also that there is no access to it. However, this measure, which is most expedient in every respect, would have to be accomplished gradually, with the perfection of the production processes at the food enterprises.

Special attention needs to be given to the preservation of prepared food products and particularly to those products which afterwards will not be subjected to thermal processing. Products such as bread and sugar, prepared foods (particularly jellies, sausage-meat products, etc.) maybe mentioned as examples. Even though sugar when used, as a rule, is dissolved in hot water the resistance of microbes to the effect of the increased temperature in the sugar solutions is markedly increased. Such food products should be protected by special preservation conditions, that is, in a container (paper bags, boxes, bins, etc.) or on refrigerator shelves covered over with impermeable material (cellophane, thick paper, canvas).

Food products which the population has on hand is protected

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from infection in a similar way.

Considerable attention should be given to the protection of food products against infection during the process of transportation. The transportation of bread, bakery and confectionary products should be accomplished in specially adapted, carefully sealed trucks. The cab doors should be covered with canvas in the form of a canopy.

Milk which is in a room of which the complete sealing is doubtful is best boiled before delivery.

Water may serve as a source of infection of food products if pathogenic microbes have entered it by any means. Therefore, it is best for food enterprises, particularly those which manufacture non-alcoholic beverages or which use a comparatively small quantity of water, either to use boiled water or water which has been additionally chlorinated.

Certain problems in the protection of water against infection by pathogenic microbes have been mentioned above. Measures for the protection of water are determined by the possible methods of infection. The latter amount to an infection of open water sources by the dropping of bacterial bombs (it should be considered that they would be dropped simultaneously with fragmentation bombs for the destruction of purification equipment) and by diversionary infections of pure water reservoirs and of the waterworks. The possibility also exists of infection through the penetration of bacterial aerosols into the pure water (particularly in reservoirs).

Measures for the protection of water against infection by the diversionary method in the area at the waterworks in which there is adherence to a strict routine are the same as for food enterprises. However, they should be supplemented by mobile security of water condites and waterworks.

The sealing of purification equipment and rooms for pure water reservoirs (if they are open) should be carried out with exceptional care. Particularly the ventilation tubes over the auxiliary water reservoirs should be covered over. At the time of an attack with bacterial aerosols, the water level in the reservoirs should not be permitted to drop, because thereby air is sucked in.

Chlorination is the chief measures for the protection of

water. After an attack, hyperchlorination is permissable. Naturally, under exceptional conditions a deviation from the GOST [All-Union State Standards] is justified.

Despite the fact that disinfection of the water can be insured by these measures the idea of obligatory boiling of water by the population during a period of threat needs to be propagandized extensively, and not only of water which is used for drinking (this should be carried out constantly) but also of water which is used for other purposes (for washing, cleaning the hands, etc.). Such a strict routine should last for as much time as needed for guaranteeing the decontamination of water in water conduits or in wells.

Among the measures for the protection of water there is also the constant bacteriological control of its quality. Here, it should be taken into consideration that artificial infection would not be accompanied in any changes in the B. coli titer. Therefore, in the examination of the water one would have to be oriented by a direct determination of the presence of pathogenic microbes and their toxins in the water.

The problem of fodder is somewhat distinct. The infection of fodder may lead to the infection of persons in contact with it according to their working conditions and, mainly, to the infection of animals, which, in their turn, can serve as sources of infection for man. The protection of fodder should be carried out according to the same rules that apply to the protection of food products.

Finally various rodents (rats, mice), which can infect water (for example with the tularemia microbe) or food products the consumption of which can lead to human infection, should have no access to water, food provisions, or fodder. Naturally, all food enterprises should be in rat-proof rooms. In addition, various deratization measures should be carried out with particular persistence.

Fundamental Principles of Organization of Anti-Epidemic Protection of the Population

The same measures which are carried out in the event of the natural occurrence of epidemic outbreaks will underlie the anti-epidemic work in artificially produced foci of acute infectious diseases. Certain differences will be determined by the massiveness of the number of primary cases and by the unusual route of spread of infection at the time of the attack, or, more accurately, by the routes of primary infection. However, even in this case the differences will be part of a definite nosologic form rather than of principles of combatting infectious diseases generally. Thus, if the air-droplet mechanism is not inherent in a given nosologic form, and if it specifically has been used in the attack, the usual measures taken for this infection will be supplemented by others usually used for infections of the respiratory passages.

The absence of differences in principles of combatting infections evidently leads to the fact that no changes are required in the principles of organization of anti-epidemic protection of the population, which can be based on the existing network of sanitary epidemiological and therapeutic institutions with active participation of the population itself. This has no bearing on the fact that under conditions of biological attack the work of anti-epidemic defense in all of its branches should be carried out in a more organized, more complete fashion and in a shorter period of time. Specifically these factors determine the characteristics of work in protecting the population against a biological weapon, and, therefore, the preparation of medical institutions and of their personnel for work under conditions of an attack should be planned and executed beforehand.

In the establishment of the duties of the chief specialists in corresponding public health organs it has been provided that the planning and organization of measures for increasing the quality of work of the existing network of medical institutions should be carried out by these specialists on the basis of an analysis of the results of their operative activity. Therefore, the planning and organization of anti-epidemic defense of the population, by analogy, should be put in charge of the chief epidemiologist. The work of the chief epidemiologist is distinguished from the work of the chief specialists in other specialties to the same degree to which the sanitary-anti-epidemic work is distinguished from therapeutic work. Its characteristics are determined primarily by its more pronounced prophylactic trend.

For understandable reasons, the work of the chief epidemiologist will be different under peacetime conditions, during a period of threat, and at the moment of attack.

Under peacetime conditions the chief epidemiologist plans

the measures for improving the work of the sanitary epidemiological institutions (improvement in laboratory diagnosis, improving the quality of sanitary and anti-epidemic work, increasing the special qualification of sanitary epidemiological stations, etc.), and for improving the water supply and food products systems.

Naturally the sanitary requirements made on public administrative organs and food enterprises should be made stricter and should provide for the elimination of possibilities of infection of water and food products by pathogenic microbes when utilized as a biological weapon by an enemy.

Concretization of these requirements is possible on the basis of data obtained through an analysis of the infectious disease morbidity and through a study of individual epidemic outbreaks, which makes it possible to elucidate the routes of spread of various infections under conditions of a specific locality. At the same time, the epidemiologist also should study the potential epidemiological factors which can play a part of the spread of an infection, absent at the present time but which can be brought about by an attack. Rats, certain species of ticks, mosquitoes, for example, may be such factors. Comparison of the cartograms of spread of possible vectors of infection on the territory of various localities makes it possible to evaluate the epidemiological situation quickly after an attack and during peacetime to initiate planned measures for the elimination and reduction of the possible effect of such factors. For example, through deratization measures taken in an inhabited place from year to year it is possible to reduce to a minimum the importance of rodents in the spread of plague in the event the plague bacillus is used as a biological weapon.

Under conditions of a biological attack the precise coordination of actions of all branches of the medical service of the affected population is of first importance. The attainment of perfect agreement in the matter of service to the population in the area of infection is possible only after a profound study of policies and medical tactics in the area of infection. The chief epidemiologist should participate in the planning and checking of the quality of preparation of medical workers for carrying out their duties under conditions where an enemy uses a biological weapon.

The particularly great importance assumed by the active use of measures of individual protection by the population,

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including punctilious observance of the rules of personal hygiene, under conditions of a biological attack has been mentioned above. Therefore, the chief epidemiologist should participate in the organization of training the population in the rules of behavior in the area of an attack. This training should be carried out by all medical workers.

Specifically, the population should be informed of the methods of prophylaxis of infectious diseases (for each type of infection) and trained in the methods of group (rules of utilization of shelters) and individual (utilization of gas masks, respirator, preparation of cotton-gauze bandages, elements of disinfection, etc.), protection.

During a period of danger, the chief epidemiologist should check on the degree of preparation of medical institutions for the accomplishment of tasks with which they would be encharged in the event of an attack. With the aid of other sanitary epidemiological workers the degree of preparation of food enterprises, food storehouses, and fodder warehouses, stores, etc., and also of water supply systems should be determined with regard to the protection of food products and water from contamination by pathogenic microbes.

At the same time, the working order of technical protective measures (disinfection technic, etc.) should be checked.

After an attack, the chief epidemiologist, who is a consultant or deputy to the chief of the medical service of the MPVO [Local Antiaircraft Defense], participates in the organization of measures for the elimination of the consequences of the attack. These measures will be discussed in the next section.

In accordance with the functions entrusted to the chief epidemiologist he is given the right to check institutions and organizations directly engaged in carrying out measures planned for anti-epidemic defense.

To the same degree to which the chief epidemiologist is the one who fundamentally plans the preparation of the population for anti-epidemic defense, the sanitary epidemiological stations are the main centers directing the accomplishment of the planned measures.

A number of the most important measures are taken by the members of the sanitary epidemiological station (SES) itself.

Thus, it provides the laboratory diagnosis and detection of the causal organisms of infectious diseases. Anti-epidemic detachments and groups are created from its staff which are entrusted with the responsible tasks in the accomplishment of sanitary-epidemiological reconnaissance, in determing the limits of the area of infection and in the direct leadership and accomplishment of measures for elimination of the consequences of the attack. The potential epidemiological factors, which may be of tremendous importance in the event of an attack (species composition of rodents, ticks, etc.), are studied by the members of the rickettsial-virological laboratories and departments of particularly dangerous infections, and laboratory diagnosis of the corresponding diseases is carried out. The disinfection departments of the SES organize and control the systematic performance of disinfection, insect elimination and deratization measures on the spot. The departments of public and food hygiene of the SES check on measures taken for the protection of water, provisions and fodder.

The role of the sanitary-epidemiological stations becomes even more important during a period of danger and under conditions where biological attack has been made.

From the time of initiation "of the threatening situation" the epidemiological department of the SES organizes the giving of inoculations on a large scale with the help of inoculation detachments created from the personnel of medical groups. First, the so-called organized population is covered by inoculations, that is, laborers, white collar workers, students, children in kindergartens and nurseries (small pox). This makes it possible to include the major portion of the population in the minimum period of time. Under such conditions, a vaccinator can inoculate 200 persons during a work day. Then, inoculations are given to the non-working population. With good organization of the inoculation system and with active aid of the members of sanitary organs the vaccination of the population can be carried out at the same rate.

Good organization of the giving of inoculations should provide for the equipping vaccinators with an adequate number of syringes and needles, of population groups at a single point, which reduces the loss of time in traveling, sterilization of material and instruments, etc. Selection of a person from the active members of a sanitary organ who is sufficiently literate for the purpose of recording inoculations increases the productivity of the vaccinator's work.

However, the number of those inoculated in this case in practice rarely exceeds 100 persons per vaccinator. The success in carrying out this measure will depend to considerable degree on the educational work carried out among the population. The inoculation should be recorded carefully, because only in this way is it possible to avoid errors in the future, when vaccination with other types of vaccines will be given.

The disinfection department organizes the provision of the population with disinfectants and directs the training of the population in their utilization. During this period, the fight against rodents and insects should be sharply intensified. Disinfection technics are put in a state of battle readiness.

The sanitary groups of the SES, each in its own fields, checks the state of preparedness of various objects for defense against biological attack: the existence of measures of concealment, sealing-off of rooms, reserve supplies of disinfectants, etc., and also the state of readiness of sanitary units and posts of particularly important installations. Under the conditions of the threatening situation, the sanitary condition of cities should be markedly improved with the aim of eliminating the germination sites of flies, the mechanical vectors of infections. The cleaning up of cities also contributes to the fight against mouse-like rodents. The qualitative preparation of an inhabited place for a biological attack and the systematic sanitary epidemiological supervision with the aim of timely detection of the fact that an enemy has used a biological weapon determine to a considerable degree the success of anti-epidemic defense of the population and elimination of the consequences of the attack.

In the area of the attack, that is, during the period after the attack, the members of the SES and institutions attached to it should carry out measures directed at the disinfection of the focus and for preventing the spread of infection (these measures will be listed in the next section).

Anti-epidemic defense of the population is accomplished not only by the members of the sanitary-epidemiological service. General medical care of the population, which is provided by the medical system, is an important element in it.

During the period following the beginning of "the threatening situation", additional infectious disease beds are set

up in the existing hospitals at the order of the chief of the medical service of the MPVO. Medical personnel brought in for care of persons in the additional infectious disease beds are carefully instructed as to the rules of care of infectious disease patients (primarily, of patients with particularly dangerous infections), concerning the routine in the infectious disease department, and they are provided with measures of individual protection. The department should be provided with a sufficient quantity of disinfectants and vessels for disinfecting linen, feces, etc.

The polyclinic departments of medical institutions select a group of workers for inoculation detachments and train them in the rules and technic of inoculations in case of need and also supply them with material needed for inoculations (syringes, needles, cotton, alcohol, sterilizers, etc.). The district physicians and the secondary school medical personnel attached to them should carry out the recording and observation of all febrile patients on the territory of the medical district, which would be very important if the district should be in an area of infection.

Medical institutions should train detachments of medical workers and Red Cross and Red Crescent workers for continuous medical observation of the population in an area of infection in the event an observation or quaranteen routine is established. The personnel of these detachments should be trained in the methods of individual protection and in the simplest methods of processing and disinfection in the focus of detection of the patient.

Recruiting of the population (primarily of the Red Cross and Red Crescent groups) for observation and assistance in the elimination of consequences of the biological attack requires the obligatory creation of sanitary units in inhabited places, of sanitary posts at various industrial enterprises, in institutions and homes (or house committees) before their direct participation is needed. These elements of the population should be carefully trained in methods of individual and group protection for various methods in which the biological weapon may be used, in the simplest methods of sanitary processing and disinfection. The training of the personnel of these groups should not be limited merely to an acquaintance with the technic of carrying out the measures indicated. Sessions with them should include a populat presentation of all the information concerning properties of the causal agents and their species; concerning the routes of spread of infection, methods of infection, etc. It should be kept in mind that only sufficiently trained persons, who are well acquainted with the rules of behavior in an area of infection, can be enlisted for work in a focus of infection.

The sanitary-anti-epidemic unit (SPED) created from the population in inhabited places of rural type and in cities, and rayon centers are put in charge of the sanitary-epidemiological stations at which they are organized. By means of them all the measures are carried out in an area of infection for elimination of the consequences of an attack, supervision of the observance of the established routine, disinfection, insect elimination and deratization operations, etc. The sanitary-anti-epidemic team carries out its work in the area of infection under the direct supervision of the mobile anti-peidemic detachment or of the group (PPEO [mobile anti-epidemic detachment] or PPEG [mobile anti-epidemic group]), carrying out in the technical division the same functions as these groups [PPEO and PPEG] in anti-epidemic defense.

Measures for the Elimination of Consequences of the Biological Attack

Announcement of a Biological Attack to the Population. In preceding sections a basis has been repeatedly made for the statement that timely application of individual and group measures of protection prevents the penetration of the causal agents of diseases into the human body. It has been mentioned that in contrast to specific prophylactic measures these very simple methods protect against infection by any causal agents and because of their very simplicity they can be used on a very massive scale. In other words, the effectiveness of these measures of defense is assured by the timeliness of their application. The timely and at the same time massive application of individual measures of protection is possible only when the population is informed in time of a biological attack. This responsible function is carried out by a special service of the MPEO [Local Anti-aircraft Defense].

Warning of the population of the threat of an attack from the air is accomplished by giving the "air alarm" signal, at which the population should be prepared for the use of one or of several mass attack agents simultaneously by an enemy, including the biological one.

At the "air alarm" signal the population should take cover

in the shelters, having measures of individual protection with them. Persons who have not succeeded in taking cover in the shelters for various reasons should take cover in specially adapted rooms which protect them primarily against the effects of powerful explosions (airwave, fragments of buildings, light and radioactive emanation, etc.). Sealing of such rooms as much as possible reduces the concentration of organisms in the air but does not exclude the penetration of aerosols into the room. Therefore, persons taking cover in such rooms should be prepared to use individual measures of protection immediately (gas mask, respirators, etc.).

The population should be informed of the use of a biological weapon by the enemy through the "chemical attack" signal. A common signal has been introduced for chemical and biological attack because the indirect (visible) signs of a biological and of a chemical attack as well as the nonspecific measures of protection and rules of behavior of the population in them are the same to a considerable degree. Among the signs suspicious of the use of bacteriological or chemical weapons are the following: the appearance of a cloud in the form of a fog or smoke coming from one of the airplanes or from a bomb which has been dropped, the faint sound of an explosion, the occurrence of the wet ground or pulverized substances at the site where the bomb has fallen, the presence of large bomb fragments from the weak explosion or parts of a container fragmented from impact, etc. In addition, the appearance of a large number of insects, ticks or rodents or of containers which cannot be used for other types of weapons constitute evidence of a biological attack.

At the "chemical attack" signal the airconditioning-filter apparatus in the shelters is switched over to a "Kh N (chemical attack)" or "complete isolation" routine. Exit from the shelter is forbidden until specifically indicated. Persons who are outside the shelter should immediately use measures of individual protection (gas mask, respirators, cotton gauze bandages). In the absence of specially prepared respirators, handy measures are used.

Epidemiological Reconnaissance. At the "chemical attack" signal the chief of the medical service of the MPVO at the instructions of the chief of the MPVO of the city sends the mobile anti-epidemic detachment (PPEO) or group (PPEG) to the presumptive site of infection.

The epidemiological branch of the PPEO (or PPEG) makes a

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careful examination of the locality with the aim of detection of signs of biological weapons (bomb or container residues, an unusual collection of insects, ticks or rodents; unusual drops or the unusual character of the dust on environmental objects, scattered food products and articles, etc.). Data of the examination are compared with reports of eye-witnesses of groups of the observation service of the MPVO and of the population. All suspicious material is collected in the form of samples for prompt laboratory examination in order to establish the species of causal organism used for the attack. The collection of samples and the performance of the bacteriological examination are accomplished by the laboratory branch of the PPEO.

If the reports of eye-witnesses and other signs (spraying of aerosol from an airplane, residuals of bombs with a spraying device, etc.) attest to the use of a microbial aerosol, the detachment establishes the direction of the wind, and its speed, the humidity, air temperature and temperature of the upper layers of the soil, nature of the locality (height of the buildings and density of construction, presence of vegetation, etc.), conditions of the movement of the aerosol cloud in the given locality (for example, whether the direction of the wind coincides with the direction of the streets, whether the formation of air eddies is possible) etc. In addition, the detachment establishes the population census, the character and duration of measures of defense used, length of time the population has been in the aerosol cloud, and it collects other information which makes it possible to establish the limits of the area of infection, the possibility of massiveness of involvement of the population under specific conditions of the focus of infection. Simultaneously, according to the data of public health organs and veterinary service organs they clarify which infectious diseases have been observed recently in the given locality among people and animals and their territorial distribution.

On the basis of the epidemiological reconnaissance information obtained the limits of the area of infection are determined, and appropriate signs and protection posts are set up. In certain cases (for example, when dropped rodents and fleas are found) the focus is immediately surrounded (armed guard). The armed guard of the boundaries of the area of infection is put under the orders of the chief of the MPVO of the city.

The disinfection branch of the PPEO determines the character

and volume of disinfection operations in the focus, the conditions under which they are performed, the types of disinfection technic needed for work in the given focus, the quantity of disinfection agents which are needed for disinfecting the focus. Also, the existence of baths, sanitary inspection stations, etc. which may be of use for sanitary processing of the population is clarified.

A specialist on infectious diseases of the anti-epidemic detachment checks the condition of the system of hospitals within the limit of the focus of infection and plans the setting up of temporary infectious disease beds for the hospitalization of patients and the isolation of persons suspected of disease.

On the basis of all the reconnaissance data the chief of the PPEO or senior officials coming into the area (head physician of the SES, chief epidemiologist) construct a specific plan for the elimination of the consequences of the biological attack. This plan should provide for the following: 1) the establishment of infectious disease beds; 2) census of medical personnel for the purpose of accomplishing a continuous medical observation of the population; 3) the order and sequence of accomplishing disinfection operations; 4) the taking of the census of MPVO groups for the performance of disinfection operations; 5) the accounting of technical mobile and hospital agencies and the location of them; 6) estimation of necessary therapeutic, inoculation and disinfection agents; 7) measures for the protection of the focus in accordance with the OPB [?] service.

In the plan to be constructed the fundamental measure before the occurrence of cases of the disease should be considered to be the performance of disinfection work. The location of temporary washing-disinfection stations at the limits of the focus of infection should be particularly well planned so as not to permit the spread of the infection beyond its limits, and the order and sequence of performing the disinfection operations should be particularly carefully thought out. Evidently, the routes along which persons would be evacuated from shelters, that is, those known to be healthy, should be disinfected first. Then, the areas and routes which would be used in the process of supplying the population with food products and water in the event of a disturbance in the operation of the water supply system should be disinfected. Well shafts, which can be utilized for water supply existing on the territory of the focus of infection should also be

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disinfected and appropriately outfitted. Also, places where repair work of the water supply system and of the sewer system would be carried out should be disinfected. The rooms and yards adjacent to hospitals and buildings in which there are temporary infectious disease beds and other medical institutions should be carefully disinfected. The places where the bomb, containers, etc. fell and nearby areas should be disinfected immediately. In other words, places and the routes to them which provide for a normal way of life in the focus of infection and which assure the performance of anti-epidemic measures should be disinfected first. After this, disinfection operations are carried out on a broad scale (complete-area disinfection, insect elimination or deratization).

The need for assuring the normal way of life of the population is dictated by the fact that an observation or quarantine routine may be imposed on the area of infection as a whole.

By "observation" is understood the system of measures which provide intensified medical observation of the population in the focus of infection with the performance of therapeutic prophylactic and isolation-restriction measures for preventing the occurrence and spread of infectious diseases.

Medical observation in the area under observation should have as its problem the detection of afflicted persons, early detection and hospitalization of patients, isolation of persons who have been incontact with patients and observation of them, the giving of inoculations and the use of anti-biotics (after establishing the species and the drug resistance of the causal organism used in the attack), the increase in health propaganda, particularly concerning the rules of behavior and personal hygiene in the specific given focus. Ingress, egress and travel through the area of the focus of infection should be restricted.

By "quarantine" is understood the system of anti-epidemic routine measures which provide for the complete isolation of the focus of infection from the surrounding population including people and animals which are on its territory and also the measures directed at limiting the size of an epidemic outbreak and eliminating the cases of disease in the focus itself.

The imposition of a quarantine provides a prohibition of

ingress, egress, and travel through the territory of the focus of infection. With the exception of the transportation of special services (bringing in provisions, etc.) which, nevertheless, observe the rules made (disinfection of the means of transportation, sanitary processing of persons associated with it, etc.). An armed guard (surrounding) of the focus of infection is established for the purpose of assuring the execution of this measure.

In the focus of infection the population is divided into as small groups as possible (in houses, apartments) in order to restrict the contact of people with one another. In the event of an air-droplet mechanism of transmission of the infection the population in the focus is provided with an adequate number of respirators, protective glasses, etc. A special service for the observation of order in the focus is organized for the purpose of insuring the execution of this measure, and extensive educational work is also conducted among the population.

Anti-epidemic measures are the same during quarantine, but should be more complete, extensive and more rapidly carried out. In certain cases (for example, in plague) individual hospitalization of patients and isolation of persons suspected of disease should be provided. As has been mentioned above, in certain infections anti-epidemic measures should be supplemented by anti-epizootic measures. For example, in the event of use of the psittacosis virus or some other virus of an ornithosis it should be forseen that not only people but also birds will be affected.

Because determination of the nature of restrictive measures in the focus of infection (observation, quarantine) is possible only after establishing the species of causal organism by the laboratory method, which requires quite a long time, strict restrictive measures (prohibition of egress, or of free movement of the population within the limits of the focus, etc.) should be provided for in the plan to be constructed before the accomplishment of complete-area disinfection (if it is required by the circumstances). After disinfection of the environment, contaminated clothes, etc., observation is established temporarily, and this may be prolonged or replaced by quarantine depending on the results of the laboratory analysis or of the clinical picture of diseases which occur.

Regardless of which routine will be established in the focus of infection afterwards, the plan of eliminating the focus of infection and of combatting diseases which occur should provide for the immediate performance of anti-epidemic and sanitary measures of general nature, which are made more specific after the establishment of the species of causal organism. For the accomplishment of all the necessary operations in the focus, in addition to workers of medical institutions (including scientific research institutes) and students in medical colleges, all other groups of the MPVO, public organs and administrative organizations should be enlisted also, which should find its reflection in the operative plan constructed for the elimination of the consequences of the biological attack.

The operative plan for the elimination of the focus of infection and measures providing for the prevention of a development of an epidemic outbreak should be approved by the chief of the city (or rayon) MPVO.

Epidemiological reconnaissance and planning of measures for the elimination of the consequences of a biological attack, which have been presented in their general outlines, are oriented with respect to the use of a biological weapon in an air attack fundamentally in the form of aerosols. Naturally, the nature of the reconnaissance and the contents of the anti-epidemic measures being planned would be modified in the case of other methods of attack. For example, in a diversionary attack of the water-supply-system water the fundamental reconnaissance information may be obtained on the basis of data of continuous laboratory checking of the water and an analysis of the development of the morbidity, its level and territorial distribution of patients in accordance with the ramifications of the water supply network. It should be considered that in the event continuous laboratory control does not provide for the timely detection of infection of the water a probable biological attack would be established on the basis of the occurrence of cases of diseases en masse. In this case, anti-epidemic measures for the elimination of the focus would be no different from the ordinary ones. Certain characteristics of anti-epidemic measures in the focus of infection can be conditioned simply by the massiveness of a water outbreak, with which the majority of epidemiologists is acquainted only from the literature.

<u>Disinfection Measures in the Focus and Sanitary Processing of the Population.</u> It has been mentioned above that prior to the occurrence of cases of disease produced by the use of the biological weapon the fundamental prophylactic measure is the disinfection of the focus of infection, that is, disinfection in the broad sense of the word.

By disinfection is meant different kinds of measures directed at the elimination of pathogenic microorganisms in man's environment. Usually, when we speak of disinfection measures in the focus we understand by them not only the disinfection proper but also insect elimination (elimination of insects and ticks, the vectors of infections) and deratization (the extermination of rodents, the sources of infection).

The disinfection may be accomplished by the use of mechanical, physical and chemical agents. In accordance with this mechanical, physical and chemical methods of disinfection are distinguished. In an artificially created focus, of all the methods of disinfection those which assure the reliability of disinfection with the simplest possible methods in the shortest periods of time are of practical application when there is a large volume of work to be carried out.

Filtration of the air in shelters, through the canister of the gas mask, through the filtration device of the respirator, etc. are examples of mechanical methods of disinfection. Drinking water maybe reliably disinfected by filtration through bacterial filters, but the no less reliable disinfection of the water by boiling (physical method of disinfection) would be used more often because of its greater simplicity.

Of the physical methods of disinfection methods based on the application of high temperature are the most prevalent: boiling in water, processing by steam or by dry hot air (in the latter case for the purpose of insect removal from personal effects). If, for example, in an area of infection brucellae fall pasture grounds, then, after fencing off this area, we may count on the disinfection of the soil as a result of the effect of physical factors such as sunlight and desiccation. However, in this case no less than two to two and a half months are required for eliminating the brucellae from the pasture grounds. To be sure, this method is not applicable to the inhabited portion of an era of infection.

Chemical methods are applicable for the disinfection of

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underwear, linen, utensils and tablewear, furniture, rooms, outside walls, soil, etc. The application of various chemical agents is determined by the species of causal organism and by the character of the object to be disinfected. Chemical means are utilized extensively also for insect elimination and deratization.

The main disinfectants which have been recommended as highly effective are the following groups of agents:

I. Chlorine-containing preparations (chloride of lime, chloramine, sodium and potassium hypochlorite, louseum hypochlorite, neopantocide, etc.).

1. Chloramine is a white or yellowish crystaline powder with a chlorine odor. It should contain no less than 25 percent of active chlorine. When kept properly (in a dry room, in a dark well stoppered container) cloramine is quite staple. Chloramine solutions can be kept up to 15 days in a closed, dark vessel. Disinfection of contaminated articles requires a high concentration of chloramine and a long exposure time. Chloramine is very suitable for disinfection of linen (one to three percent solution), tablewear (one to three percent solution). By means of a 0.5 to 1 percent solution of chloramine it is possible to disinfect also exposed parts of the body (face, neck, hands). It is also used for the disinfection of excretions (urine, feces, pus, sputum).

2. Chloride of lime (bleaching powder, calcium hypochlorite) is a white powder with a yellowish hue with the odor of chlorine. When it has less than 15 percent active chlorine chloride of lime is not suitable for disinfection. Chloride of lime, particularly clarified solutions of it, can be used for the same purposes as chloramine. However, it can also be used for the disinfection of soil (10-20 percent solution) and in vertical plains (thick suspension of chloride of lime). If the objects to be disinfected contain a sufficient quantity of water chloride of lime is used in the dry form. Metal articles should not be disinfected with chloride of lime because of it corrosive effect.

Chloramine and chloride of lime can be used in the form of activated solutions. Amonium chloride, sulfate or nitrate in quantities equal to half of that of chloramine can be used as activators. First, the chlorine-containing substances are dissolved, and then the activator is added. Activated

solutions act more vigorously, but they are unstable and should be used immediately after preparation.

II. Group of phenol and cresols (phenol, cresol, lysol, creolin, etc.).

1. Phenol (crystalline carbolic acid) in the pure form consists of large prismatic crystals with a characteristic odor. On adding 10 percent water to the crystals liquid phenol is obtained which is convenient to use in practice. Because there is already water in liquid phenol a little less of it should be taken in preparing solutions. For example, in the preparation of the five percent solution 550 grams of liquid phenol are used per bucket of water (10 liters) instead of 500 grams of the crystalline form. Usually 3-5 percent solutions are used for disinfection and these rapidly kill the non-spore forming species of microbes. Phenol is not suitable for disinfection of objects contaminated with spore forms. Phenolated soap solutions are used for disinfecting rooms (walls, windows, doors, etc.) and linen. Linen is moistened with the 1-2 percent solution and is kept in it for two hours. The odor of phenol is readily adsorbed by food products; therefore, it is recommended that it should not be used to disinfect a room in which food products are kept.

2. Lysol is a solution of cresols in a potassium soap prepared in the factory. Lysol possesses greater bactericidal properties than phenol. For the purpose of disinfecting rooms and furniture in the case of intestinal and droplet infections, 3-5 percent of solutions of lysol (900 milliliters per square meter). Other cresol preparations (sulfuric-cresol in mixtures, creolin, etc.) are used for rough disinfection (toilets, rooms for animals, etc.).

III. Alkalis (sodium hydroxide, potassium hydroxide, unslaked lime, etc.).

1. Sodium hydroxide is a white crystalline substance which is readily soluble in water. For disinfection, 2-4 percent solutions of commercial sodium hydroxide (caustic soda) are used. For anthrax disinfection 10 percent hot (75°) solutions of sodium hydroxide are used. Sodium hydroxide is used for the processing of rooms of food enterprises, rooms for animals, storehouses of animal raw material, etc.

2. Unslaked lime is utilized in the form of 10-20 percent

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solutions for the purpose of disenfecting walls are treated three times with paint brushes for the purpose of disinfecting soil, a 20 percent solution of unslaked lime (5-10 leaders per square meter) is used.

For purposes of insect elimination chemical agents with different mechanisms of action can be used (nerve poisons, intestinal poisons, etc.) as well as substances of plant origin. Most widely used at the present time are DDT preparations and hexachlorcyclohexane.

DDT (4, 4-dichlordiphenyltrichlormethylmethane) is a white chrystaline powder. Its good qualities are determined by its great proxisity for very many species of insects and its lack of proxisity for men (coming into contact with the dry preparation of), its prolonged retention of activity. (Stability to oxidation and slight evaporation), its lack of an odor or of a soiling tendency. In connection with the latter, it can be used for the impregnation of fabrics. In practical work DDT is utilized in the form of dusts (10 percent DDT and 90 percent filler-talc kaolin, etc.), of emulsions (20 to 30 percent DDT) aqueous suspensions (the preparation is insoluble in water) and aerosols. DDT aerosols are particularly suitable for the insect elimination of large areas, and inadequate density are highly insecticidal with respect to all blood sucking insects (mosquitoes, fleas, ticks, etc.).

Hexachlocyclohexane (hexachlorane, HXCH) is a chrystaline, white or whitish brown-colored powder which is oily to the touch. It dissolves well in organic solvents (acetone, gasoline, kerosene, etc.) and does not dissolve in water. Hexachlorane is several times more toxic to insects then DDT, possesses an unpleasant odor, is used in the same way as DDT (dust, emulsions, aerosols). Hexachlorane, like DDT, can be added to soap. Laundering linen with hexachlorane soap can protect it for a long time against the settling of insects in it, (residual effect of hexachlorane).

Gas disinfection of rooms is carried out with chlorpicrin or sulphur dioxide obtained from burning sulfur.

For the purpose of exterminating rodents the mechanical trapping of them, infection of baits with pathogenic microbes (biological methods) and various chemical toxic substances acting through the digestive tract (raticide [$C_{11}H_{10}N_2S$]), barium carbonate, zinc phosphite, or by means of asphyxiation (chlorpicrin, hydrogen sulphide, hydrogen cyanide), etc.) are

used in connection with the fact that very toxic substances are used for the extermination of rodents this work is carried out by specially trained personnel.

Physical methods of disinfection with the use of high temperature and steam provide the most reliable form of disinfection. Linen, clothing, bedclothes, etc., are disinfected by these methods. The physical method of disinfection is usually combined with sanitary proces ing of the population, because in both cases a special washing-disinfection technic is required.

For the purpose of disinfection of the articles mentioned above various systems of mobile and stationary steam and steam-formalin chambers are used. Therefore, this method of disinfection is frequently called the chamber method. Stationary chambers are set up in sanitary inspection stations, bath houses, stationary washing points (SOP) and washing-disinfection departments (ODO) in medical first-aid detachments (OPM). Disinfection of underwear and bed linen can be carried out also in public laundries in bucking apparatus.

Incidentally, the disinfection of linen by boiling it in a solution of washing powder can be carried out by the population itself. This reduces the load on disinfection chambers, by the same token shortening the periods required for processing the focus, for example, steam-formalin chambers mounted on a chassis (APK), shower-disinfection truck (DDA), etc. Washing-disinfection mobile technic of this type makes it possible to carry out the processing of the population in any place where it is necessary.

There are special trucks and trailer arrangements for spraying disinfectent solutions, spraying dry disinfectents and insecticides, and also aerosol trucks available for the performance of chemical disinfection and insect elimination. Large-scale technic (irregation trucks,) can be successfully used for these purposes. The use of the technic for disinfection by the chemical method makes it possible to process large areas in the zone of infection in very short periods of time.

By means of the disinfection measures and technic listed above, various groups of the MPVO set about the plan that sanitary processing of affected persons and the disinfection of infected rooms and articles used by the population and also of environmental objects (soil, outside walls of buildings, etc.) immediately after they carry out the primary disinfection operations which were mentioned above (disinfection of the roots of egress of persons known to be uninfected of the supply routes of the population in the area, etc.) In the event of an enemy attack from the air (aerosol use of the biological weapon) these measures are conducted on a large scale in the area through which the aerosol cloud passes. All persons in the focus are subjected to sanitary processing regardless of whether or not they use individual methods of protection. Naturally, other methods of attack do not require the total processing of the whole population. Thus, after the scattering of insects by an enemy, the population in the vicinity of the containers dropped is subjected to processing (local processing of the population). When flying insects are dropped the sanitary processing of the population is not conducted at all, and insect elimination in rooms becomes most important (houses, sheds, outside toilets, etc.)

Even if it is detected in time a diversionary infection of the water and food products requires, first of all, a disinfection of the infected object and places of storage of them. Infected food products belonging to the population should be destroyed. Only persons who have been in contact with infected products are subjected to sanitary processing.

When cases of disease occur in the area of infection, processing of posei should be carried out according to the type of terminal disinfection throughout the entire work in the focus the personnel of the working groups should undergo sanitary processing systematically (at the end of a shift, during an interval period in the work, before taking food, etc.)

Epidemiological Observation of the Focus of Infection

Simultaneously with the performance of preventive disinfection measures, a systematic epedimiological observation is established in the zone of infection as a fundamental measure for the anti epidemic defense of the population before the occurrence of cases of the disease produced through the use of a biological weapon.

Before the occurrence of cases of the disease and before the laboratory establishes the species of the causal agent used, epidemiological observation should be performed with the aim of clarifying the data of the epidemiological reconnaissance with respect to the infectious disease morbidity rate prior to the attack. The original figures for epidemiological reconnaissance based on official reports of patients

with infectious diseases in whom the diagnosis was established will always be less because of persons in whom the diagnosis has not been established at the time of attack. The true number of patients (febrile) is established by house-to-house rounds. Patients detected are subjected to careful clinical examination by a specialist in infectious diseases, and this examination is combined with an epidemiological examination; in necessary cases they are hospitalized immediately.

Epidemiologists should carefully plot cases of the diseases detected on a map of the locality (plan of the city), which afterwards facilitates an evaluation of the sources of the infection for new patients and also serves for the determination of the territorial distribution of new cases of disease. In certain cases (for example, in water infection) study of the territorial distribution of the cases of disease is a clue to the determination of the character of the epidemiological outbreak and the sites of infection.

The map of the infectious disease morbidity rate in inhabited places constructed by the epidemiologists in the process of their usual work may be of invaluable benefit. It should be then made more precise through the addition of newly detected patients. It gives an idea as to the infectious disease morbidity rate through a long period of time, which is very important in certain infections.

House-to-house rounds, which are to be made by the medical workers enlisted, are continued with the aim of the earliest possible detection of infectious disease patients. Each new patient with an infectious disease is examined by an infectious disease specialist, subjected to laboratory examination and to an epidemiological analysis not only with the aim of the rapid establishment of the diagnosis and the source of infection but also for the purpose of early detection of new diseases which are either not characteristic of the given locality or which have not been observed for a long time. The detection of the first cases of any unusual diseases, not only facilitates the fight against the further spread of infection but can serve as the earliest indication of the species of causal organism used, which permits an extension and particularization of anti-epidemic measures, and which makes it possible to direct them against a definite infection.

An important epidemio;ogical measure, which should be carried out before the occurrence of cases of the diseases, is cleaning up of the affected locality. Cleaning up of the focus of infection is carried out by members of the public administrative organs. In the focus of infection the militia should make their requirements stricter with respect to public administrative organs.

The order of cleaning the inhabited place, however, can be changed, and in each specific case should be determined by the sanitary organization. The problem will be solved most readily when rubbish-burning and biothermal apparatus are presently in the affected area, which makes it possible to avoid carrying the rubbish out of the focus of infection if the latter has been caused by the application of causal organisms which are particularly dangerous infections. Apparently, in certain cases the preliminary disinfection is necessary of dirt which is to be carried out and transportation which is to be used. The possibility exists that recourse will be needed to burning the rubbish in the boiler-rooms of enterprises on the territory of the focus of infection when there is a need for destroying dry rubbish (feeding places of rodents). Only the need for preventing an accumulation of rubbish is indisputable, sights of the germination, habitation and feeding of insects and rodents which play an exceptionally important part in the spread of infection. Examinations of all enterprises and institutions having stores of provisions and fodder should be included in the system of measures of sanitary epidemiological observation of the focus of infection. During the examination it is essential to determine the timeliness and adequacy of measures taken at the time of the attack for the safeguarding of provisions. In addition to this, a laboratory evaluation should be made of food products for contamination by pathogenic microflora. The order of carrying out the laboratory examinations is established by the sanitary service in cooperation with interested organizations.

The sale of food products which are in the area of infection at the time of the attack is forbidden until the permission of the sanitary service for this is obtained, and the latter can determine the nature of the preliminary processing of these food products. This group of measures should completely eliminate the participation of the food factor in the infection and subsequent spread of the infection, the causal organism of which was used during the attack.

The species of causal organism can be established most accurately by laboratory examination. However, the occurrence

of diseases on a large scale and particularly those which are unusual for the given locality gives us an adequate basis for an idea as to the species of the causal agent used and for the adoption of appropriate anti-epidemic measures. In those cases where it is possible to isolate the causal organs, bacteriological analysis should be supplemented by a determination of the sensitivity of causal organisms to various antibiotics. This is accomplished by the application of circles of filter paper dipped in various antibiotics to a continuous inoculum of the microbe in Petri dishes. Information as to the sensitivity of the microbe to the antibiotics is needed for the purpose of including the latter in the group of prophylactic agents.

After obtaining information concerning the species of causal organism and certain of its properties vaccination is organized of the entire personnel of the MPVO groups and of the entire population in the focus of infection. The occurrence of cases of disease is not a contra indication to the accomplishment of active immunization of clinically healthy persons. In cases of need (short incubation period, contact with patients with, for example, the pulminary form of plague; etc.) specific serum can be used prophylactically for the purpose of passive immunization. If the use of the collarvibrio hasbeen established, anti-cholera bacteriophase should be used along with immunization of the population.

The giving of innoculations can be entrusted only to persons with a medical education. The prophylactic application of anti-biotics can be carried out by distributing powders to the population for the purpose of internal consumption.

With the occurrence of cases of the disease produced by artificial infection, anti-epidemic measures are directed at eliminating the source of infection from the group (hospitalization of the patient) and the performance of this infection in the focus of the disease. Persons who have been in contact with patients are either subjected to quarantine or are put under an intensified observation at home.

Hospitalization of patients is carried on only by a special ambulance. It is categorically forbidden to use just any chance trucks. The patients are accompanied only by persons specially selected for this purpose from the groups or institutions of the medical service of the MPVO (local anti-aircraft defence)

As a rule, hospitalization of patients should be carried out in rooms which are on the territory of the focus of infection, particularly in cases where a quarantine has been imposed. This eliminates the spread of the infection beyond the limits of the infected area.

In certain cases (for example) in the event of preceding use of atomic weapons), when it is impossible to organize a hospitalization of patients in the infected area, the transportation of the patients out of this area becomes inevitable. Classification of patients in this case is carried out on the territory of the focus of infection. Trucks leaving the focus of infection should be subjected to disinfection on a special platform located at the border of the area of infection. After delivering of the patients, they are again subjected to disinfection.

The use of atomic and thermonuclear weapon undoubtedly considerably complicates conditions for carrying out anti-epidemic measures, without changing them in principle. Therefore, there is no particular need for a special description of them. However, it should not be overlooked that in a focus affected by atomic weapons there will evidently be all the conditions needed for the development of an epidemic outbreak even without the use of biological weapons (destruction of houses, water-supply systems, sewerage systems, etc.). Therefore, a focus affected by atomic weapons should be regarded as a potential epidemic focus of any infection inherent to the given locality and it should be considered that this infection will obtain more favorable conditions for its spread. Anti-epidemic plans should be constructed in accordance with this.

If infected animals or birds are the sources of infection, measures should be taken with respect to them which are provided by the veterinary-sanitary legislation.

Measures directed at cutting the routes of spread of the infection are exceptionally numerous. The most general of them have already been partially presented. Special measures apply to each infectious disease presented in detail in a course of specific epidemiology.

Epidemiological observation of the focus (quarantine, observation) is stopped when no new cases have been observed in it for the period of time which in the majority of cases is equal to the incubation period for the given infection.

This period is reckoned from the time of hospitalization of the last patient.

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The Organization of the MPVO Medical Service and Its Basic Tasks

A. Ye. Minenko (Chapter 11)

The continuous armament race in capitalist countries is creating a constant threat of the outbreak of war. The peace-loving countries together with the USSR are stubbornly striving to safeguard peace throughout the world. The Soviet Union is actively coming forward and persistently striving for prohibition of weapons of mass annihilation, for disarmament in conventional types of armament, and for peaceful coexistence of different states regardless of their social system.

Yet the imperialistically minded circles in capitalist states maintain their former positions of a "cold war", of continuance of the armament race, and for the use of atomic weapons.

Certain government officials in capitalist countries continue to preach the use of atomic, bacteriological and chemical weapons and are training their armies for the use of these types of weapon. Thus, for instance, according to a report in the newspaper Pravda (9 November 1955), the United States Secretary of Aviation, Donald Quarles, in his speech on 6 November 1955 claimed that the United States possesses atomic might "capable of annihilating communist Russia". According to a report of the Associated Press, the United States Secretary of the Army Brucker ordered the Chemical Corps to conduct work in the field of creating "new types of bacteriological and chemical weapons, such as only the human mind could devise". On 6 November 1955 the United States Secretary of the Army approved the report of the so-called "Civil" Advisory Committee, where it is noted that chemical and bacteriological methods of warfare are allotted an "appropriate place" in American military plans. It is also reported that "in the past year (i.e. 1954) information has leaked out that the American Army is engaged in work on a fatal nerve gas "G", by means of which a person can be killed within a few minutes.

Such speeches of government officials, the race in atomic and other forms of armament in capitalist countries, and press reports, blurting out information concerning preparations in these countries for use of methods of mass destruction, gives reason to assume the possibility of use by an aggressor of

methods of mass destruction.

In the event that enemies of the Soviet Union attack the peaceful cities and villages of our Homeland with atomic, bacteriological or chemical weapons, there will be extensive centers of destruction with much devastation of residential districts, factories, plants, railway junctions and other targets. All this will produce many victims among the civilian population, especially in the event of sudden atomic attack.

The MPVO medical service, which is a division of the local Anti-Aircraft Defense, must be ready at any moment to give medical aid to citizens injured by atomic, bacteriological or chemical weapons. In the event of use by the enemy of bacteriological weapons, the medical service is obligated to promptly determine what agent of infectious disease has been employed, to take urgent preventive measures against spread of the infection, and to provide medical aid to the sick.

In order to properly understand the problems of organization and tactics of the MPVO medical service, one must have a concept of possible casualties in the event of use by the enemy of methods of mass attack. It must be assumed that of all known methods of mass attack, atomic weapons with explosive action will cause maximal casualties among the population of the cities subjected to air attack. World experience in military use of atomic bombs is limited to the atomic attack by the United States on the Japanese cities Hiroshima and Nagasaki. This affords an opportunity to make use of the statistical information on number of victims in these cities. According to data of the American press[1], based on material of the reconnaissance service of the American Bombing Command, on 6 and 9 August 1945 in the cities of Hiroshima and Nagasaki, 216,000 out of a total population in the two cities of 500,000 were victims of the atomic attack. It follows from these figures that 43.2 percent of the population in the two cities were victims of the explosion of two atomic bombs.

The casualties in each city separately were as follows:

[1] T. Sears. The Role of the Physician in Anti-Atomic Defense /The Physician in Atomic Defense/, Foreign Literature Press, Moscow, 1955.

	Hiroshima	Nagasaki
Total population (according to data of T. Sears)........................	300,000	200,000
Population density per km^2................	13,566	25,193
Area in which destruction occurred (km^2)...	12.2	4.6
No. killed and missing...................	70,000	36,000
Wounded..................................	70,000	40,000

Total casualties in Hiroshima were 46.6 percent and in Nagasaki 38 percent, when both cities were bombed with atomic bombs of the same caliber, equivalent to 20,000 tons of TNT (Lepp) /Lapp/.

The relatively low casualties in Nagasaki (almost one-half those in Hiroshima) is explained by the fact that the city was situated in a hilly locality - the hills sheltered parts of the city from the effect of the shock wave, and destruction occurred over an area of 4.6 km^2. Hiroshima was situated in flat country, and the area of destruction was 12.2 km^2. Hence the considerable difference in number of victims, despite the fact that in Nagasaki the population density per km^2 was almost twice that in Hiroshima. This provides a basis for the collateral conclusion, that cities on plains suffer considerable destruction from atomic attack, less in hilly regions.

According to data of an estimate by a British commission, total casualties in Hiroshima were 170,000 - 190,000, i.e. about 60-63 percent of the total population.

All statistical data, published in the foreign press, on number of victims of the atomic explosions in the Japanese cities are distinguished by great inexactness and can serve only as very tentative indexes of the effect of an atomic bomb in military practise.

However, recalling the complete unexpectedness of the use of an atomic bomb, the unpreparedness of the population for an air attack, the absence of organized rescue work and medical aid, one might assume that the figure 50-60 percent casualties in Hiroshima somewhat approximates the truth.

According to the same British and American statistical data, of the total number of casualties in Hiroshima 70,000 - 90,000 were killed, which is 41-47 percent.

If this figure is real and there actually was such a mortality percentage, it was a result of the complete unexpectedness of use of so powerful a weapon as the atomic bomb. The explosion created panic and confusion among the population and organs of authority in Hiroshima. Rescue work in the city was not begun until 30 hours after the atomic bomb explosion, and medical aid was begun by 30 physicians and about 100 nurses, uninjured by the explosion, only after much time following the catastrophe.

Of course under these circumstances a considerable number of severely wounded perished as a result of the lack of prompt medical aid, and many wounded could not without assistance get out of burning buildings and perished in the fire. Well organized and rapid medical assistance and properly set up rescue work could have saved the lives of a considerable number of inhabitants of Hiroshima; the percent mortalities could have been reduced to approximately 30-35 percent, and hospital casualties in this event would have been 65-70 percent.

Such are the conclusions, highly tentative, that can be drawn from the statistical data published by the American, T. Sears, on the number of victims in Hiroshima and Nagasaki.

It should be noted that in the event of preparedness in anti-atomic defense, prompt notification of the population of the possibility of an atomic attack, and the people's knowledge of a behavior standard under attack, it may be assumed that casualties in Hiroshima could have been reduced to one-half or one-third, i.e. would not have exceeded 20-30 percent.

Those injured from weapons of mass destruction are notable for a diversity of injuries. In an atomic destruction center one can anticipate the most varied wounds of every degree of severity, burns of all degrees up to charring, injury by ionizing radiation and radioactive substances. A chemical attack necessitates assi-

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stance to the injured against the chemical poisons: skin-blistering, suffocating, generally toxic and other effects. Use by the enemy of bacteriological weapons requires preparedness for struggle, in all probability, with especially dangerous infections and those causing severe illnesses and capable of rapid spreading.

The presence in the hands of an aggressor of weapons of mass destruction and an opportunity of using them will entail the appearance of mixed centers and will complicate still further the problems of organizing and giving medical aid to the injured.

The use by the enemy of weapons of mass destruction may result in contamination of a locality and the buildings, water sources, food (in stores, warehouses, depots, etc.) situated therein, in contamination of clothing and footwear, which in turn can be an additional agent of human injury.

Possibilities of casualties so enormous among the civilian population of cities and villages, the diversity of injuries, and all the after-effects resulting from use of weapons of mass destruction, confront the MPVO medical service with serious problems in organizing and giving medical aid to the injured.

The former MPVO medical service was designed chiefly for medical aid to the injured in centers of destruction caused by high-explosive, splinter and incendiary bombs, and for giving medical aid to the injured in chemical attack centers. This demanded a special network of MPVO medical service hospital installations (DPM, PPM, SPM, city MPVO hospitals, SKhL, etc.) and a relatively small number of field units (sanitation posts, sanitation teams, sanitation brigades, OPM, reinforcement brigades). The appearance of new types of weapons of mass destruction has confronted the MPVO medical service, in the event of air attack by an aggressor using weapons of mass destruction with different problems that consist essentially of the following:

Rapid premedical first aid to injured directly in the attack center, their removal to a safe place with subsequent evacuation to MPVO medical service field units or installations giving medical aid; maximally rapid emergency medical aid in the immediate vicinity of the attack center;

casualty clearing at all points and rapid evacuation of injured to their destination;

hospitalization of injured, and skilled, specialized medical aid in MPVO medical service hospital installations;

determination of persons contaminated with radioactive substances among injured arriving at medical stations and hospital installations;

organizing and carrying out sanitary treatment for arrivals in MPVO medical service installations, and special treatment for those injured by poisonous or radioactive substances (OV or RV);

organizing and carrying out inspection of water and food for bacteriological contamination and contamination with OV and RV, and determination of fitness of water and food provisions for the population;

carrying out sanitary and anti-epidemic control over the condition of collection stations for injured and of other population distribution points;

carrying out necessary sanitary and anti-epidemic measures to prevent mass spreading of infectious diseases;

sanitary and anti-epidemic supervision of the condition of the resources of collective defense;

sanitary supervision of burial of bodies.

This combination of measures represents essentially the tasks that the medical service must perform in the event of enemy attack upon our peaceful cities and villages.

In order for the medical service to perform these tasks, it was necessary to considerably reinforce existing field units and to create new ones for work in the attack center. The new units must quickly reach the center, give premedical first aid to the injured and remove them from the attack center within a short time. The necessity of hospitalizing a considerable number of injured required, in addition to existing stationary installations, the formation of large-scale clearing and evacuation bases, in suburban and rural areas, able to accept and give skilled and specialized medical aid to the injured.

Considerations were presented above concerning the likelihood of occurrence of mixed attack centers and the possibility of mixed injuries. The occurrence of an atomic attack center may

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be accompanied by additional bacteriological attack, which will appreciably complicate the situation. Atomic weapons with explosive action produce a considerable number of combined injuries (trauma and burns; trauma and radiation sickness; burns and radiation sickness; trauma, burns and radiation sickness). T. Sears reports the following concerning casualties in Hiroshima and Nagasaki: "On the basis of interpolated data obtained on relatively small groups of injured, it has been estimated that 70 percent of the injured received mechanical injuries, 75 percent burns, and 30 percent radiation injuries; this gives a total of 175 percent and indicates that the majority of injured received simultaneously injuries of various types." Without going into a criticism of the methods and correctness of the data cited by T. Sears, it can be concluded that mixed injuries in Hiroshima and Nagasaki occupied a considerable place.

In order to effectively provide medical aid to victims of various types of weapons and in centers of combined attacks, the new organization of forces and resources of the MPVO medical service envisages combined measures to aid the injured.

Also altered is the tactical solution of problems in liquidating the attack center. The massiveness of population destruction in atomic attack (50-60 percent in Hiroshima according to preliminary conclusions) demands considerable numbers of medical personnel to give prompt medical aid to the injured.

Under these conditions not a single city will be able to provide the required medical personnel by its own efforts, much less so since some field units and installations may be destroyed. Hence the new organization envisages mutual assistance between cities, oblasts, regions, and republics with enlistment of their forces and resources to give medical aid to a center of large-scale attack.

Medical aid to the injured during liquidation of the destruction center will be carried out by the entire public health network, on whose base is organized a considerable number of the MPVO medical service field units and installations.

The health agencies are conducting this work jointly with the volunteer Red Cross and Red Crescent Society, which is forming a number of units from among its members.

The health agencies are organizing the medical service by utilizing the wide network of hospital, medical, anti-epidemic and other medical institutions of our country, irrespective of their institutional affiliation. With these as a base, medical service field units and installations are created, which are staffed with physicians, secondary and junior medical personnel recruited from the base institutions.

In order to equip field units and installations with stock medical and sanitation-administrative equipment, the medical service can utilize in full or in part the equipment of the base institution. The enormous and complex tasks confronting the MPVO medical service have required the enlistment of a large number of physicians, secondary and junior personnel from the public health network. But even under circumstances the medical service will not be able to perform the tasks confronting it without the assistance of broad masses of the population. Hence the health agencies are planning their work on giving medical aid to the injured jointly with the volunteer society, Red Cross and Red Crescent. The latter is performing much work among the population in self-help and mutual assistance, and is forming from the ranks of its members sanitation posts and teams, sanitation brigades, etc.

By enlisting these units into the MPVO medical service staff, the Red Cross and Red Crescent Society is creating an enormous force capable of performing the most difficult tasks in giving first aid to the injured in an attack center, in removing them from the attack center, of care for the wounded, etc. The health agencies through the Red Cross and Red Crescent Society will be able when necessary to enlist this national force in order to liquidate possible serious after-effects of an attack upon our cities and villages by an agressor using weapons of mass destruction. Hence the Red Cross and Red Crescent field units occupy an important place in the MPVO medical service and are an integral part of it.

The medical service, with the health agencies and network as a base, is drawn up on the succession principle. The Minister of Health USSR is the chief of the country's MPVO medical service, ministers of Union republics are chiefs of the republics' MPVO medical services, directors of region, oblast, city, and rayon health departments are the respective chiefs of the MPVO medical services.

In region, oblast, and city health departments there are formed, for operational leadership of the MPVO medical service, region, oblast, and city MPVO medical service staffs, headed by a chief of staff having advanced medical training. In health departments without

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regular posts of chief of staff, their duties are laid, by order of the health department director, upon a physician in the apparatus for holding multiple posts. Chiefs of region and oblast medical services appoint consultants from among head specialists in the health department. The principal consultants appointed are: head surgeon, head therapeutist (toxicologist), head radiologist, and head epidemiologist. In region and oblast health departments without a given staff specialist, his duties are laid upon a specialist in a region or oblast hospital.

The chief of a region or oblast MPVO medical service appoints as staff members:

1. The deputy director of the region or oblast health department on medical problems - as deputy chief of the MPVO medical service on medical problems.

2. Assistants to the chief of the region or oblast MPVO medical service:

a) the head physician of a region or oblast sanitation-epidemiological station - as assistant on sanitation-epidemiological problems;

b) the chairman of an oblast Red Cross and Red Crescent committee - as assistant on mass field units;

c) the manager of an oblast pharmaceutical board - as assistant on medical supplies;

d) the chief of region or oblast sanitation-administrative supplies - as assistant on sanitation-administrative supplies.

The MPVO medical service has a double subordination. The region, oblast, city, or rayon MPVO medical service chief on special problems is subordinate to the higher ranking MPVO medical service chief, from when he receives necessary instructions and to whom he reports on work completed. On the other hand, he is operationally subordinate to the corresponding chief of the Local Anti-Aircraft Defense [MPVO]. On this basis all city and rayon medical service chiefs on special problems are subordinate to the region and oblast MPVO medical service chief. To him also are fully subordinated the Offices of clearing-evacuation bases

placed on territory of the region or oblast.

The forces and resources of the MPVO medical service are made up of field units and installations formed by the Red Cross and Red Crescent Society and the health agencies.

The units formed by the Red Cross and Red Crescent Society include:

sanitation posts (teams;

sanitation and sanitation-anti-epidemic brigades;

detachments for searching and carrying out wounded (ORVP);

searching-clearing groups (PSG).

The units formed by the health agencies include: detachments of medical first aid (OPM) with divisions for washing and decontamination (degassing, disinfection), for receiving and clearing, for surgery and dressing, for hospital evacuation, and a mobile laboratory (PL);

detachments and groups of specialized medical aid (OSMO and GSMP);

mobile anti-epidemic detachments and groups (PPEO and PPEG);

mobile radiological laboratories (PRL);

medical groups to accompany transport of wounded.

In addition to field units, the health agencies form the following MPVO medical service stationary installations:

premedical stations for first aid (DPM);

stations for medical first aid (PPM);

hospital stations for medical aid (SPM);

clearing-evacuation bases (SEB), comprising the clearing-evacuation base office (USEB), clearing-evacuation hospital (SEG), MPVO medical service rural hospitals, and collection stations for the lightly wounded (PSLP). The latter are formed by city executive committees;

radiological stations;

city, inter-rayon and reserve laboratories of the MPVO medical service.

On instruction of MPVO city staffs, on the base of public baths, bath pavilions, sanitary inspection stations, etc., hospital washing stations (SOP) are organized. SOP formation is laid upon departments and ministries to whom the base institutions are subordinated.

The mobile forces or, in other words, the MPVO medical service field units are designed to give medical aid to wounded in the attack center or its immediate vicinity. Despite a considerable number of such units, they nevertheless cannot perform the tasks confronting them without assistance from other MPVO services, working in the attack center.

The MPVO medical service units therefore work in close contact with other MPVO services, especially the disaster-equipment and fire-prevention services. These services give access to wounded in collapsed shelters or under debris of buildings and remove people from fire centers, whether sanitation field teams and medical personnel cannot penetrate without assistance; other services provide information on limits of contamination with OV, RV, and BRV and on amount of radiation after an atomic explosion, report data on degassed or decontaminated passage-ways in the destruction center, etc. Without good contact with the inits of other MPVO services, the medical service cannot rapidly and effectively organize its work in the destruction center, and consequently cannot give prompt aid to the wounded. All MPVO units working in the destruction center should give every possible assistance to the medical service in its work of promptly aiding the wounded, and take measures to preserve life and health of the population suffering from weapons of mass destruction.

Assuming that the target of a possible air attack using weapons of mass destruction will be primarily large industrial cities and important administrative centers, we will examine the structure of the MPVO medical service of a city with a rayon division.

The chief of a city MPVO medical service has a service staff, headed by a chief of staff - the physician who is first deputy director of the city health department for MPVO medical service.

The chief of staff coordinates the work of assistants to the MPVO medical service chief and of medical service chiefs of city rayons, directs compilation of staff documentation, and during liquidation of the destruction center conducts operational direction of the service on instruction of the MPVO medical service chief.

The MPVO medical service chief appoints consultants on special medical problems. There should be without fail among the consultants: head epidemiologists, head surgeon, head radiologist, and head therapeutist- toxicologist. These persons are appointed from among head specialists in the city health department. In cases where there are no head staff specialists, the MPVO medical service chief appoints head specialists from among qualified city hospital physicians having MPVO training.

A city MPVO medical service staff comprises:

1. The head physician of the city sanitation-epidemiological station (SES) - as assistant to the MPVO medical service chief on sanitation-epidemiological problems.

To him are subordinated the following installations and units of the MPVO medical service:

MPVO medical service city laboratory;

mobile anti-epidomic groups (PPEG);

mobile anti-epidemic detachments (PPEO);

disinfection (degassing) stations;

mobile radiological laboratory (PRL);

MPVO medical service inter-rayon laboratories

In addition to the units and installations indicated, the assistant to the MPVO medical service chief on sanitation and anti-epidemic problems has under him all city SES divisions.

2. The deputy director of the city health department - as deputy chief of the city MPVO medical service in medical work. To him are subordinated the following units and installations:

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detachments and groups of specialized medical aid (OSMP and GSMP);

blood-transfusion stations (SPK);

city radiological station;

detachments of medical first aid (OPM);

MPVO medical service city hospitals.

3. The chairman of the city committee of the Red Cross and Red Crescent Society is a staff member - as assistant to the city MPVO medical service chief on mass field units, and is in charge of the latter.

4. The head physician of the city first aid station is a staff member - as assistant to the city MPVO medical service chief on evacuation of wounded. The motor transport of the city first aid station and institutional transportation are at his disposal.

5. The manager of a large city pharmacy is a staff member - as assistant to the MPVO medical service chief on medical and administrative supplies, under whom is the pharmaceutical supply base, and administrative supply base when such exists in the city health department.

The staff personnel is appointed to posts and released from them by order of the city medical service chief.

The MPVO medical service chief of a city rayon has: 1) a deputy in medical work; 2) an assistant on mass field units; 3) an assistant on sanitation-epidemic problems. To the first are subordinated pre-medical stations of (first aid (DPM), medical first aid stations (PPM), detachments of medical first aid (OPM), hospital stations of medical aid (SPM), and rayon hospitals. To the second are subordinated sanitation brigades, sanitation posts, and sanitation teams. To the third are subordinated hospital washing stations and rayon MPVO medical service laboratories, if the latter exist in the rayon.

As deputy chief of the MPVO medical service of a city rayon in medical work, the deputy director of the rayon health department is appointed. If this post does not exist, the rayon MPVO medical service chief may appoint to this post the head physician of a rayon hospital. As his assistant on sanitation-

epidemiological problems, he appoints the head physician of a rayon SES, as assistant on mass field units - the chairman of the KK and KP [Red Cross and Red Crescent] rayon committee. In addition an outside chief of staff is appointed.

Such is the organizational scheme of the MPVO service of a city with a rayon division. If the city has no rayon division, then the MPVO medical service installations and units, indicated in the scheme, are transferred to the jurisdiction of the respective or deputy of the city MPVO medical service chief.

The large number of units and installations of the MPVO medical service, the responsible tasks confronting them, and the necessity of being prepared at any moment to aid the wounded, now require of the MPVO medical service the training of installations and units for work under conditions of possible use by an aggressor of the weapons of mass destruction.

Mobile Formations of the MPVO Medical Service

A. Ye. Minenko (Chap 12)

The new types of weapons of mass destruction, primarily atomic weapons with explosive action, have sharply changed the dimensions of attack centers and the extent of devastation in them. Population casualties have also risen immeasurably. Human injury in atomic attack is of great severity. A feature of the injury in an atomic attack center is the fact that a considerable number of victims simultaneously incur injuries of different types, such as burn and trauma, burn and radiation sickness, trauma and radiation sickness, and possibly burn, trauma, and radiation sickness. The likelihood of occurrence of combined attack centers gives reason to suppose that victims may also be injured by poisons or be subjected to bacterial infection.

Upon explosion of an atomic bomb of medium caliber, a destruction center of up to 30-35 km^2 in area is possible in which victims will have injuries from light to extraordinarily severe. Devastation and fires in the destruction center will greatly hamper search for wounded and evacuation outside the center.

Data on destruction of buildings in an atomic attack center give reason to suppose that in the area of great destruction the city hospital institutions will be destroyed, and in the area of intermediate destruction if not destroyed, will scarcely be able to operate.

An enormous area of devastation with tens of thousands of injured caught in collapsed and demolished structures and in fire areas, loss of many medical personnel and hospital institutions, as well as difficulties in evacuating wounded from the devastated part of the city, are the conditions that the MPVO medical service will obviously have to face if an enemy makes an atomic attack upon any city of our country.

Our medical experience in the Second World War, 1941-1945, showed that the majority of wounded required early surgical treatment, and that surgical treatment given within a few hours after injury gave the best results. Hence conclusions were made on the necessity of maximally

rapid evacuation of wounded from the battle field to points where medical aid was available, and medical aid was brought maximally close to the wounded in battle.

These two concepts are fully applicable to the conditions of giving medical aid to wounded in an atomic attack center. On the basis of the principle of giving rapid premedical first aid, of bringing medical aid close to the wounded, and also of giving them maximally rapid skilled and specialized medical aid, MPVO medical service field units and installations were formed of types able to perform these tasks. Moreover, the possibility of use by an aggressor of bacteriological and chemical weapons required the MPVO medical service to plan for units which could give the people the necessary medical aid, in the event of use of any of the three types of weapons of mass destruction or combination of them.

The necessity of organizing mutual aid among cities, regions, oblasts, and republics demanded in turn the formation of mobile units, whose movement could give prompt aid to some other city.

The new structure of the MPVO medical service provides for units which fulfill the requirements for work under conditions of attack by an enemy using modern methods of mass destruction.

Units Formed by the Red Cross and Red Crescent Society

S a n i t a t i o n   p o s t s (SP) are mass units formed by the Red Cross and Red Crescent Society at enterprises, in institutions and educational institutions, on railroad and water transport, in residential buildings, etc.

In places where self-defence groups or unitary squads are formed, the sanitation posts belong to them as the medical teams or groups. If for any reason these groups or squads are not formed, sanitation posts remain independent units working under the direction of the local organizations of the Red Cross and Red Crescent Society.

A sanitation post staff consists of four persons, one of whom is appointed chief and three are team members. For staffing of sanitation posts GSO and BGSO badge-holders 16-55 years of age are selected. Persons are enlisted in sanitation posts who live in residential buildings, if they do not belong to MPVO units for local service, students, employees, kolkhoz workers, and auxiliary labor workers and employees in factories.

As stock supplies of the sanitation post the following equipment has been planned: hospital stretcher - 1, kit for sanitation post chief - 1, stretcher straps - 2, individual anti-chemical packets - 4. This equipment is acquired from resources of the institutions on whose base the sanitation post is formed.

Training of personnel is conducted by the Red Cross and Red Crescent Society with assistance of its medical group. For guidance of their daily work and participation in prophylactic and sanitation-educational work of the health agencies, the sanitation posts are attached to hospital institutions by order of the respective director of the medical institution. In order to learn methods of work under conditions in mass attack centers, sanitation post personnel is enlisted in training courses of the MPVO medical service, with release from work for five days per year. During participation in the training courses, average wages at their place of work are maintained for persons working in factories, institutions, etc. Students are released from studies for the same period. Sanitation posts in peace-time, in order to assist medical personnel, inspect sanitary conditions in industrial enterprise workshops, kolkhoz field camps, public dining rooms, residential buildings, institutes, schools, etc. Sanitation posts conduct prophylactic work on reducing illness and injury among workers and kolkhoz farmers, give first aid in accidents, participate in organizing sanitation-educational work, inspect sanitary conditions of outside premises of plants, factories, residential buildings, educational institutions, etc.

Sanitation posts are a great social force contributing to public health care in the matter of further improving sanitary conditions in our cities, villages, industrial enterprises, kolkhozes, and sovkhozes.

Sanitation posts in the MPVO medical service during liquidation of attack centers are charged with the duties of searching for wounded, giving them first aid, and carrying them to the nearest medical station. In addition, they are charged with sanitary supervision of refuges and shelters within the territory of activity of the sanitation post.

S a n i t a t i o n b r i g a d e s (SD) are the basic and permanent unit of the Red Cross and Red Crescent Society. They are formed to assist the health agencies in carrying out prophylactic and sanitation improvement measures among the people and to function in the MPVO medical service. Sanitation brigades are formed by local organizations of the Red Cross and Red Crescent Society in plants, factories, special secondary and higher educational institutions (sectoral SD); on railroad and water transportation (transport SD); in kolkhozes, MTS, and sovkhozes (rural SD); in secondary schools and educational institutions for labor reserves (school SD). In addition to the sanitation brigades enumerated, city and rayon sanitation brigades are formed. These brigades are recruited essentially from persons not working in factories or institutions (housewives). Rayon sanitation brigades may also enroll institutional employees working and living in the same rayon where the unit is formed.

In the sectoral, transport, and rural sanitation brigades are enrolled women aged 16-45 years, chiefly from among persons in auxiliary labor. Boys and girls in special secondary and higher educational institutions, in educational institutions for labor reserves, and in schools (classes 8, 9, and 10), are enrolled in sanitation brigades.

A sanitation brigade staff consists of 23 persons, of which there are: brigade commander - one, brigade political instructor - one, communications-supplies agent - one, team commanders - five, and brigade workers - fifteen.

To replace losses in personnel, a reserve is formed of two persons per team, a total of ten per sanitation brigade. A sanitation brigade consists of five teams. Each team consists of four persons, including the team commander.

The task of a sanitation brigade in the MPVO medical service comprises searching, giving first aid, and carrying wounded from the destruction center, as well as participation in carrying out sanitation and anti-epidemic measures under direction of the sanitation-epidemic station.

Sanitation brigades in peacetime participate under direction of medical workers in sanitation improvement and anti-epidemic work, organize sanitation education, and give first aid in accidents.

Instruction of personnel in a special program is carried out by the Red Cross and Red Crescent Society with enlistment

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of medical institution workers. For every-day guidance of the work of sanitation brigades, the latter are attached to hospital and medical institutions, which is formalized by order of the respective health department.

The stock equipment of a sanitation brigade provides for: medical assistant's sanitation kit - 1, team commanders' kits - 5, sub-kits - 17, hospital stretchers - 5, stretcher straps - 10, gasmasks - 23, rubber boots - 9 pairs, rubber gloves - 9 pairs, protection suits (evacuation clothing) - 23, anti-chemical covers - 23, flash-lights - 7, individual anti-chemical packets - 23, water canteens - 7, berets - 23, and sleeve-bands - 23.

Sanitation brigades are equipped from resources of institutions on whose base the brigades are formed. Exceptions are city and rayon sanitation brigades, which are equipped by the Red Cross and Red Crescent Society.

In addition to the sanitation brigades described above, there are formed on special instruction s a n i t a t i o n - a n t i - e p i d e m i c b r i g a d e s (SED). These brigades are formed by the Red Cross and Red Crescent Society at sanitation-epidemiological stations in a number of cities and rural rayon centers.

Sanitation-anti-epidemic brigades are formed by rayon and city committees of the Red Cross and Red Crescent from the rayon center or city population and are instructed at the base sanitation-epidemiological stations. They are designed to aid sanitation-epidemiological stations in carrying out prophylactic measures and in liquidating epidemic centers.

A sanitation-anti-epidemic brigade staff consists of 23 persons, of which there are: brigade commander - one, political instructor - one, communications-supplies agent - one, team commanders - four, brigade members - sixteen. The brigade has the four following teams: 1) reconnaisance, 2) disinfection, 3) quarantine, and 4) sanitation.

Each team consists of five persons, including the team commander.

It must be emphasized that a medical assistant should, as a rule, be appointed as sanitation-anti-epidemic brigade commander, whose appointment is approved by the sanitation-epidemiological station's head physician. Brigade members are enlisted from society members having at least seven

purpose of training ORVP at different times of year and day, not less than twice a year the detachment attends study assemblies, with release from lessons. Duration of these assemblies should not exceed five days per year.

In order to provide medical guidance the detachment is attached to a medical institution located nearby. The attachment is formalized by order of the respective health department after approval by the Red Cross and Red Crescent Society.

Detachments for searching and carrying wounded are equipped according to an approved list. For teaching purposes a special list provides for the following: medical assistants' kits - 5, sanitation team commanders' kits - 5, sanitation sub-kits - 17, hospital stretchers - 5, stretcher straps - 10, gas masks - 25, rubber boots - 25 pairs, rubber gloves - 25 pairs, protection suits - 25, individual anti-chemical packets - 25, water canteens - 7, berets - 25, sleeve-bands - 25.

The entire complex of ORVP teaching equipment is acquired from resources of the educational institutions on whose base ORVP is formed.

S e a r c h i n g - c l e a r i n g g r o u p s (PSG) are formed by the Red Cross and Red Crescent Society jointly with hospital institution directors. PSG are staffed by nurses in conformity with an approved staff, providing for posts of PSG chief (preferably a medical assistant) and 11 nurses.

Each nurse is equipped with a sanitation kit and contents, individual anti-chemical packets, gas mask, protection clothing, lamp, canteen. PSG stock equipment is supplied by the Red Cross and Red Crescent Society.

PSG personnel goes through special training and is systematically trained under various conditions, in order to learn methods of searching for victims and giving them pre-medical first aid. The Red Cross and Red Crescent Society organizes these courses and conducts them together with the director of the medical institution on whose base the searching-clearing group is formed. In addition, PSG personnel attend study-training assemblies twice a year, with release from work not more than five days per year. Average wages are maintained for persons enlisted for study assemblies for duration of the assembly.

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years of education.

Sanitation-anti-epidemic brigades are equipped within limits of the approved list by the Red Cross and Red Crescent Society and partially by the sanitation-epidemiological station at which the brigade is formed.

Detachments for searching and carrying wounded (ORVP) are MPVO medical service field units. They are formed from students in the first three classes of all higher educational institutions, students in technical schools, and classes 8, 9 and 10 in secondary schools.

Detachments for searching and carrying wounded are formed by the Red Cross and Red Crescent Society jointly with directors of the eductional institutions, who approve by order the detachment personnel.

Detachments for searching and carrying wounded are designed for work in an attack center. The basic tasks of ORVP in work in centers of atomic and chemical destruction comprise searching for wounded, giving them first aid, and removing them to temporary collection stations for wounded or directly to OPM.

When necessary, ORVP can be employed in loading and unloading of wounded being evacuated by air, railroad, water, and motor transport.

In peacetime, the detachment personnel is enlisted to carry out mass sanitation improvement measures within the school establishment.

Detachments for searching and carrying wounded are incorporated into the makeup of five sanitation brigades, with total personnel of 125. The ORVP staff is planned to have: ORVP chief - one, ORVP deputy chief for the political section - one, ORVP supplies agent - one, communications workers - two, sanitation brigade commanders - five, sanitation brigade political instructors - five, sanitation team commanders - 25, sanitation brigade supplies-communications agents - five, team members - 75, reserve team members - five.

Theoretical and practical training of ORVP personnel is organized by the Red Cross and Red Crescent Society jointly with the directors of the school establishment. With the

Searching-clearing groups are formed as independent units of the MPVO medical service and are attached to detachments of medical first aid, in which they are a structural subdivision designed for work directly in the attack center.

During liquidation of a mass destruction center, the following tasks are laid upon the searching-clearing group:

a) search for victims in the destruction center, joint participation with disaster-rescue and fire brigades in rescuing persons from collapsed structures, burning buildings, etc., and giving premedical first aid to the wounded;

b) carrying out on the spot of initial medical clearing of wounded according to severity of injuries, and determining order of priority in removal and means of evacuation (on foot, independently or with escort, carrying on stretcher, by auxiliary means, etc.);

c) direction of work in the attack center of sanitation posts, sanitation teams, sanitation brigades, detachments for searching and carrying wounded, and stretcher teams composed of inhabitants of the surviving part of the city and environs.

Searching-clearing groups upon completing their work in the attack center may be employed in city or rural MPVO medical service hospitals.

Searching-clearing groups work in the attack center in close contact with other MPVO service units, primarily with disaster-equipment, fire-prevention, anti-chemical, and other services.

In addition to units formed directly by the Red Cross and Red Crescent Society, there exist local MPVO units containing medical teams and groups. These MPVO units include self-defense groups and unitary squads.

A self-defense group contains a medical team that is formed, as is the self-defense group, in a city residential sector, in workers' settlements, educational institutions, kolkhozes, and sovkhozes on instruction of the respective MPVO headquarters.

The medical team consists of eight persons, one of whom is appointed team commander, and seven regulars.

To equip the medical team, the self-defense group list provides for: sanitation kits and contents - 2, individual bandage packets - 55 (12 are reserves), hospital stretchers - 2, sanitation sub-kits - 2, individual anti-chemical packets - 55 (12 are reserves), sleeve-bands with red cross - 8, canteens - 8, lamps - 2, water-hose - 1, disinfection sprayer for powder - 1, pails - 2, lysol - 5 kg, hexachlorane emulsion - 4 liters, and "DDT" dust - 10 kg. In addition, all medical team personnel should have means of individual anti-chemical protection.

Unitary squads contain a medical group, which is formed together with the squad at industrial enterprises on order of the respective MPVO headquarters and in accordance with special specifications. The medical group consists of two medical teams, with total personnel of 17. Stock equipment of the medical group is almost the same as medical team equipment, but increased correspondingly.

Stock equipment of medical teams and groups is acquired through the enterprise, residential building, kolkhoz, sovkhoz, educational institution, etc., on whose base the self-defense group or unitary squad is formed.

In the event that there are sanitation posts in an enterprise, establishment, kolkhoz, residential building, etc., and self-defense groups or unitary squads are formed, the sanitation posts are incorporated into the medical team or group as a sanitation team.

Instruction of medical teams and groups is carried out by the Red Cross and Red Crescent Society with enlistment of its medical group in this work.

The medical teams and groups have the same purpose and functions as the sanitation posts. However, upon occurrence of a mass destruction center, these surviving units are not automatically included in the work of eliminating after-effects of an air attack beyond territorial limits of the industrial enterprise. The medical groups and teams may be enlisted in the work of liquidating large destruction centers upon special instruction of the respective MPVO headquarters or the city MPVO medical service chief.

MPVO Medical Service Units Formed by the Health Agencies

Detachments of medical first aid (OPM) are formed by the

health agencies on the base of medical institutions regardless of their institutional affiliation, with the exception of Ministry of Defense medical institutions.

A detachment of medical first aid consists of the following divisions and subdivisions:

receiving clearing division;
surgical;
hospital evacuation;
washing-degassing (decontamination, disinfection) division (ODO);
mobile laboratory (PL);
searching-clearing groups (PSG);
sanitation brigades (SD).

All these subdivisions, combined into a single formation under direction of the OPM chief, is a mighty mobile structural unit of the MPVO medical service available for work in a destruction center or its immediate vicinity.

T h e f i r s t t h r e e d i v i s i o n s o f a m e d i c a l f i r s t a i d d e t a c h m e n t are formed on the base of medical institutions of the health network (hospitals, their polyclinic divisions, dispensaries, maternity homes, children's clinics, etc.). In forming the OPM divisions indicated, attempts should be made to staff them completely through a single medical institution. When this is impossible, then by virtue of necessity the basic OPM divisions may be formed on the base of a single medical institution, and the remaining personnel recruited through other institutions.

The receiving-clearing, surgical, and hospital evacuation divisions when deployed form a medical station fulfilling the basic function of OPM.

The OPM receiving-clearing division is designed to receive and clear the wounded arriving from an attack center, and to regulate the load of other divisions.

The surgical and dressing division is designed to handle two groups: a) lightly wounded, b) seriously and intermediately wounded. In order to provide both groups with suitable surgical aid, a dressing room for lightly wounded is formed and a separate one for seriously and intermediately wounded. In the surgical and dressing division one operating room with several operating tables is organized. In

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this division an anti-shock ward is set up.

The hospital evacuation division is set up to handle three groups: a) lightly wounded; b) seriously and intermediately wounded, and c) ill (injured by radioactive radiation and RV), who are determined by the receiving-clearing division, as well as to deal with the group of non-transportable wounded.

The OPM medical station is supplied in accordance with an approved list through central equipment and partially through equipment available for use in the base institutions. The OPM medical station equipment consists of specific outfits of dressing materials, medicines, and assortments of medical instruments for operating and dressing rooms. These outfits are packed in standard boxes convenient to transport and carry, which keep the equipment in strict order.

The outfits are designed for first aid and emergency medical aid to those injured by atomic and chemical weapons and in combined attack. In connection with the relatively wide range of OPM surgical aid, the equipment of the surgery and dressing division permits minor to highly complex surgical operations.

W a s h i n g - d e g a s s i n g (d e c o n t a m i n a t i o n, d i s i n f e c t i o n) d i v i s i o n (ODO) is formed on the bases of city hospital and sanitation-prophylactic institutions and is designed to service wounded arriving at OPM.

However, ODO may also be employed as an independent unit in the event of occurrence of epidemic centers. The basic tasks laid upon ODO are:

sanitation treatment of wounded contaminated with radioactive substances, decontamination of their clothing and foot-wear;

sanitation-chemical treatment of wounded injured by stable toxic substances and degassing of their clothing;

in the event of use of bacteriological weapons, ODO gives the population sanitation treatment and disinfects clothing.

The washing-degassing division is supplied centrally with equipment according to a planned list. The stock

equipment provides for thorough sanitation treatment of contingents arriving at ODO, including decontamination, degassing, or disinfection of their clothing. ODO is equipped with a disinfection-shower bath installation hauled by motor. ODO staff consists of secondary and junior medical personnel, 18 in all.

M o b i l e l a b o r a t o r i e s are formed as independent MPVO medical service units. Bases for forming mobile laboratories are hospital and medical institutions, regardless of their institutional affiliation.

A mobile laboratory staff consists of five persons, including: laboratory chief (medical assistant), one laboratory worker, and three radiometric technicians. Personnel is recruited from the base institutions. Completed mobile laboratories are assigned to OPM, one to each, and are a structural subdivision of it, but when necessary they may independently perform allotted tasks.

Mobile laboratories are charged with: a) dosimetric inspection of wounded arriving at OPM; b) analyzing blood of wounded arriving at OPM, subjected to high doses of radioactive radiation; c) collecting water and food samples and delivering them to the MPVO medical service city and rayon laboratory to analyze qualitatively and quantitatively for contamination with chemical OV and radioactive substances; d) collecting water and food samples to be examined in the MPVO medical service city or rayon laboratory for bacterial contamination.

Mobile laboratories are equipped through the base institutions and in part centrally.

S e a r c h i n g - c l e a r i n g g r o u p s (PSG) a n d s a n i t a t i o n b r i g a d e s, incorporated into OPM, are assigned to it from Red Cross and Red Crescent units formed in a city and are OPM structural subdivisions.

These PSG and sanitation brigades are equipped by the Red Cross and Red Crescent Society.

The searching-clearing groups incorporated into OPM fulfill their immediate functions in the attack center, and sanitation brigades work in OPM divisions.

Total OPM staff is 104 persons, of whom 33 are at the medical station.

Nine trucks are assigned to OPM, of which eight are ZIS-150 types adapted to transport wounded, and one is for work in ODO. This motor transport serves to transport OPM personnel and equipment during deployment, disengagement, or transfer.

Detachments of medical first aid, mighty MPVO medical service units, play a fundamental and decisive part in liquidating an attack center. They fulfill the following basic tasks:

giving first aid and emergency medical aid to wounded;

medical clearing of wounded;

temporary hospitalization of urgent cases (shock, hemorrhage, etc.);

dosimetric inspection and sanitation treatment of wounded if contaminated with radioactive material or sanitation-chemical treatment if injured by stable toxic substances;

partial decontamination of foot-wear and clothing of wounded if injured by radioactive material, and degassing of foot-wear and clothing if injured by stable toxic substances;

evacuation of wounded to MPVO medical service stationary installations located in city or rural areas (SEB);

direction of all medical units working in the attack center (ORVP, SD, SP, SZ) and those assigned to OPM (ODO, PL, SD, PSG);

giving aid to special units (PPEO, PPEG) when carrying out anti-epidemic measures upon occurrence of epidemic attack centers and when liquidating them;

compilation of initial medical documentation on wounded passing through the detachment of medical first aid.

Detachments of specialized medical aid (OSMP) are formed by the health agencies on the base of certain medical institutes and institutes for advanced training of physicians.

Staff is recruited from skilled institute specialists.

A professorial-teaching group in various specialties (surgeons, therapeutists, stomatologists, etc.) is enlisted for this purpose.

Detachments of specialized medical aid are designed primarily for work in MPVO medical service stationary installations.

OSMP in its structure and principle of use has considerable resemblance to the detached medical reinforcement companies (ORMU), which played a large part in the matter of giving specialized medical aid in medical-sanitation battalions and first line field hospitals. However, the resemblance of ORMU and OSMP is a relative one, for the latter have considerably greater group specialization than ORMU. OSMP is made up of three groups, each group of 14 brigades. An OSMP brigade is staffed by physicians, secondary and junior medical personnel. Total number of OSMP personnel is 259. A group of specialized medical aid is made up of the following brigades (according to specialties): neurosurgical, face and jaw, thorax and abdomen, traumatic, otorhino-laryngeal, ophthalmological, general surgery, burn, roentgenological, toxicology and therapeutics, radiological, and brigades of infection specialists, blood transfusion, and clearing.

Groups of specialized medical aid (GSMP) are formed not only in the make-up of OSMP, but also independently on the bases of medical institutes and institutes for advanced training of physicians (which do not form OSMP), and on bases of large kray, oblast, and city hospitals.

The group structure and brigade types are identical to those in OSMP groups.

Number of GSMP staff personnel is defined by staff order and consists of 86 persons.

Detachments and groups of specialized medical aid are equipped in conformity with listed standards through resources, when present, of the institutions on whose base OSMP and GSMP are formed.

When the bases are medical institutes and institutes for advanced training of physicians, not having clinics, OSMP and GSMP are equipped by those hospitals and divisions having one or another of the departments, whence also the

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specialized brigade.

The maneuverability and tactical use of OSMP and GSMP require portable packing of supplies. Hence all surgical instruments and necessary equipment must be put in special packing boxes which keep in definite order the packed surgical instruments, sterile bandage material, medicines, and administrative inventory (sheets, towels, etc.).

The necessity of transporting, sometimes of carrying, equipment by group or brigade personnel requires that packing boxes be convenient for carrying and the weight of each not exceed 16-20 kg.

OSMP and GSMP brigades should have in packing boxes an amount of medicines and bandage sufficient for aiding 100-150 wounded. Upon exhaustion of medicinal and bandage supplies, they are replenished from pharmaceutical stores on request of directors of the installations where brigades or groups of specialized medical aid are working. OSMP and GSMP mobility and presence of highly skilled specialists allow ready movement of these units and rapid organization of specialized medical aid at various evacuation points.

Detachments and groups of specialized medical aid are employed not only in MPVO medical service stationary installations, but in specific cases may also work in OPM, depending on requirements of the situation.

M o b i l e a n t i - e p i d e m i c d e t a c h m e n t s (PPEO) a n d m o b i l e a n t i - e p i d e m i c g r o u p s (PPEG) are formed by the health agencies: the former on bases of oblast sanitation-epidemiological stations and institutes of epidemiology and microbiology, and the latter on bases of city sanitation-epidemiological stations (SES).

Mobile anti-epidemic detachments and groups are mobile MPVO medical service forces, which carry out anti-epidemic measures in the event of a "menacing situation." At this time their activity consists of increased sanitation-epidemiological supervision, prophylactic inoculations of the population, sanitary inspection of refuges and shelters. In case of an air attack by an enemy using bacteriological weapons and occurrence of an attack center, PPEO and PPEG carry out anti-epidemic measures for liquidating the center, enlisting in this work all mobile forces and resources of

the MPVO medical service. In case of atomic attack these units take sanitation and anti-epidemic measures to prevent possible epidemics resulting from the great dislocation of population and its accumulation upon roads and in certain parts of the attacked city.

In the event of occurrence of a chemical attack center, PPEO and PPEG take the same measures as in an atomic attack center.

PPEO staff has three divisions - epidemiology, laboratory, and disinfection. Total PPEO personnel is 14. Specialists in epidemiology, laboratory, and disinfection are specified for the staff.

These units are recruited from medical personnel of sanitation-epidemiological stations, in accordance with the approved staffs.

PPEO and PPEG are equipped through the institutions on whose base they are formed. Trucks are assigned to these units from the sanitation-epidemiological stations, in accordance with staff order. In cases where city or oblast sanitation-epidemiological stations have no motor transport, machines are assigned PPEO and PPEG from other medical institutions. Assignment of institutional motor transport is carried out by order of city or oblast health department directors.

G r o u p s t o a c c o m p a n y w o u n d e d are formed by the health agencies from medical personnel of hospital institutions of ministries of health and ways of communication.

These groups are designed for medical service along the line of movement of transports of wounded being evacuated from attacked cities to the oblast interior or beyond its limits.

To each hospital train or motor column is assigned an escort group of physician, nurse, and nurse's aide. The group may be enlarged, depending on number of escorted wounded and severity of their condition, from MPVO medical service units and installations.

M o b i l e r a d i o l o g i c a l l a b o r a t o r i e s (PRL) are formed in certain cities on special instruc-

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tion. The base for their formation are city sanitation-epidemiological stations, from which the personnel is selected. They are designed for analyzing water and food contaminated with RV or BRV in cases where the situation requires urgent decision of the question on the spot, or if for any reason the MPVO medical service laboratories cannot fulfill this task.

PRL are equipped centrally with all necessary equipment.

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