МИНИСТЕРСТВО ЗДРАВООХРАНЕНИЯ РЕСПУБЛИКИ БЕЛАРУСЬ
БЕЛОРУССКИЙ ГОСУДАРСТВЕННЫЙ МЕДИЦИНСКИЙ УНИВЕРСИТЕТ
КАФЕДРА ЭПИДЕМИОЛОГИИ

Г. Н. Чистенко, М. А. Шилова

ОСНОВЫ ОБЩЕЙ ЭПИДЕМИОЛОГИИ. ПРОТИВОЭПИДЕМИЧЕСКИЕ МЕРОПРИЯТИЯ И СРЕДСТВА. ПРОТИВОЭПИДЕМИЧЕСКАЯ РАБОТА В ОРГАНИЗАЦИЯХ ЗДРАВООХРАНЕНИЯ

BASICS OF GENERAL EPIDEMIOLOGY. ANTI-EPIDEMIC MEASURES AND MEANS. EPIDEMIC CONTROL MEASURES IN HEALTH CARE ORGANIZATIONS

Рекомендовано Учебно-методическим объединением
по высшему медицинскому, фармацевтическому образованию
в качестве учебно-методического пособия для студентов
учреждений высшего образования, обучающихся
по специальности 1-79 01 07 «Стоматология»

Минск БГМУ 2019

УДК 616-036.22:614.4(075.8)-054.6
ББК 51.9я73
Ч-68

Р е ц е н з е н т ы: канд. мед. наук, доц. каф. инфекционных болезней Гомельского государственного медицинского университета Л. П. Мамчиц; каф. эпидемиологии и микробиологии Белорусской медицинской академии последипломного образования

Чистенко, Г. Н.

Ч-68 Основы общей эпидемиологии. Противоэпидемические мероприятия и средства. Противоэпидемическая работа в организациях здравоохранения = Basics of general epidemiology. Anti-epidemic measures and means. Epidemic control measures in health care organizations : учебно-методическое пособие / Г. Н. Чистенко, М. А. Шилова. – Минск : БГМУ, 2019. – 28 с.

ISBN 978-985-21-0211-7.

Содержит информацию об основных эпидемиологических понятиях, изложены современные представления о механизмах передачи возбудителей инфекционных болезней человека, в т. ч. инфекций, связанных с оказанием медицинской помощи. Представлена классификация и группировка противоэпидемических мероприятий.

Предназначено для студентов 4-го курса медицинского факультета иностранных учащихся, обучающихся по специальности 1-79-01 07 «Стоматология», изучающих эпидемиологию на английском языке.

УДК 616-036.22:614.4(075.8)-054.6
ББК 51.9я73

ISBN 978-985-21- 0211-7

MOTIVATIONAL CHARACTERISTIC OF THE TOPIC

Total training time is 5 hours.

The study of the main epidemiological concepts will allow students in the targeted search for sources of infection, transmission factors, determine the borderline of the epidemic outbreak and the time of its existence. Assimilation of the scientific, methodological and organizational basis of anti-epidemic measures will allow to plan anti-epidemic measures in a specific epidemiological situation taking into account the activity of the transmission mechanism and the sensitivity of people who were in contact with the identified source of infection and the direction of the activities.

The aim of the study: the study of the main epidemiological concepts, mastering the content of the main groups of anti-epidemic measures for the purpose and implementation of specific anti-epidemic measures, which will be adequate to epidemiological situation.

Objectives:

1. Study the basic epidemiological concepts:

1) epidemic process;
2) source of infection (man as a source of infection):

– patient (period of infectiousness, the endemic importance of the severity of the clinical manifestations of the disease);

– bacillicarrier (acute, chronic, transient);

3) transmission mechanism:

– phase transfer mechanisms;

– transfer factors;

– transmission route;

– types of pathogens transmission mechanisms of antroponotic infectious diseases (aerosol; fecal-oral; vector-borne; contact);

– artificial mechanism of infection;

4) epidemic focus:

– dimensions of an epidemic focus;

– time of epidemic focus existence;

5) susceptibility:

– individual susceptibility;

– collective susceptibility (heterogeneity of human population for susceptibility);

6) groups of anti-epidemic measures;
7) anti-epidemic means.

2. Get acquainted with:

1) theoretical foundations of epidemiology as a science;

2) main provisions of the theory of self-regulation of the epidemic process;

3) major groups of anti-epidemic means.

3. Learn to:

1) determine the boundaries and duration of the epidemic outbreak;

2) apply various preventive and control measures to prevent infectious diseases, decrease of infectious morbidity and liquidation of separate infections;

3) plan anti-epidemic measures in the outbreak.

Requirements to the initial level of knowledge. To fully master the topic, the student needs to know from the course:

– *Medical Biology and General Genetics* — levels of organization of life, phenotype and genotype, variability, the concept of the biological species, populations;

– *Microbiology, Virology and Immunology* — pathogens' properties of human infectious diseases, methods of laboratory diagnosis, anti-infectious immunity, principles of specific prevention and etiotropic therapy.

Control questions from related disciplines:

1. Give the definition of concepts:
– "genotype" and "phenotype";
– variability, types of variability;
– "species" and "population";
– pathogenicity, virulence, virulence factors.
2. Give the characteristic:
– concepts of the infectious process;
– stages of the course of infectious diseases.
– classification of infectious diseases by severity, carrier of infectious agents.
3. Describe the stability in the external environment of pathogens:
– intestinal infections;
– aerosol infections.

Control questions on the theme of the session:

1. Give the definitions of notions of "epidemiology", "epidemic process".
2. Name the object and subject of study in epidemiology.
3. What are the main sections of the doctrine about epidemic process?
4. Explain the significance of each factor (biological, natural and social) in the epidemic process.
5. Determine how the different theories (self-regulation, the transmission mechanism) explain the mechanism of development of epidemic process.
6. Explain the manifestations of the epidemic process from the standpoint of the self-regulation theory.

7. Determine the time when anti-epidemic measures can have the greatest impact on the epidemic process from the standpoint of the theory of self-regulation of the epidemic process.
8. Give the definitions of notions of "transmission mechanism".
9. Explain the mechanism of development and manifestations of the epidemic process taking into account the mechanisms of transmission of infectious diseases.
10. Give the definition of "artificial mechanism of infection".
11. Give the definition of "source of infection".
12. Give the epidemiological characteristics of the sick person as the source of infection.
13. Give the definition of "transfer factors" and "way of transmission".
14. Name and describe the mechanisms of transmission of infectious diseases from the source of infection to susceptible organism.
15. Give a definition of "susceptibility", and explain its importance in the epidemic process.
16. Name the qualitative and quantitative characteristics of manifestation of epidemic process.
17. Define the concept of "anti-epidemic measures".
18. Divide anti-epidemic measures into groups according to their execution time.
19. Give the definition of the term "anti-epidemic means".
20. Distribute preventive measures according to the direction of action.
21. Distribute the activities conducted in the epidemic focus according to the direction of action.

EPIDEMIOLOGY OF INFECTIOUS DISEASES AS A SCIENCE

Epidemiology of infectious diseases is a system of knowledge about the regularities of epidemic process and methods of its study, as well as the combination of anti-epidemic measures and organization of carrying them out with the aim of preventing incidence of infectious diseases in selected population groups, reduction of morbidity in the population and liquidation of particular infections (V. D. Belyakov, R. K. Yafaev, 1989).

Object in epidemiology are *infectious diseases.* Subject in epidemiology is *epidemic process.*

Epidemic process is a process of emergence and spread of infectious diseases among people.

The Tasks of Epidemiology:

1. To study the spread of diseases among the population, to establish causal relationships between disease and individual, temporary and territorial

parameters (identification of risk groups, risk time, risk areas and establishing risk factors).

2. To plan, to conduct and evaluate effectiveness of prevention activity and diseases control.

3. To identify the existing and future needs in health services.

4. To develop criteria that can be used as parameters for assessing the quality of health service.

5. To define reliability of epidemiological information.

DOCTRINE OF THE EPIDEMIC PROCESS

The reasons for the existence of infectious diseases, regularities and peculiarities of their distribution among people, symptoms and internal mechanisms of these processes are discussed in the General section of epidemiology under the title of the doctrine of the epidemic process. Despite the differences in many definitions of the concept "epidemic process", in most cases it is considered to be a process of emergence and spread of infectious diseases among people. "Why do infectious diseases occur? How are they distributed? What are the manifestations of infectious diseases among the population?" The answers to these questions, to a certain extent, are given by V. D. Belyakov in the theory of modern epidemiological process.

The modern doctrine of the epidemic process includes 3 sections:

1) factors of the epidemic process;

2) mechanism of development of epidemic process;

3) manifestations of the epidemic process.

FACTORS OF EPIDEMIC PROCESS

Biological, physical and social factors of the epidemic process are distinguished.

Biological factor in the epidemic process is represented by the interaction of two populations: the causative agent (the parasite) and the human-host.

The population of agents is defined as the aggregate of individuals of a given species, relatively isolated in their natural life from other sets of individuals of this species.

The population is territorial, social, household, age and (or) other groups of people within which the pathogen circulates.

Natural factor in epidemiology is the set of biotic and abiotic elements of external environment that affects the biological components of the epidemic process (the interaction of pathogen populations and humans) and promote or prevent the parasitism manifestations of infectious diseases' causative agents (Fig. 1).

Figure 1. Tsunami

The social factor in epidemiology is the total sum of social conditions, influencing the biological component of the epidemic process (the interaction of pathogen populations and humans), and promoting or inhibiting the manifestations of parasitism of causative agents of infectious diseases.

THE MECHANISM OF EPIDEMIC PROCESS DEVELOPMENT

Under this section of the doctrine of the epidemic process, there are three theories:

1) self-regulation of the epidemic process;
2) mechanism of transmission of infectious diseases;
3) natural focality of infectious diseases.

The theory of self-regulation of the epidemic process was developed by the academician V. D. Belyakov and registered in the USSR as a discovery in 1976. This theory is a new theoretical concept of epidemiology about the internal mechanisms of development of epidemic process, and it can rationally explain the temporal and spatial patterns in the spread of infectious diseases among the population.

The theory of the mechanism of transmission was developed by L. V. Gromashevsky in 40th years of the XX century and describes the patterns of movement of infectious agents from person to person.

The theory of natural focality of infectious diseases, formulated by academician E. N. Pavlovsky in 1939, allows you to get an idea about the regularities and peculiarities of the spread of human zoonotic infections.

THE THEORY OF SELF-REGULATION OF THE EPIDEMIC PROCESS

The main provisions of the theory of self-regulation of the epidemic process are:

1) heterogeneity of interacting populations of the pathogen and humans is the basis of development of epidemic process;

2) dynamic (phase) change of biological properties heterogeneity of interacting pathogen population and humans;

3) stabilizing (controlling) role of reverse negative connections in the processes of self-regulation;

4) regulatory role of social and environmental conditions in the phase change of the epidemic process.

The *first position* of the theory of self-regulation indicates that the basis for the development of the epidemic process is the interaction of two non-homogeneous (heterogeneous) populations of the pathogen (parasite) and the human (host).

Among the signs of the heterogeneity, characterizing the pathogen population, for the development of the epidemic process, the most significant is heterogeneity in *virulence* (i.e. the degree of virulence of the pathogen).

The next important characteristic of a population of a pathogen is the inhomogeneity of *contagiousness*. The contagiousness as the ability of the pathogen to spread among people and the survival rate of the organism in individual hosts is also a variable attribute, changing during the development of the epidemic process.

Heterogeneity in *immunogenicity* refers to the ability of the pathogen to cause some form of immunity within the host organism (anti-microbial, antitoxic, antiviral, humoral, cellular, local, general). As well as contagiousness, the attribute of immunogenicity is variable.

For the development of epidemic process of separate infections significant importance has the heterogeneity of a pathogen population according to *antigenic properties* (influenza), its *sensitivity to antibiotics* (nosocomial infection), *bacteriophages* (dysentery), etc.

For the development of the epidemic process heterogeneity of the human population (host) on susceptibility to infectious diseases has its significance. Sensitivity is a specific topic, which refers to the ability of the human body to react to pathogenic properties of the pathogen. In different periods of the spread of infectious diseases human population there are persons with different degree and nature of susceptibility to the pathogens that cause these diseases.

The *second position* of the theory of regulation states that during the epidemic process dynamic (phase) change of heterogeneity (inhomogeneity) of virulence in populations of the pathogen and susceptibility in the human population takes place. Phase rebuilding of interacting

populations involves a succession of four phases: 1) reservation; 2) epidemic transformation; 3) epidemic spreading; 4) reservation conversion.

In the *phase of reservation* human population (host) is homogeneous in susceptibility and is presented by immune and highly immune individuals. The population of the pathogen (parasite) in this phase is also homogeneous and is composed of avirulent and weakly virulent pathogens. Avirulent pathogens are at low intensity of the process of toxin producing, have lost adhesive properties, the structure of surface receptors is changed, etc.

In the reservation phase, the population size of the pathogen is minimal and most of the parasites are concentrated in the body of the hosts with defects of the immune system. The state of the population of the pathogen matches the state of the environment: an avirulent population of pathogen — immune environment. The reservation corresponds to a phase interepidemic period and is characterized by the absence of disease. This phase can't last infinitely long, because in homogeneous populations of parasites the processes of natural selection are violated. Therefore, in the process of evolution survived and still exist those types of pathogens, which have developed the ability to epidemiological change.

The *phase of epidemic conversion* begins with the fact that the host population, which was homogeneous in previous, reservation phase, becomes increasingly heterogeneous as a consequence of the emergence of susceptible individuals and increase in their numbers. Susceptible persons appear as a result of fertility. Heterogeneity in susceptibility is enhanced by variable speed of decay of postinfectious immunity in humans. This also contributes to the unequal lowering of general resistance to infectious diseases in different persons under the influence of adverse environmental factors (chemical, radiation, etc.). Migration processes and a factor of "agitation" greatly increase the heterogeneity in susceptibility leading to the fact that collectives face new members, which have never met circulating pathogens and are susceptible to them. Avirulent pathogens, passing through the body of susceptible individuals, increase their virulence. In this phase, operates the directional selection that establishes in the circulation of pathogens, to the greatest extent adapted to parasitism in changing environment, i.e. in circulation are secured virulent variants of the pathogen. In the epidemic transformation phase, typically, the incidence is not increasing, disease may occur only in some cases in the most receptive persons. This phase can be identified by immunological changes accompanying the circulation of virulent infectious diseases among people.

When accumulated in the human population in a sufficient number of susceptible individuals the pathogen-parasite increases virulence so that it goes into a qualitatively different state — a phase of epidemic spread. In this phase the state of the population of the pathogen begins to match the state of the environment. However, this correspondence is absolutely opposite to that in

the phase of reservation: highly virulent population of pathogen — susceptible habitat.

The population of the pathogen in the *epidemic spread phase* is maximal. This phase leads to the development of the epidemic, during which fall ill both non-immune persons and persons with partial immunity, which doesn't protect them from highly virulent (epidemic) variants of the pathogen. The duration of the phase of epidemic spread (duration of the epidemic) is always limited in time. This phase ends, despite the presence of susceptible individuals in the human population. Phase of epidemic spread cannot last infinitely above all in the "interests" of the agent — otherwise he would destroy all susceptible individuals, depriving themselves of the environment and energy resources. Therefore, already in the phase of epidemic spread the next phase takes its origin.

The *reservation transformation phase* starts with the passaging of the virulent variants of the pathogen through the body of immune persons (those, who recovered and developed immunity during the epidemic). In circulation there are only those variants that have reduced virulence and adapted to the new (immune) habitat. In this phase a significant part of the pathogen population is killed, and the incidence is on the decline.

The third position of the theory of self-management reflects the role of reverse negative connections in the processes of self-regulation. The system "parasite-host" at the population level is self-adjusting due to reverse negative connections that exist between virulence of populations of the parasite and susceptibility of the host population. The decline in the number of immune persons initiates the growth of virulence and the size of the pathogen population and, conversely, an increase in the number of immune individuals leads to a decrease both in virulence, and the size of the pathogen population. Relation between the virulence of the population of the pathogen and susceptibility of the human population are reverse because they return the system "parasite-host" to the initial state, and negative because they deny diversion of the specified system from the initial condition.

The fourth position of the self-regulation theory reveals the regulatory role of social and environmental conditions in the phase change of the epidemic process. Social and environmental conditions that determine the phase of development of the epidemic process can be divided into three groups:

a) factors that contribute to the creation of various forms of "mixing" people – formation of groups, natural and artificial migration;

b) the factors contributing to the activation of mechanism of transmission;

c) factors that reduce immunity and resistance.

Thus, it is possible to formulate a scientifically substantiated concept of "epidemic process". **Epidemic process** is the result of interaction between populations of pathogen-parasite and the human host, which manifests under

certain necessary and sufficient, social and environmental conditions in explicit or latent forms of infectious diseases among people.

The theory of self-regulation of the epidemic process can rationally explain the temporal and spatial patterns in the spread of infectious diseases among the population. The practical significance of this theory is that it focuses on the need for preventive measures in the phase of reservation. Thus, rational will be those activities that prevent the transition of the pathogen from the reservation phase to the conversion phase of epidemic and epidemic spread.

THE THEORY OF MECHANISM OF TRANSMISSION OF INFECTIOUS DISEASES

In the life cycle of the pathogen-parasite there are two phases:

1) staying in the host organism;
2) moving from one host organism to another host organism.

In the first phase nutrition and reproduction of infectious diseases agents take their places.

The conditions in the stay phase of the pathogen in the host organism may not provide its preservation as a species. Therefore, in human pathology, only those parasites are significant, which in the course of evolution have developed the ability to change their masters, i.e. develop the transfer mechanisms.

The transmission mechanism is evolutionary formed process of the movement of the pathogen within one population of organism from one host to another susceptible organism, which ensures the preservation of the pathogen as a biological species in nature.

According to the basic law, formulated by L. V. Gromashevsky, **parasitism** is the result of an evolutionary process of adaptation of microorganisms to conditions of existence in certain types of biological host and to spread in the populations of these hosts. The transmission mechanism is a prerequisite for the existence of the parasite species in nature (Fig. 2).

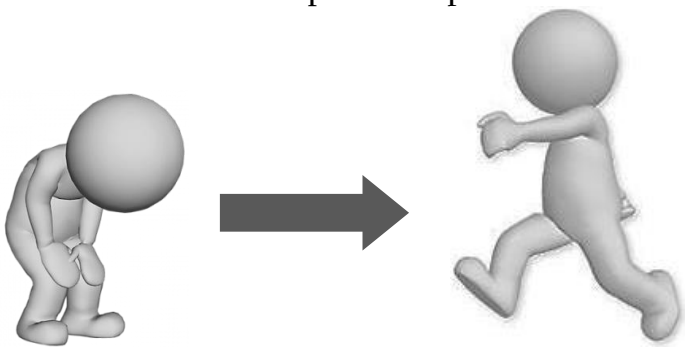

Figure 2. Phases of the transmission mechanism

Transmission mechanism includes 3 phases. ***The first phase*** — *the elimination of pathogen from the source of infection* — results from the localization of the pathogen in the host and is implemented with a specific group of infectious diseases in the same way. For example, if the localization of

the pathogen is in the intestine, only one method of launching it into the environment is possible — by defecation, if pathogen is localized in the respiratory tract, there is also only one way of removing it — with the flow of exhaled air, i.e. during exhalation.

An infected human or animal, where the pathogens can live, multiply, accumulate and be allocated to the outer environment is called the **source of infection**. It's the natural habitat of the pathogen.

Among people sick persons and carriers can be sources of infection. Most important characteristics of the patients as sources of infection are the period of infectiousness and severity of clinical manifestations of the disease.

Taking into account the cyclical flow of infectious diseases, it should be noted that during the incubation period causative agents of the majority of infectious diseases are not excreted in the environment and, consequently, the infectiousness of these persons is excluded. However, if in the incubation period excretion of pathogens occurs, it dramatically increases the epidemiological significance of such persons as sources of infection and complicates prevention efforts due to the absence of clinical manifestations possibility to identify such sources of infection during incubation period. This provision is typical for viral hepatitis A and is one of the main reasons for the widespread of this infection. During the height of the disease the number of pathogens in the patient's body reaches a maximum. The virulence of pathogens that stands out on the background of clinical manifestations is significantly higher than in other periods of the disease. Furthermore, infectious diseases are characterized by such symptoms, which help the body to get rid of pathogens (cough, runny nose — during aerosol infections; diarrhea — intestinal infections, etc.). As a result, the peak maximum is characterized by isolation of the pathogen from the body of the patient and this determines the greatest epidemic risk of infectious patients in the midst of clinical manifestations.

In the period of convalescence clinical recovery coincides with the elimination of pathogens in most cases. Sometimes some individuals on the background of clinical recovery continue to release pathogens which can be a source of infection for others.

Thus, the greatest epidemic risk comes from patients who are in the period of the height of the disease. Then comes a period of convalescence. In some infectious diseases sources of infection may be persons who are in incubation period.

Epidemic significance of severity of clinical manifestations is as follows. Patient, suffering from severe infectious diseases, is a potent source of infection, since it has large amount of highly virulent pathogens. However, severe disease severely limits the activity of such sources of infection, and

possessed patients with mild clinical forms have ultimately the greatest epidemic danger.

The main reasons for the high epidemiological significance of patients with mild forms are:

a) in the structure of morbidity, generally, mild forms are more common than severe;

b) patients with mild forms are treated later or do not ask for medical help at all;

c) the diagnosis in such patients because of the uncertainty of the clinical picture is later installed;

d) isolation of patients with mild forms is less strict and often performed at home.

Epidemic risk increases even more, if patients with mild forms of infectious diseases excrete the causative agent of infection during incubation period.

Carrying of causative agents of infectious diseases is excretion of pathogens from human body in absence of clinical manifestations of disease. According to duration, carriers are divided into transient, acute, and chronic carriers.

Transient carrying involves short-term (often single) excretion in the absence of clinical manifestations of disease.

Acute carrier — excretion within period from several days to two-three months. Acute carrying is mainly a result of a recent illness.

Chronic carrier — excretion for many months and even years. This type of carrier is also often formed as a result of the transferred disease in individuals with immune system defects.

The degree of the epidemiological significance of these forms of carriage under other equal conditions is directly proportional to its duration. However, individual infections in particular acute conditions role of the carriers as sources of infection may be more significant than persons in a state of chronic carriage.

In the analysis of the mechanism of development of epidemic process in zoonotic infectious diseases concepts of “basic” and “additional” sources of infection are used. **The main source** is a specific host of the pathogen, which ensures its preservation as a species (natural habitat). **An additional source** is a non-specific host of the pathogen, capable of transmitting it to people. In attitude to certain zoonoses (plague), humans may become additional, the most epidemically dangerous sources of infection.

The reservoir of infection is the set of pathogen populations in the interaction with the natural environment.

The second stage of the transmission mechanism — *presence of pathogen in the environment* — depends on the method of excretion of the pathogen that

determines the environment in which he finds himself after removal from the host. So, a pathogen leaving the body of the source of infection during conversation, coughing or sneezing, inevitably gets into the air. Pathogen released with feces, falls on different objects that participate in its further spatial movement.

For the implementation of the phase of the pathogen's staying in the external environment **factors of transmission** are necessary, i.e. elements of the external environment, providing movement of the pathogen from the source of infection into susceptible organism. All of the elements of external environment, acting as factors of transmission of infectious diseases, are divided into 6 groups:

1) air;
2) water;
3) food;
4) soil;
5) household items and environment;
6) live vectors.

Elements of external environment onto which pathogen gets, leaving the body, are called **primary factors of transmission**, and those delivering it in a sensitive organism are **the final transfer factors**. Sometimes, the primary and the final factor are the same element of the external environment.

Certain types of pathogens evolutionary adapted not only to a specific localization in the host organism, but also to specific factors of transmission. These are specific factors. Other factors are optional, but they in particular can acquire important epidemiological significance.

A combination of factors of transmission, involved in the movement of a specific pathogen from a particular source to a particular susceptible organism, is defined as **the route of transmission** of the infectious agent. Different routes of transmission are named after final factor of transmission: airborne, waterborne, foodborne, household contact and other routes of transmission.

The third phase is the *introduction of the pathogen in the susceptible organism* is determined by the previous phase (the presence of pathogen in the environment). The character and nature of factors contributing pathogen in a susceptible organism, determine the primary localization of the pathogen in the human body. The introduction of the pathogen into a susceptible organism is carried out during physiological (breathing, eating) and pathological (violations of the integrity of skin and mucous membranes) processes.

Parasites have adapted to the existence in the human body in four environments: respiratory tract, intestines, blood and skin surface. These locations correspond to four mechanisms of transmission of causative agents of infectious diseases.

The aerosol mechanism of transmission is specific for infectious agents, primarily localized in the respiratory tract (Fig. 3).

Figure 3. Sneezing person

In this case, the agents are excreted from the source of infection in the composition of the droplets (droplet phase of the aerosol), which tend to cluster around the source at a distance of 1–2 m, and the risk of infection is reduced in proportion to the square of the distance from the source of infection. Large droplets settle quickly. Droplets remaining in the air, dry up in 20 minutes after excretion. Large droplets are deposited on household items, dry, unite with the dust as the result the secondary particulate phase of aerosols which contains pathogens.

The aerosol mechanism of transmission is a very active mechanism, so in case of a source of infection appearing a nearly universal contamination of people is provided. Due to the simplicity of implementation of this transmission mechanism (exhale — inhale), and short residence time of pathogens outside of a living organism, the vast majority of them, extending this mechanism, have a low stability in the external environment. The mechanism of aerosol-transmitted causative agents is typical for causative agents of diphtheria, measles, influenza, meningococcal infection, etc.

Fecal-oral transmission mechanism is specific for infectious agents, primary site of which is gastro-intestinal tract.

The agents allocated to the outside environment with the faeces and are spread mainly by three groups of factors of transmission — food, water and household items. In some cases, flies can have the value in the transmission of pathogens of intestinal infections (mechanical vectors). Through household objects and water in the human body only small amount of pathogens can be delivered, so diseases, associated with these transfer factors, in the majority of cases occur in milder forms. The scope of infectious diseases, which pathogens are spread by the fecal-oral mechanism of transmission, depends on the consumption of contaminated with pathogens food and water. Due to

the fact that the realization of fecal-oral mechanism of transmission takes time, and the agents depend on the factors of transmission for a longer period, they should have a high resistance in the external environment. Fecal-oral mechanism is typical for pathogens of typhoid, dysentery, viral hepatitis A, etc.

Vector-borne mechanism of transmission is specific for the causative agents of infectious diseases, which place of primary localization is blood. With the localization in the blood the pathogens don't have exit from the body, so further distribution is possible only with the participation of blood-sucking arthropods. In the body with the living vectors occurs accumulation of the pathogen, or a certain stage of the cycle of its development. The main vectors are mosquitoes, lice, fleas, ticks (Fig. 4).

Figure 4. Mosquito

Unlike factors of inanimate nature, live vectors actively attack people, and with a significant number are able to provide a very high degree of their infectiveness. Because pathogens are transmitted by biting vectors, and there is almost no contact with environmental factors, most of them are characterized by weak resistance to the external environment. By vector-borne mechanism causative agents of malaria, typhus and relapsing fever, etc. are transmitted.

Contact mechanism of transmission is specific for the causative agents of infectious diseases, which place of primary localization is skin surface. Contact mechanism of transmission is realized through touching the affected skin by the source of infection and then healthy parts of skin (mucous membranes) of sensitive persons. In this case, transmission of pathogens happens by *direct contact*. Contact transfer mechanism includes delivery of pathogen to skin (mucous membranes) of susceptible individuals by household objects, contaminated with pathogens named as *indirect contact*. Contact transfer mechanism results in limited spreading of infectious diseases. In these cases, epidemic process involves a narrow circle of people united with welfare and using common objects. By contact mechanism causative agents of tetanus, venereal diseases, etc. are transmitted.

Thus, localization of the pathogen in the body of the source of infection and the mechanism are mutually determining phenomena, which, naturally

replacing each other, form a continuous chain, ensuring the preservation of the pathogen as a biological species in nature.

These transmission mechanisms provide the spread of infectious diseases among individuals of the same generation, i.e., they are horizontal. The transfer of pathogens from mother to fetus provides *vertical (transplacental) transmission mechanism* (Fig. 5).

Figure 5. Pregnant women

The vertical mechanism of transmission is a transmission of pathogens throughout the period of fetal development, i.e. from conception to the appearance of the newborn. The most severe defects, malformations of the fetus are observed during infection in the stage of embryogenesis. 5 routes of transmission are provided within a vertical mechanism:

1) germinative;

2) hematogenous — transplacental (hematogenous transition of pathogens from pregnant woman to the fetus during the prenatal period since the formation of the own circulation of the embryo);

3) ascending through vagina and uterus (aspiration or ingestion of contaminated with pathogens amniotic fluid by fetus in 5th month);

4) intranatal (neonatal infection while passing the birth canal);

5) through breastfeeding.

The epidemiological significance of vertical mechanism is that children infected in utero from their mothers, are epidemically danger to others. By this mechanism can be transmitted causative agents of rubella, toxoplasmosis, herpes, cytomegalovirus infections, etc.

In the process of development of new methods of diagnostics, treatment and prevention of infectious diseases in medicine has formed a new mechanism of human infection with pathogens of infectious diseases. It was called *artificial mechanism* of transmission. The establishment of large hospitals, a significant increase in the number of “aggressive” interventions, invasive diagnostic and therapeutic procedures, the formation of hospital strains and

other factors contributed to the intensification of artificial mechanism of infection. Within artificial mechanism of transmission can be realized:

– airborne (ventilation, intubation);

– contact (non-invasive therapeutic and diagnostic procedures);

– enteral (fibrogastroduodenoscopy, enteral nutrition);

– parenteral (invasive therapeutic and diagnostic procedures) routes of infection.

Artificial mechanism of infection is not a transfer mechanism, because it doesn't correspond with this definition (the prevailing evolutionary process, necessary for the existence of the pathogen as species in nature). The pathogens of human infectious diseases, which are currently often distributed with the help of artificial mechanism of infection (HIV, HBV, HCV and others), always have a natural primary transmission mechanism, leading to the preservation of their species in nature.

Determination of the type of transfer mechanism is possible only through analyzing the distribution of pathogens within populations of the same species. The penetration of the pathogen from the owners' population of one species (animals) in the hosts population of another species (human) is not a transmission mechanism, because this movement has no value in saving of the pathogen as a biological species in the nature. Regarding zoonotic infections, transmission mechanism takes place only during epizootic process. In cases when people are involved in epidemic process of zoonotic infections specialists speak about the mechanism (process) of infection or transmission routes of pathogens of zoonotic infections.

MANIFESTATIONS OF THE EPIDEMIC PROCESS

Epidemic process as a process of interaction between heterogeneous populations of the parasite and the host, under certain necessary and sufficient social and natural conditions is manifested by incidence. The incidence has qualitative and quantitative characteristics.

According to *qualitative characteristic* the following types of morbidity are distinguished:

Endemic incidence is an incidence constantly registrated in a particular area, i.e. incidence, specific for the region.

Exotic incidence is an incidence, unusual for the area; it occurs as a result of introduction of the pathogen from outside of the host's body or objects of the external environment.

Sporadic incidence are isolated cases of infectious diseases. Sometimes sporadic incidence is understood as minimal morbidity regularly observed in the area.

Epidemic incidence is the morbidity above sporadic level. Epidemic incidence in turn differentiates on epidemic outbreak, epidemic, pandemic.

Epidemic outbreak is a short-term increase in morbidity in a limited group of people (collective settlement). Cases of infection in these groups are usually linked together by a common source of infection or general transfer factors.

Epidemic is mass distribution of infectious diseases of the same name covering the country (city, collective) and originating from a common source of infection or common pathways, as well as related chain of infections.

Pandemic is an epidemic that spans multiple countries or the entire globe.

Quantitative characteristics of the epidemic manifestations are the indicators reflecting the intensity, dynamics, structure and spatial characteristics of disease.

The intensity of the epidemic process (**incidence**) is the frequency of infectious diseases; expressed as indexes (ratios) per 100,000, 10,000 or 1,000 population. These indicators allow us to compare the incidence in different populations, at different times, in different areas.

The dynamics of the epidemic process is the change of its intensity in time. Long-term and annual dynamics of morbidity are distinguished. In the first case we are talking about changes of its annual performance during the studied period, the second is the changes of monthly morbidity.

The structure of morbidity is its distribution among age, social, professional and other population groups.

The spatial characteristic is the distribution of disease in the territory within the administrative units (countries, regions, districts, cities and other settlements).

The incidence and its distribution in time, in population groups of the territory is a reflection of the self-regulation of the epidemic process in close connection with the natural and social factors.

Based on the results of study of epidemic manifestations, the risk groups, risk time and risk areas are determined and risk factors are established.

Risk groups are age, professional and other groups, among which the incidence is higher than among other groups.

Risk time is time periods characterized by higher levels of morbidity than in other periods.

Risk areas are administrative and other areas, where the incidence is higher than in other areas.

Risk factors are the causes and conditions that led or can lead to a rise in morbidity in specific conditions and period of time.

EPIDEMIC FOCUS

An epidemic focus is the residence of the source of infection with the people around him and the territory within which the pathogen can be transmitted. From the standpoint of population approach, the epidemic focus is

the pathogen population and population of humans, supporting its existence (Fig. 6).

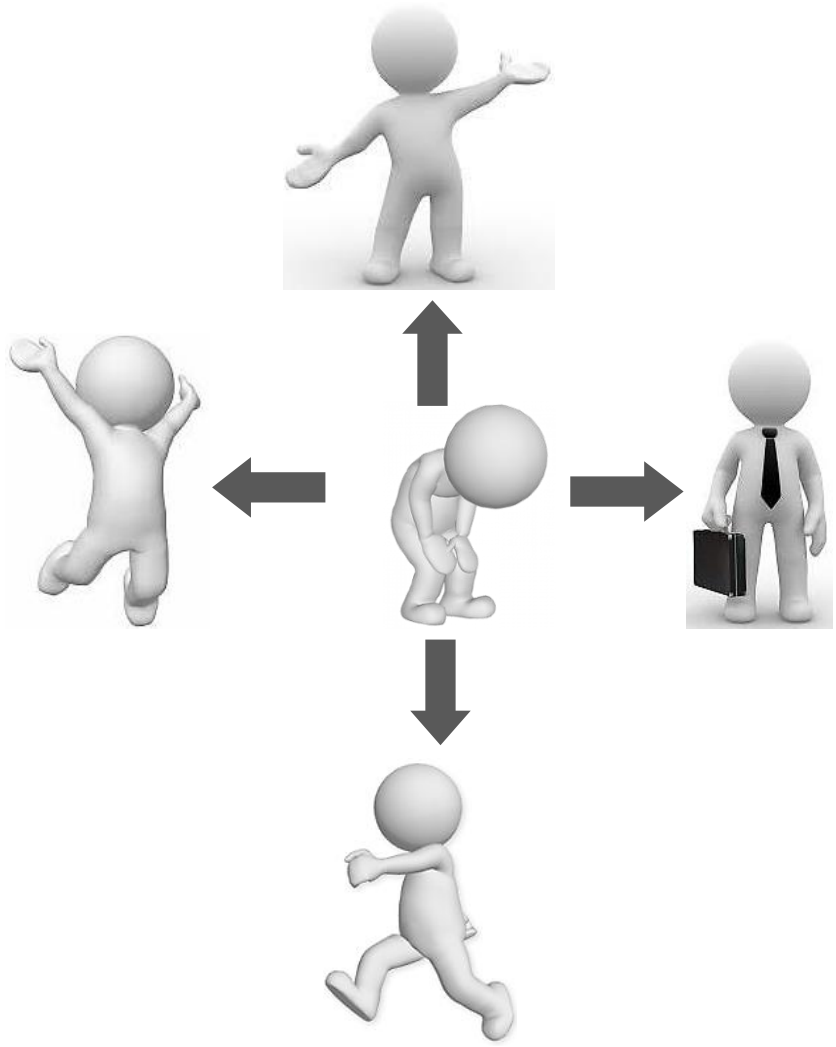

Figure 6. Epidemic focus

Epidemic focus is characterized by lifetime (the time index) and size (spatial index).

The *time of existence* of a focus is calculated from the onset of the disease before hospitalization and a final disinfection with the maximum incubation period, typical for a given infectious disease. Knowing the maximum incubation period is required for the control of epidemic focus. If anybody communicated with the patient and was infected from him in the last day, within the maximum incubation period the disease would occur clinically and would be revealed during the observation of the focus. In cases where an infectious patient left for home treatment, epidemic focus will exist from the onset of the disease until recovery and final disinfection with the maximum incubation period typical for this infection. If there are several diseases in the focus, the maximum incubation period should be calculated from the moment of occurrence of the last case of the disease in this focus.

The *dimensions (size)* of the epidemic focus depend on:

– nosological forms of infectious disease and its transmission mechanism;

– the specific conditions under which the disease has arisen;

– sustainability of the etiological agent in the environment.

In addition, the size of the epidemic focus is under influence of communal and social factors: utility of developed area; living conditions; the level of sanitary culture of people in the focus. For example, during pertussis the size of the lesion is usually limited with the room in which the patient is located. This is because the causative agents of whooping cough weakly stable in the environment and propagated to a distance of 1–2 m from the patient. Therefore, the infection of persons who communicate with patient ill with pertussis, is only possible when they are in the same room. In case of dysentery the focus is the whole apartment. Speaking about measles pathogens, which can be distributed with air currents into an adjacent room or even on adjacent floors, the structure of the focus includes apartments located on the one site.

Epidemic foci, according to the *number of cases*, are divided into *singular* (one case) and *multiple* (several cases). In multiple foci transmission may be *fan-shaped* (the causative agent is transmitted from one source of infection immediately to a large number of individuals without subsequent transmission of the pathogen from the infected) and *relay* (the causative agent is transmitted from the source of the infection to another person who becomes a source of infection to a third person), etc.

According to the intensity of the epidemic process in the foci, they are divided into two groups. At high levels of manifestation of diseases, the early period of infectiousness, short incubation period, if you have a large layer of non-immune individuals, as well as the conditions for the realization of the transmission mechanism foci with explosive character of incidence are formed. In cases of low manifestation rate, long incubation period in the presence of a significant layer of immune persons, foci with indolent character of incidence are formed.

ANTI-EPIDEMIC MEASURES AND MEANS

EPIDEMIOLOGICAL WORK IN HEALTH CARE ORGANIZATIONS

Anti-epidemic measures are a set of actions, justified at this stage of development of science, aimed on prevention of the occurrence of infectious diseases among certain groups of the population, reduction of morbidity in the population and liquidation of separate infections.

It is customary to divide the control measures into two groups according to their execution time:

1) **preventive activities** are conducted before the emergence of communicable diseases and aim to prevent the occurrence of these diseases;

2) **activities in the epidemic focus** held in connection with the occurrence of epidemic focus to prevent the spread of infection in the given focus.

There are many activities that can be classified as preventive or events in an epidemic focus. From practical point of view, the most rational thing is to group each of the mentioned groups according to the orientation of their action. Distinguish activities aimed at:

1) the source of infection;
2) the transmission mechanism;
3) the susceptibility of the organism.

In addition, this group highlights the group general activities.

Epidemiological funds are special preparations that are used to carry out control measures. Basic anti-epidemic groups of funds include: antibiotics, mechanical means of rodent control, chemical raticides, bacterial raticides, mechanical disinfectants, chemical disinfectants, insecticides, acaricides, repellents, chemosterilants, vaccines, immunomodulators, immune sera, immunoglobulins, bacteriophages.

PREVENTIVE MEASURES

Preventive actions are carried out regardless of the presence of the disease to prevent the formation of epidemic variants of the pathogen. According to the direction of action the following groups of activities are distinguished:

1. Measures aimed at the source of the infection: in case of anthroponoses (the source of infection are people) — identification of infectious patients and asymptomatic carriers of pathogens of the infectious diseases; in case of zoonotic infections (the source of infection are animals) — veterinary and sanitary measures and deratization.
2. Activities aimed at the transmission mechanism: sanitary-hygienic measures; preventive disinfection, disinsection.
3. Activities aimed at the susceptibility of the organism: planned immunization.
4. General activities: laboratory research; hygienic education of the population.

ACTIVITIES IN THE EPIDEMIC FOCUS

In an epidemic focus the following groups of activities are organized and conducted according to the direction of action:

1. Measures aimed at the source of the infection:

– detection;
– diagnostics;
– records and registration;

– emergency notification to CHE;
– isolation;
– treatment;
– an order of discharge and admission to the groups;
– clinical supervision;
– zoonotic foci — the veterinary-sanitary measures; focal deratization.

2. Activities aimed at the transmission mechanism: the current and final disinfection, focal disinsection.

3. Activities in regard to persons who communicate with the source of infection (contact persons in the focus):
– identification;
– clinical examination;
– collecting the epidemiological anamnesis;
– medical supervision;
– laboratory testing;
– emergency prevention;
– regime-restrictive measures.

SELF-CONTROL THE TOPIC

Task 1. Formulate the concept of "source of infection", name the main categories of sources of infection in anthroponosis. Identify the epidemic risk of the sources of the infection in different periods of escherichiosis and viral hepatitis A.

Task 2. Formulate the concepts of: a) the transfer mechanism, b) the transmission factors, c) the transmission route.

Explain the difference in the stability of pathogens transmitted by various mechanisms from the position of the mechanism of transmission theory.

Task 3. Specify the typical transmission mechanisms by which the listed pathogens of infectious diseases are spread with viral hepatitis A, chickenpox, viral hepatitis B, dysentery, diphtheria, tick-borne encephalitis, whooping cough, malaria, meningococcal infection, typhus, cholera, scabies.

Task 4. Determine the time of existence of the epidemic focus.

The patient with rotavirus infection, who works in an industrial enterprise, manifested the first signs of the disease on 9.02. The patient was hospitalized on 10.02. Final disinfection was performed on 11.02.

Task 5. In the senior group of the kindergarden, a child with pertussis was identified. In the group, a quarantine has been declared for 14 days, during which the other children had medical supervision.

Indicate the need for disinfection in the group.

STANDARDS OF ANSWERS

The answer to the task 1. An infected human or animal, where the pathogens can live, multiply, accumulate and be allocated to the outer environment is called the source of infection. Among people sick persons and carriers can be sources of infection. Most important characteristics of the patients as sources of infection are the period of infectiousness and severity of clinical manifestations of the disease.

During the incubation period, the causative agents of most infectious diseases are not released into the environment, for example, in the case of escherichiosis. The majority of escherichia are released during the period of clinical manifestations. But a person who sick with HAV can infect surrounding people from the last 7–12 days of the incubation period and not so long (in average, 14 days) during the period of clinical manifestations.

The answer to the task 2. The transmission mechanism is evolutionary formed process of the movement of the pathogen within one population from one host to another susceptible host organism, which ensures the preservation of the pathogen as a biological species in nature. Transmission factors are elements of the external environment, providing movement of the pathogen from the source of infection into susceptible organism. All of the elements of external environment, acting as factors of transmission of infectious diseases, are divided into 6 groups: 1) air; 2) water; 3) food; 4) soil; 5) household items and environment; 6) live vectors. Elements of external environment onto which pathogen gets, leaving the body, are called primary transmission factors, and those delivering it in a sensitive organism are the final transfer factors. A combination of transmission factors, involved in the movement of a specific pathogen from a particular source to a particular susceptible organism, is defined as the route of transmission of the infectious agent.

Aerosol transmission mechanism is specific for infectious agents, primarily localized in the respiratory tract. Most of these infectious agents have a low resistance to the environment conditions. Fecal-oral transmission mechanism is specific to the infectious agents, primary site of which is gastro-intestinal tract. Most of infectious agents of intestinal infections have a moderate sensitivity to the environment conditions. Vector-borne transmission mechanism is specific for the causative agents of infectious diseases, place of primary localization of which is blood, that's why these infectious agents have a low resistance in the environment. Contact transmission mechanism is specific for the causative agents of infectious diseases, place of primary localization of which is skin and mucosa. These infectious agents can be different in resistance to the environment conditions, but most of them have a moderate and even strong one.

The answer to the task 3.

Main transmission mechanism for following infectious diseases

Main mechanism of transmission	Diseases
Aerosol	chickenpox, diphtheria, whooping cough, meningococcal infection
Fecal-oral	viral hepatitis A, dysentery, cholera
Vector-borne	tick-borne encephalitis, malaria, typhus
Contact	viral hepatitis B, scabies

The answer to the task 4. Time of existence of the epidemic focus is from 11.02 till 18.02 (incubation period of rotavirus infection is from several hours till 7 days).

The answer to the task 5. Pertussis is an aerosol infection. Infectious agent of whooping cough has a low resistance in the environment. It means that in this case we don't need in disinfection in the kindergarten group.

LITERATURE

Basic

1. *Infectious* Disease Epidemiology : Theory and Practice / ed. by K. E. Nelson, C. M. Williams. 3rd ed. USA : Jones and Bartlett Learning, 2014. 963 p.

2. *Зуева, Л. П.* Эпидемиология : учеб. / Л. П. Зуева, Р. Х. Яфаев. Санкт-Петербург : Фолиант, 2006. С. 91–84.

3. *Эпидемиология.* Противоэпидемические мероприятия в очагах инфекционных болезней : учеб. пособие / Г. Н. Чистенко [и др.] ; под ред. Г. Н. Чистенко. Минск : Новое издание, 2007. С. 6–33.

Additional

1. *Кравчук, Ю. В*. Epidemiology : the manual for the Medical Faculty for international students / Ю. В. Кравчук, Т.В. Лиопо. Гродно : ГрГМУ, 2013. 236 с.

2. *Черкасский, Б. Л.* Руководство по общей эпидемиологии / Б. Л. Черкасский. Москва : Медицина, 2001. С. 135–459.

3. *Инфекционные* болезни и эпидемиология / В. И. Покровский [и др.]. Москва, 2000. С. 7–35.

CONTENTS

Учебное издание

Чистенко Григорий Николаевич
Шилова Маргарита Александровна

ОСНОВЫ ОБЩЕЙ ЭПИДЕМИОЛОГИИ. ПРОТИВОЭПИДЕМИЧЕСКИЕ МЕРОПРИЯТИЯ И СРЕДСТВА. ПРОТИВОЭПИДЕМИЧЕСКАЯ РАБОТА В ОРГАНИЗАЦИЯХ ЗДРАВООХРАНЕНИЯ

BASICS OF GENERAL EPIDEMIOLOGY. ANTI-EPIDEMIC MEASURES AND MEANS. EPIDEMIC CONTROL MEASURES IN HEALTH CARE ORGANIZATIONS

Учебно-методическое пособие

На английском языке

Ответственный за выпуск Г. Н. Чистенко
Переводчик М. А. Шилова
Компьютерная верстка Н. М. Федорцовой

Подписано в печать 03.01.19. Формат 60×84/16. Бумага писчая «Снегурочка».
Ризография. Гарнитура «Times».
Усл. печ. л. 1,63. Уч.-изд. л. 1,46. Тираж 99 экз. Заказ 11.

Издатель и полиграфическое исполнение: учреждение образования
«Белорусский государственный медицинский университет».
Свидетельство о государственной регистрации издателя, изготовителя,
распространителя печатных изданий № 1/187 от 18.02.2014.
Ул. Ленинградская, 6, 220006, Минск.