

EPIDEMIOLOGY OF INFECTIOUS DISEASES

The object of epidemiological research into infectious disease is to identify the process of spreading infection in a population. The basic criteria involved within this spread are:

1. **Source of infection**
2. **Mode of transmission of infectious agent**
3. **Susceptible organisms i.e. the host**

The process of spread of infection occurs via complex and complicated conditions that are influenced by natural, social and economic factors.

Ultimately the aim of epidemiology of infectious disease is to eliminate or eradicate infections within the population.

Elimination of the infection – is a state of lasting territorial interruption of the process of spread of certain infections. There is still the possibility of sporadically “brought in disease” which may result in some contacts to these diseases falling ill.

Elimination of infection as a serious medical problem – residual focus of infection or sporadic cases of infection can still appear for a number of years.

Eradication of infection – is a state of global liquidation of pathogens and consequently, global eradication of the respective infectious disease.

Epidemiology of infectious disease uses a methodical approach to work just as described in this text's introduction

FORMS OF INFECTION OCCURRENCE

Depending on intensity and extent occurrence of infectious diseases can be distinguished accordingly:

Sporadic – isolated cases of disease without obvious epidemiological connections

Epidemic – mass occurrence of infectious disease in mutual epidemiological connection taking place in a limited territory for a certain amount of time. When two or more cases of disease occur in one family or household we speak about family occurrence.

Pandemic – mass occurrence of infectious disease affecting the whole continent i.e. without territorial limits

Endemic – occurrence of the disease which is bound to a certain territory without time limitation i.e. tick encephalitis, tularaemia or where transmitter (vector) is bound to certain climatic conditions (yellow fever, malaria).

PROCESS OF SPREADING INFECTION

To the process of spreading infection, we can designate a summary of all factors and conditions enabling and influencing transmission of the agent of infection from one organism to another.

Agents of disease (etiological agents) are as follows:

Metazoa – parasitic helminths

Protozoa – malaria, leishmaniasis, amoebic dysentery

Fungi – dermatomycosis, histoplasmosis, blastomycosis

Bacteria – rickettsiae, chlamydia, pleuropneumonia

Viruses – incomplete virus particles

In the process of spreading infection we must consider characteristics of following etiological agents:

Pathogenicity – ability of agent to cause specific pathological condition in an organism

Virulence – degree of pathogenicity of agents is determined by toxicity and invasiveness, both of these are variable

Toxicity – ability to harm organism by creating toxins

Invasiveness – ability to penetrate into the tissues of organism, to stay there, to propagate events and undergo certain degree of development

In addition to the above the following factors should be considered:

Infection dose – quantity of pathogenic agent that has penetrated into the organism

Resistance to physical factors - low or high temperatures and radiation...

Ability to infect intermediary hosts or vectors

Ability to propagate out the organism

Basic links of spreading of infection are:

Source of agent of infection

Mode of transmission of agent

Organism susceptible to agent

Prevention of spread of infection can be done by:

- ✓ liquidate the source of infection either by isolation or casual treatment of the agent of infection
- ✓ destroying agent in outer milieu via disinfection
- ✓ increase resistance of population susceptible to agent (immunization) or prevent propagation of agent after infection (chemoprophylaxis).

SOURCE OF INFECTION

An object is designated as the source of infection in which the agent of infection lives and propagates. The source of infection can be a **person** or an **animal** from which the infectious agent is secreted into the outer milieu and from there to individuals. In certain circumstances the **outer milieu** can be the source of infection where the agent lives as a saprophyte (mycoses, legionnaires).

A person can be the source of infection in the following cases:

- ⇒ **during incubation period of disease** - in some infections the agent is secreted during the incubation period (Hep A, B). Careful consideration should be made of this patient as their infection is usually not known
- ⇒ **sick person** – in clinical, abortive, atypical, in apparent forms
- ⇒ **convalescent** – secretion of these agents occur during convalescence i.e. as in pertussis.

Animals can be source of infection in a similar way to persons. Diseases that can be transmitted from animals to persons are called ZOOZOSES (anthrax, salmonella, brucellosis, Q-fever, tularaemia). Animals that can act as sources are sheep, goats, ducks, hens, pigeons, dogs, cats, deer, stags and small rodents.

Carriers – short term (salmonella), long term (typhoid fever), intermittent (secretions at certain periods).

Reservoirs of infections we designate certain milieu (animate/inanimate) in which the infectious agent survives and eventually propagates. Various kinds of slugs in the case of schistosomiasis can act as an intermediate host.

MODE OF TRANSMISSION

Mode of transmission is how the etiological agents get from the source to the host. The way an infectious agent is secreted from the source can influence mode of transmission, as can resistance of the agent to outer milieu and also the site of entrance of infectious agent into the susceptible organism.

Most infections have only one mode of transmission. However infections such as tularaemia and plague have more than one mode of transmission.

Modes of transmission are:

Direct – when the individual comes into contact with the etiologic agent at transmission.

Indirect – when transmission source and host are mediated by a further factor.

Direct transmission

By contact – the skin or mucosa of the affected individual comes into contact with another individual (sexual intercourse, biting, scratching, and kissing). Most venereal diseases are transmitted this way.

By droplet – transmission through the air; when infectious agents are expelled from the upper respiratory airway of the source to the host who inhales them. Mainly acute respiratory infections are transmitted this way (influenza, parainfluenza).

Transplacentally - transmission of infection can occur from mother to foetus (rubella virus, HIV virus, cytomegalovirus, toxoplasma gondii, treponema pallidum)

Perinatally – newborns can be infected by a number of agents during birth (streptococci group B, E-Coli, N.gonorrhoea).

Indirect transmission

Mediated by contaminated objects – infectious agent is transmitted by objects of daily domestic use (towels, handkerchief, combs, dishes, cutlery, etc.)

Transmission by inoculation – instruments and equipment used by medical personnel may introduce the etiologic agent into host (injections, transfusions, operations, blood plasma). Viruses such as Hep B & C, cytomegalovirus, HIV infection can be spread by this way as can nosocomial infections.

Transmission by air – usually from upper respiratory airways when a person sneezes, coughs, or speaks. These etiologic agents can be inhaled by another individual who may become infected.

Droplets larger than 100 μ create contaminated dust when they fall to earth and dry out. This dust may be breathed in and result in subsequent infection. This also may occur by dried pus.

Depending on their size droplets smaller than 100 μ stay in the air for a shorter or longer period of time. Smaller droplets get dry immediately and can remain in the atmosphere for a longer period of time. Due to their size they may infiltrate alveolus resulting in decreased effect of ciliary epithelium. The smaller the droplet the further it may be carried from source of infection.

This type of transmission occurs in respiratory infections (acute respiratory disease, exanthematic disease, pertussis, diphtheria, pulmonary tuberculosis). It may also occur in dermatological diseases (staphylococci), alimentary disease (oxyuriasis) and even in the transmission of zoonoses (tularaemia, anthrax).

Transmission by alimentary way – point of entrance for this type of etiologic agent is through the digestive tract and occurs due to substances containing this agent (water, milk and most foodstuffs)

Transmission by water – occurs when the pathogenic germs get into the water supply; this can be due to interrupted sewage, leaking of waste water, waste water being carried to water flows or water basins. This type of transmission usually results in an explosive epidemic, the extent of which depends on how many people are supplied by that water. This occurs in abdominal typhoid fever, parathyroid fever, cholera, Hepatitis A, poliomyelitis, leptospirosis. The duration of survival of this agent within the water depends on the physical, chemical and biological qualities of the water.

Transmission by food/foodstuffs – these can also lead to explosive epidemics as the food is a perfectly suitable transport medium for the propagation of microbes and the production of their toxins. This is most often food of animal origin (meat, eggs), vegetable (manure by faeces), or fruit (used without peeling).

Contamination of food that is off animal origin occurs (a) primarily when cause is due to endogen contamination occurring intravitaly in animals (salmonella), (b) secondarily when preparing various foods, the dishes and cooking instruments used are contaminated or due to dirty contaminated hands of personnel preparing the food.

Milk and milk products can be primarily contaminated by zoonotic agents (bovine tbc, foot and mouth disease, Q-Fever, tick encephalitis, brucellosis).

Eggs are contaminated both primarily and secondarily by salmonella. Highly dangerous are cold meal products (mayonnaise) and confectionary products in which raw eggs are used. To ensure safety of eggs from salmonella contamination you should boil them for 8-10 minutes.

Meat products can also be contaminated both primarily and secondarily, mostly in meals prepared from grinded meat, blood, intestinal (salmonella, trichinella, and

toxoplasma). Meats that are not sufficiently smoked or warmed can endanger persons with botulism.

Transmission transmissive (vector-born) – mediation of agent can be by various kinds of arthropods and can be as follows:

Biological – the agent propagates in the vector and undergoes a part of its development cycle. Can be transmitted in a transovarian way. It is mediated by arthropods that live on human or animal blood (malaria, trypanosomiasis, leishmaniosis, arbovirus, tularemia, rickettsiosis, plague, recurrent typhoid fever, Q-Fever).

Mechanical – the surface of an insect may be infected when it comes into contact with faeces (synantropic flies, cockroach), upon contact with food the pathogenic germs can be transmitted. Salmonella and enterovirus may be transmitted by this method:

Infections of natural focus – these are infections occurring in certain localities characterized by:

- animals that act as a reservoir for infection (small rodents)
- vectors (transmitters) which act as a reservoir on animals and can transmit infection to further hosts
- flora & fauna (biocenosis) which create a milieu for animal and vectors that act as a reservoir or infection

Transmission by contaminated soil - tetanus spores, anaerobic clostridium, some types of mycoses.

SUSCEPTIBLE INDIVIDUAL – HOST

The susceptible individual is the third link in the process of spreading infections. The result of the infectious process is due to mutual interaction between microorganisms and macroorganisms.

Microorganisms (etiologic agent) – certain qualities such as virulence, size of infection dose, resistance of agent of infection to outer and inner milieu can express influences on process of infection.

Macroorganisms (person) – receptiveness or resistance is decided through a number of factors:

1. character and degree of immunity
2. age and time of infection
3. state of nourishment
4. presence of other diseases
5. infection by several agents at the same time
6. personal habits (smoking, alcohol, dependence on medicines, psychological factors like depression, belief, will)

Three basic groups of mechanism come into effect at the defence of organism: non-specific resistance, non specific immunity, gained specific immunity.

Non-specific resistance – based on the in-born protective factors of an individual. These include physical (mechanical) barriers such as surface of cilia or non disturbed epithelium surfaces, and biochemical barriers such as HCL in stomach, genetic and hormone cellular effects.

Non-specific immunity (natural) – includes the processes conditioned by the previous etiologic agent who work independently and are not specific (phagocytosis, complement system, lysozyme, interferon, inflammatory processes).

Gained specific immunity – conditioned by previous etiologic agent or its antigens. It is divided between humoral (antibodies) and cellular (mediated by T-lymphocytes).

Specific immunity is itself divided into:

Passive immunity gained in a natural way – antibodies in newborns are gained from the mother transplacentally. They protect newborn against infections mother had or was vaccinated against. Antibodies also pass from mother to child through breast feeding.

Passive immunity gained artificially – antibodies are acquired in the form of immune globulin or gammaglobulin. The effect is short term.

Natural active immunity – antibodies are created in response to infection. Immunity has various duration against different infections, with some of them life long.

Gained active immunity – antibodies are gained after application of vaccines.

Collective immunity – in opposition to real infection, this is a state of naturally or artificially gained immunity in individuals present within a certain group or as part of the population. When a certain level of mass immunity is reached against a given etiologic agent, transmission of this agent stops and no epidemic occurs. However, unique or individual cases of this disease may appear. The level of effective mass (collective) immunity for various agents is usually 85-95%.

NATURAL & SOCIAL FACTORS INFLUENCING THE PROCESS OF SPREADING INFECTIONS

Certain conditions may significantly influence the process of spreading infection such as **natural factors** i.e. factors not connected with human activities. Social and economic factors also influence the process of spread of infection.

Natural conditions encompass conditions such as climate, geographic position, altitude, quantity of rainfall, moisture levels, flora & fauna (biocenosis) levels in a region. To these you should also consider the vectors, animals that may act as reservoirs and mediating hosts in a region.

Climatic conditions influence geographical occurrence of a number of infections i.e. occurrence of malaria is bound to the occurrence of Anofels, yellow fever to the occurrence of mosquito (*Aedes*), sleepy sickness to occurrence of tse-tse, encephalitis to the presence of respective mosquitos and ticks.

Seasonal occurrence in our climatic conditions can be observed by the higher occurrence of alimentary infections in the warm period and accumulation of respiratory infections during the winter season.

Social conditions – socio-economic conditions contribute to changes in the process of spreading infections.

Societies with a highly developed social structure have a number of advantages which contribute to the health of their population. This is demonstrated by the following: hygienic safety of environment (drinking water, dwellings, rubbish removal, production and distribution of foodstuffs, quality and quantity of nourishment), level of medical care and its accessibility...

There is however also a downside to social conditions. The rising collectivisation of the life (collectives at work, pre-school collectives) represents larger possibility of contact to and spread of respiratory infections. In the same way mass transport in towns can contribute to the risk of infection, especially droplet infection. Air transport represents the possibility to bring in exotic infections. Industrial production of foodstuffs and taking meals in canteens or common places at work lead to possibility of bringing alimentary infections into numerous collectives and into larger populated regions.

Improvement of living standards of the population means that natural contamination by certain infectious agents proceeds more slowly, which changes not only the age of distribution of individual diseases but can even offer a changed clinical picture.

METHODS OF CONTROL INFECTIONS

Preventive anti-epidemic measures – this represents a set of measures aimed at preventing occurrence and spread of infections in a population. Basic preventive measures are as follows:

Improvement of hygienic level of population – with strict observation of regulations concerning supply of water, nourishment, production and handling of foodstuffs, waste water treatment, rubbish, dung water.

Vaccination – selected groups are vaccinated against selected infections. The aim is to bring about the highest possible collective immunity against the given infection.

Registration & control of carriers – persons with agent of typhoid fever, salmonella, dysentery bacillus and diphtheria must be under permanent medical control, be regularly tested microbiologically, and medically treated. They are required to keep to certain conditions as per instructions of the physician. Change of address must be notified of. The patient must not undertake any activity that may expose other people. The persons living in the household with the patient must be under medical supervision as well.

Measures preventing infection spread into large areas/populations (collectives) – these measures include introductory examinations before taking up employment, or entering children's camps or the military. It is highly important to ensure that infectious disease is not brought into schools. The aim is to prevent from entry those persons who can act as a source of infection, affecting other individuals.

Prophylactic disinfection – this is done to reduce pathogenic germs in the outer milieu. It is performed in public buildings, mass transport, and medical establishments. Drinking water and waste water are also disinfected. Another measure of prophylactic disinfection is the pasteurization of milk.

Protection of frontiers – represents a system of measures protecting frontiers or borders against infection being brought in from abroad. At airports or harbours attention must be paid to persons coming in from countries that may have an epidemic and endemic occurrence of contagious disease. People from these countries must have a Certificate of Vaccinations. If they do not have this certificate or have not been vaccinated fully, they must undergo medical supervision, and quarantine. The diseases to quarantine are as follows: plague, yellow fever, and typhus exanthematicus. Measures against infection from being brought into the country also concern raw materials, imported animals. The importer must present a certificate of medical or veterinary authorities for the goods being brought in.

Medical education – systemic increase of cultural and medical consciousness of all inhabitants is significant for prevention of infectious disease. Therefore basic question of hygiene & epidemiology should be included into the system of school education.

Anti-epidemic measures in the focus of infection - these are carried out at the occurrence of infection within the population. The focus of infection is represented by its source and its nearest neighbourhood. The introduced measures have a repressive character.

Early & correct diagnosis of the disease – this is a basic pre-condition for the execution of quick and effective anti-epidemiological measures. On the one hand, it helps to set up the correct diagnosis by properly executed epidemiological history taking, on the other hand, by properly executed clinical & laboratory examinations, be it microbiological, serological, or other .

Notification of the sick & the ones suspected of infection – this is done immediately after a diagnosis is confirmed or if there is a suspicion of an infectious disease. The physician who examined the person is responsible for notifying respective departments. In conformity with legal provisions, the announcement is done on the forms sent to the epidemiological department of the medical establishment responsible for that region. In case of highly contagious diseases or in the case of epidemic outbreaks, the Ministry of Health should be informed by telephone.

Isolation of the sick – separation of the sick, convalescents and carriers is aimed at preventing transmission of infection to susceptible individuals. The physician is responsible for isolation of the patient. The epidemiologist may also isolate the patient after consulting the list of diseases which require institutional isolation.

Epidemiological investigation in the focus of infection – is carried out immediately. A short history is taken from the sick before transportation to the hospital. Depending on the type of infection and its extent, the duration and origin of infection can be determined. A search for all persons who might be affected follows, and then a search is conducted for the source of the infection. Data must be collated about the sick, contacts with the sick, age and sex of affected individuals, when the disease started, profession, and living conditions of affected individuals. On the basis of the information obtained, epidemiological curves and working hypotheses about the source and way of transmission are prepared.

Anti-epidemic regime – is a set measure aimed at liquidation of the focus of infection at the earliest possible opportunity:

Search for sick and possibly infected, aimed at detection of further sources of infection.

Quarantine measures are set up for possibly infected. The infected individuals are regularly examined by the physician for the entire period of incubation. Increased medical supervision is needed to ensure no spread of disease. Quarantine requirements must meet WHO standards outlined for diseases such as plague, yellow fever and typhus exanthematicus.

Focus disinfection – disinfection is performed in the vicinity of the sick and is again carried out after transportation to the hospital and after death of infected individuals. Immunization – utilization of passive or active immunization.

Chemoprophylaxis – use of antibiotics in indicated cases i.e. anti-malarial drugs in the case of malaria.

Hygiene – control of hygienic measures in the supply of water and foodstuffs, trash removal and waste water disposal.

Education – the affected and susceptible individuals should be properly advised about health, hygiene and disease prevention.

Control & evaluation of anti-epidemic measures – done daily and represents the main part of work for the epidemiologist. Daily results are evaluated and can be changed in accordance with change in disease/patient condition. Effectiveness of the measures is evaluated from both, a medical and economic point of view. The measures should be simple, understandable, effective and easy to implement.

EPIDEMIOLOGICAL EVALUATION

This represents a complex of obtaining information with the occurrence of certain disease or disturbance in the population, systemic monitoring of all conditions and factors influencing the development and occurrence of the disease being monitored.

Surveillance represents a number of long term and complex programs in which experts of various medical fields participate (epidemiologists, microbiologists, hygienists, clinicians) together. Other non medical personnel (statisticians, vets, ecologists) also take part alongside medical personnel. The epidemiologist is usually the initiator and organizer of the program. At first, the surveillance started in the field of infectious diseases. Recently it has also included monitoring of the mass occurrence of non infectious diseases, such as tumours, cardiovascular diseases and metabolic disturbances.

Surveillance is put into effect in three successive stages:

Obtaining of necessary data – the number of sick, dead, data from microbiological laboratories on circulation and qualities of etiological agent, collecting clinical information on symptomatology of individual diseases, monitoring of vaccination and collective immunity of population, monitoring of infections with animals, data of natural sciences on vectors.

Analysis of collected data – evaluation of information and suggestions of measures. Long term executed surveillance gives the possibility to make a prognosis of occurrence of the given disease for the future.

Guaranteeing qualified information – to all people concerned who can further use it to improve their own measures and theories.

Surveillance program can be carried out on a large scale such as district and region-wise. However, they are usually carried out in the territory of whole states. In the Czech Republic, surveillance programs are focused on poliomyelitis, pertussis, diphtheria, measles, viral hepatitis, alimentary infections and influenza. Under WHO guidelines, surveillance of influenza is carried out on an international level.

DECONTAMINATION

Decontamination represents a broad set of measures aimed at getting rid the outer milieu of the risk of infection. It involves the removal and liquidation of etiological agents, vectors and animals that may act as a reservoir for infection.

Disinfection – along with antisepsis, asepsis and sterilization means the liquidation of pathogenic agents in the outer milieu. We distinguish preventive and focus disinfection.

Disinsections – represents measures oriented against epidemiologically significant and harmful insects.

Deratisation – represents measures oriented against epidemiologically significant and harmful rodents.

DISINFECTION AND STERILIZATION

Sterilization – means liquidation of all forms of microorganisms (even spores) in the given milieu.

Antisepsis – means liquidation of pathogenic organisms on the surface of human body and body cavities.

Asepsis – represents a set of measures leading to a maintained sterilized milieu and preventing contamination of tissues (use of sterilized instruments, washing hands etc.)

Disinfection – means liquidation of pathogenic microorganisms in the given milieu.

Preventive disinfection – is set to prevent occurrence and spreading of infection. It is implemented in places that are epidemiologically exposed, especially in highly populated areas. It is also used in medical establishments, schools, nurseries, mass transport means, foodstuffs and nourishment i.e. chlorination of drinking water, pasteurization of milk, waste water treatment.

Focus disinfection – done at the focus of infection. Current disinfection is carried out during the period of secretion of the etiological agent into the outer milieu. It is involved with excretion (faeces, urine, blood, sputum) and objects which the infected person is in touch with (linen, dishes, medical instruments). Final disinfection is carried out after termination of agent (departure to medical establishment, recovery, death). Disinfection is performed in places where the persons concerned have been residing, working and studying.

Effectiveness of disinfectant and sterilization procedures is influenced by a number of factors. It depends on knowledge of epidemiology of the infectious disease, characteristics of the etiological agent and knowledge of suitable techniques of disinfection or sterilization.

When choosing a suitable way of disinfection you must consider the following:

Sensitivity – of various kinds of microorganisms to disinfectants (some have a narrow disinfection spectrum).

Effect – on individual kinds of microorganisms is different (some show a bacteriostatic effect and some a bactericidal)

Organic substances - presence of these decreases effectiveness of some disinfectants.

Chemical disinfection – is applied in solutions that should be soluble in water. They are more effective in higher temperatures, lower temperatures slow their effect. The pH milieu also influences the effect.

Disinfection substance – must cover the whole surface of the disinfected object.

Damage – disinfectant should not cause damage to objects or cause irritations.

Selectivity – disinfectants should have a selective effect.

Allergies – disinfectants should not cause allergies.

Inexpensive – disinfectants should be cost effective.

METHODS OF DISINFECTION & STERILIZATION

Physical methods

Heat – boiling destroys most non-spore bearing a microorganism, effect on spores occurs within a prolonged time or not at all. Combustion is used for liquidation of objects of low value and for biological waste and is carried out in furnaces at temperatures higher than 300 C. Sterilization by hot air (table 1) at temperatures 160 – 220 C, utilizes gravitation of forced circulation of hot air. Used with thermo resistant materials (metal, porcelain, glass). Steam sterilization (table2) uses water steam under high pressure for materials tolerating temperatures from 110 – 134 C (metal, glass, ceramics, porcelain, textiles, rubber, some plastics). With this last method, it is important to abide with prescribed values of temperature, pressure, and exposed time.

Radiation – UV radiation is used for disinfection of air in closed premises (operating theatres, laboratories), it is not a penetrative method. Radioactive sterilization is performed by beta and gamma rays for objects not able to tolerate heat or chemical sterilization. The effects on viruses cause problem, this method cannot be used for re-sterilization of objects. Executed by use of radioisotope CO 60 by 25 k/gy.

Chemical methods

(1) **Sterilization by formaldehyde** is used in pressure appliances at temperatures 60 – 80° C. Used for thermo-labile objects (optical appliances, sharp metal instruments, rubber). **Ethylenoxyde** is used in pressure appliances at temperature 55° C and relative moisture temperature 70° C. Used for sterilization of thermo-labile objects. Sterilized objects must be given 3-7 days ventilation before use.

(2) **Higher degree of disinfection** is used as supplementary decontamination of optical and thermo-labile objects. After pre-stabilizationary preparation, objects are immersed into sporicidal solutions.

- (a) **Glutaraldehyde** at 2% concentration, alkalized by 3% sodium bicarbonate, exposure for 2-3 hours,
- (b) **Sekusept forte** at 1.5% concentration or 5%, exposure for 6 hours or fifteen minutes respectively.

Disinfection utilizes effects of some chemical substances on microorganism. Mechanism of effect on etiological agent varies with different disinfection substances.

- (A) **alkali's & acids** – inorganic (sodium hydroxide, potassium hydroxide, chromo-sulphuric acid, boric acid) and organic (peroxo acids: formic acid, acetic acid, Persteril).
- (B) **Oxides** – substances of various chemical structure that split off from oxygen at birth (ozone, hydrogen peroxide, potassium permanganate)
- (C) **Halogenicides** – mostly chlorine and iodine and their compounds are used (hypochlorites, iodine tincture, and iodoform)
- (D) **Heavy metal compounds** – compounds of mercury, silver, copper, tin.
- (E) **Alcohols** – causes coagulation of cytoplasm and dehydration of cellules (ethyl alcohol, izopropanol)
- (F) **Aldehydes** – due to reducing and alkylating qualities they cause inactivation of cellular enzymes (formaldehyde, glutaraldehyde)
- (G) **Tensides** – chemical compounds highly active on the surface; quaternary ammonium compounds (ajatin, septonex) are most important ones
- (H) **Cyclical compounds** - cause inactivation of enzymes and coagulation of protein in microbial cellules (phenol, cresol), halogenized phenols and cresols (Orthosan BF 12, chlor-hexadine)
- (I) **combined compounds** – represent a number of various combinations of the above mentioned chemical substances.

CONTROL OF STERILIZATION & DISINFECTION

For the control over sterilization and disinfection procedures, the following methods are used:

Physical testing – represents current monitoring of temperature and pressure by means of built-in appliances (thermographs, monographs).

Physico-chemical testing – utilizes the changes of colour of certain chemical substances depending on the temperature and length of exposure.

Chemical testing – utilizes the change of colour of some chemical substances depending on the concentration of disinfection substance used.

Biological testing – based on the destruction of tested microorganisms (thermorestant strain of *B. mesentericus*, *B. stearothermophilus*).

Sterility control of instruments & appliances – done by sterile tampon or impression of the object on nutrient medium, irrigation by liquid propagating medium, by placing small objects into test tubes containing nutrient medium. It is followed by cultivation which should be negative if sterilization was done properly.

NOSOCOMIAL INFECTIONS

These are infections occurring in connection with stay in a medical establishment, even as an out-patient.

The decisive factors for this type of infection is *the place of transmission* of infectious agent; due to different incubation times infection may appear at the medical establishment or later upon returning home or on transfer to a different department within the medical establishment.

Nosocomial infections can be divided into:

Non-specific –infections currently affecting the population i.e. respiratory infections, children's exanthema diseases, alimentary infections belong to this group. Occurrence of these reflects the epidemiological situation of the region the medical establishment resides in. The patient is usually weakened by basic disease and this type of infection can have more serious development and a poorer prognosis for them.

Specific – nosocomial infections occurring as a consequence of diagnostic or therapeutic procedures belong to this group as well. Common mode of transmission in these cases is the inoculation and implantation of the agent. Apart from health establishments, there is no other way for these infections to spread in the current population. Early post surgical infections, staphylococcus infections from mothers to newborns, burn related infections, urinary infections (after instrumental procedure), new born children's and child diarrhoea, Hepatitis B and some mycoses are amongst these infections.

The appearance of this group of infections reflects the level of asepsis, sterilization and disinfection of the respective health establishment. It also takes into account the following of principles of anti-epidemiological regime.

The above mentioned infections do not usually occur as the consequence of exogenous or endogenous infection.

Exogenous – infection arises due to introduction of etiological agent into susceptible individual from the outer milieu.

Endogenous – infection arises due to introduction of etiological agent from a colonized place into another system (wound, blood flow, serous liquid). Endogenous infections do not have a stable incubation period, they are not infectious as such and no specific immunity arises after cure of so called infection. The development of infection is often protracting and has the tendency to repeat. Certain influences have a weakening effect (instrumental procedure, surgery, corticosteroids, cytostatics, immunosuppressive, stress, climatic, hormonal, meteorological activities) leading to the onset of infection.

OCCURRENCE OF NOSOCOMIAL INFECTIONS

According to the reported cases, occurrence of nosocomial infections in the Czech Republic represents 1-2 %. The aimed studies show that the occurrence is higher and involves 4- 7% of people.

Percentage of occurrence at various departments can be significantly different. We mostly witness these infections at urological departments, where they affect 10-40 % of the patients. Departments for immature babies and ARO have an occurrence of 25-

30 %. Surgery departments (general, orthopaedics, gynaecology) have a 1-5 % occurrence. In other departments occurrence is significantly lower.

ETIOLOGY OF NOSOCOMIAL INFECTIONS

Agents which are conditionally pathogenic cause specific nosocomial infections and endogenous infections.

The most often occurring etiologic agents that are bacterial in origin are:

gram +ve cocci (staphylococcus, streptococcus)

gram –ve sticks (pseudomonas, serratie, proteus, klebsiella, enterobacter, e-coli)

anaerobic microbes (bacteroides, fusobacterium, clostridium perfringens)

Of **viral origin**, some specific infections occur:(Virus VHB, Herpetic viruses, EBV, CMV)

Mycosis (aspergillomycosis, candida albicans)

SOURCES OF INFECTION

Patients:

When infectious disease was incorrectly diagnosed.

People currently within the incubation period.

People in acute stage of the infectious disease i.e. when the disease has not been diagnosed in accordance with the disease the patient was admitted for having.

Bacilli-carriers.

Personnel:

In incubation period of infectious disease.

Acute stage of disease

Bacilli-carriers

Visitors:

In incubation period of infectious disease.

Acute stage of disease

Bacilli-carriers

Rodents – are present in number of health establishments and can play a role especially in alimentary way of transmission of infection.

MODES OF TRANSMISSION

Direct contact:

When admitting, examining, treating the patient.

Contact with the sick and visitors.

Indirect contact:

With objects, appliances, instruments used in examining or treating patient.

Object of personal effect (towels, handkerchiefs, books, shaving objects)

Airway:

Inhalation (scarlet fever, influenza, pneumonia, children's exanthema diseases, pertussis, staphylococcus infections).

Implantation & inoculation:

During operations or re-bandaging wounds.

Unsatisfactory sterilization of instruments and materials & unsuitable prophylactic disinfection.

Infection in surgical wounds

Burns

Urogenital infections after surgery

Infection of digestive tract after probing

Puncture during surgery

Transfusions

Alimentary:

After consumption of home or hospital food (typhoid fever, salmonella, and new born diarrhoea) due to disease such as *E-coli*, *Ps. Aeruginosis*, viral hepatitis A.

Insects & rodents:

Passive transmission of etiological agents, mostly by insects to food or sterile materials.

PREVENTIVE MEASURES AGAINST OCCURRENCE OF NOSOCOMIAL INFECTIONS

Sterilization - of surgical materials, instruments and appliances.

Prophylactic disinfection – using the correct concentration and in the correct area, ways of transmission may be interrupted (operating theatres, examination rooms, bathrooms, mattresses, bedpans and social available equipment).

Used bed linen – should be sorted and counted away from the department to limit the rise of infectious dust. They should be handled as infectious material, therefore should be transported in impermeable wrapping.

Bandages – both, applying and re-applying, should be done in suitable environment.

Single use – instruments, syringes, needles, and catheters should be used only once and then thrown away in suitable containers.

Antibiotics – should be used after verification of disease.

Hygienic principles (observing basics) – for food preparation and storage

Monitoring – after surgery for complications or raised temperatures.

Announcement & registering – for presence of nosocomial infections.

The same measures should be applied for occurrence of infection in field medicine situations. Isolation and announcement of infection are highly important factors to remember.

Occurrence of infection is announced by the physician who orders diagnostic tests or expresses suspicion of disease. This fact should be announced to the head of the department and to epidemiological services of the medical establishment. The head of the department should announce the occurrence to the director of the medical establishment and is obliged to ensure registration of infection. Furthermore, he is responsible for carrying out the necessary anti-epidemiological measures within the department, including disinfection, quarantine, collection of specimens, microbiological examination and liquidation of the focus of infection.

In a number of medical establishments there is an onsite hygiene physician whose function is to monitor infectious problems. We do not count any “professional diseases” encountered among medical staff or personnel amongst these.

TABLE 1: STERILIZATION TEMPERATURE & EXPOSURE WITH HOT AIR STERILIZATION

TEMPERATURE (C)	STERILIZATION EXPOSURE (MINS)	
	FORCED CIRCULATION	GRAVITATIONAL
160	60	120
170	30	60
180 +	20	40

TABLE 2: TEMPERATURE OF STERILIZATION, PRESSURE, AND EXPOSURE OF STEAM STERILIZATION

TEMPERATURE	PRESSURE (KPa)	EXPOSURE (minutes)
110	150	40
115	170	35
120	200	20
125	240	15
135	300	10