

The Volgograd State Medical University
The Chair of hygiene and ecology

Lecture:

Hygiene of therapeutic and preventive medical establishments Preventive measures against hospital –acquired infections



The Hospital hygiene

- is a branch of preventive medicine develops standards and requirements for the placement, a lay-out and sanitary-engineering maintenance of treatment and prophylactic establishments with the purpose of creation of optimum conditions for patients, effective treatment process and favorable working conditions of the medical personnel

Persons x risks

Patients

- **Biological factors** (pathogens, opportunistic pathogens)

Medical staff

- **Chemical factors** (pollutants)

Other staff

- **Physical factors** (ionizing and non-ionizing radiation, noise, lighting and microclimate, injuries)

Visitors

- **Ergonomic factors**
- **Psychological and organization factors**

Tasks of hospital hygiene

Preventive tasks:

- to develop standard working procedures to ensure hygienic and epidemiologic aspects of HCF
- to coordinate programs to lower the risks of hospital infections
- to consult (new) building and reconstructions of HCF from hygienic point of view
- occupational safety of medical staff

Tasks of hospital hygiene

Control Intervention and surveillance:

- to control compliance of SOP (standard operating procedure)
 - to supervise disinfection procedures and sterilisation centres
 - to control microbiological quality of hospital indoor
 - to monitor cleaning practice
 - to monitor waste management
 - to monitoring quality of food and its proper handling
- etc.

1. Favorable conditions for hospital stay should be created for patients, a medical and protective regime should be provided, conditions for the prevention of nosocomial infections, and the possibility of adverse environmental factors (city noise, toxic substances of atmospheric air) excluded

- From other side, hospitals are considered as the working environment of the medical staff which is associated with the use of radioactive, X-ray, laser radiation, ultrasound, the microwave radiation, various drugs, anesthetics and so on., which in some case may have a negative effect on health and functional state of medical staffs .

Creation the optimum quality of external environment includes:

- comfortable microclimate in premises
- absence of air pollution
- sufficient level of lighting and isolation in premises
- low level of noise
- creation of peaceful, comfortable and good esthetic impression
- elimination of spreading nosocomial infections

Hygienic conditions in hospital depends upon the following factors:

- System of constructing hospitals.
- Capacity of hospitals.
- Location of hospital according to population area.
- Well designed part of hospital
Internal planning of hospitals departments and building.
- Sanitary-technical equipment,
- Nutrition, daily regime and other organizing moments

Systems of hospitals constructions

- Centralized
- Decentralized
- Blocked
- Mixed

The **centralized** system of hospital construction



The centralized system of construction is placing all medical sections in one many-storied building

The decentralized system of construction is placing the medical sections in separate little-storied buildings

ПЛАН ТЕРРИТОРИИ ЦЕНТРАЛЬНОЙ КЛИНИЧЕСКОЙ БОЛЬНИЦЫ №1 ОАО "РЖД"



- 1 инженерно-хозяйственный корпус
 - 2 корпус лечебный
 - 3 "свято-пантелеимоновское училище сестер милосердия"
 - 4 корпус лечебный
 - 5 корпус консультационно-диагностический
 - 6 корпус хирургический
 - 7 корпус административный
 - 8 корпус патолого-анатомический
 - 9 корпус автомеханический
 - 10 корпус лечебный
-  Храм святого великомученика и целителя Пантелеймона

Mixed system of hospital construction

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The mixed system of construction includes the combination of two above-mentioned systems.

Mixed system – the basic somatic departments are situated in one multi-storied building.

Other departments are placed in a separate buildings.

Mixed system of hospital construction

- The reception room and all main somatically and clinic-diagnostical sections (X-ray section, physiotherapeutic section, clinic-diagnostical laboratory), drug-store are situated in the main building.
- Polyclinic, born-section, children and infectious sections are situated in separate buildings.

Mixed construction system

The most favorable system for the construction of hospitals from both hygienic and economical positions.

- not very large land plot is required
- construction and operation are cheaper than with a decentralized system
- it is possible to provide a medical and protective regime
- it is possible to provide the prevention of nosocomial infections

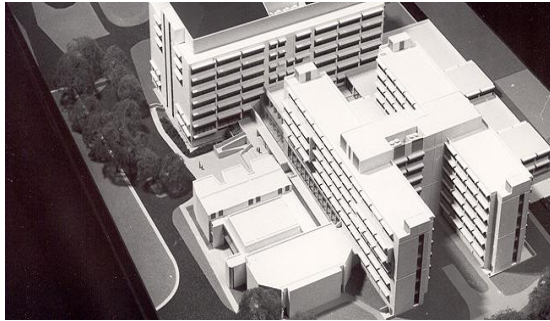
The blocked system of construction

all sections, occupying the separate buildings, are united in one block and joined with each other by passages

- The infectious and radiological sections and auxiliary services are situated in the separate buildings

The systems of hospital constructing

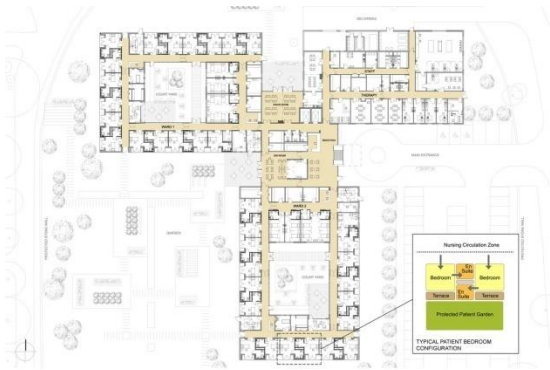
Centralized -block system



H-form

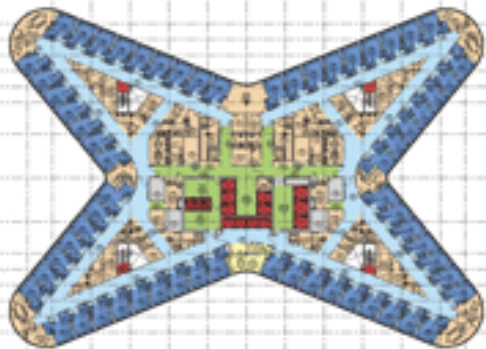
- isolated blocks in multi-storied buildings:

- a block of wards,
- a medical-diagnostic block,
- a block of material and technical service.



T-form

East Tower: Interior Detail Design



X-form

The centralized system of construction



- **Advantages:**

- all medical diagnostically cabinets and sanitary-technical equipment are rationally used.
- The constructing-exploitation expenses reduce
- needs lesser area of land

- **Disadvantages:**

- it has some difficulties in organization the medical-protection and sanitary regime

The decentralized system of construction

Advantages:

- it is easy to organize the medical-protective regime
- from the hygienic position it is more favorable
- it is favorable for prophylactic of nosocomial infections.
- Such system of construction provide the opportunity for patients, for using hospital garden, for organization of rest

Disadvantages:

- from the economic position it demands greater expenditures
- needs lesser area of land
- the construction of a hospital requires a large area
- medical protective regime

It is allowed to locate some Medical establishments on private and residential premises

- Such institutions include: antenatal clinics, therapists' consulting rooms and private consulting rooms, health-improving and rehabilitation centers as well as day in-patient departments

Hygienic requirements to the hospital location

- the content of harmful substances in the air, the levels of electromagnetic radiation, noise, vibration, infrasound should not exceed hygiene standards
- far from the railways, airports, high-speed high-ways, industrial enterprises and other powerful sources of air pollution and noise
- sanitary protection zone must be observed between the hospital site and industrial enterprises (500-1000 m)
- ground should be clean, dry, without sharp differences of a relief, gardened

Hygienic requirements to the hospital location

- the level of noise in the therapeutic establishments should not exceed 50 dB.
- should be electrified, supply with water-pipes and water drain, bordered on perimeter and protected by a strip of green plantings
- maximal approximation to groups of the population, which they are served
- distance not less than 30 m from a red line of building and 30-50 m from apartment houses

The area of the land

The numbers of beds in the hospital	The area of the land for 1 bad (for adults), m ²	The area of the land for 1 bad (for children), m ²
150	150	250
300-400	125	200
500-600	100	135
800-1000	80	-

Zoning of hospitals area

Totally following zones are indicated in hospital area:

1. Zone of medical institution
2. Zone of polyclinic and administration
3. Zone of household yard.
4. Zone of greenish planting.

Hygienic meaning of vegetation

The area of green spaces in the hospital should be at least 50% of the total area of the site. This allows you to organize aero- and heliotherapy.

Positive:

- Protection against wind, dust and noise.
- Optimization of microclimatic conditions.
- Bactericidal influence of phytoncides.
- Oxygenation of the air.
- Fixing of dust.
- Architectural-planning.
- Aesthetic and psychohygienic.



Hygienic meaning of vegetation

Negative:

- × A potential source of allergens.
- × Some plants are poisonous.
- × Danger of traumatization
- × Adsorption of dust particles by plants surface



- To prevent the decrease of natural light exposure and insolation in the hospital wards and departments, trees should be planted at a distance of about 15 meters and bushes at a distance of about 5 meters from the main building.

- The structure of departments and lay-out of its rooms should exclude an opportunity of a crossing or contact of "clean" and "dirty" technological streams (at hospitalization of patients, rendering of medical aid, realization sanitary-and-hygienic and
- antiepidemical actions).



The territory of medical establishment

- Polyclinics
- Medical departments for infectious and not infectious patients, pediatric, psychosomatic, radiological cases, maternity hospitals and obstetrical departments
- Landscape gardening
- Morgue
- Economic and engineering constructions
- Dietary department

Basic unit of internal planning hospital is hospital ward section.

- **Hospital ward section(units)** - complex with a range of hospital wards, therapeutic units and auxiliaries, a corridor and a lavatory, personnel and auxiliary rooms for patients with similar diseases.

Size of ward sections depend on its profile and varying from 15 to 30 beds

- The **hospital ward section** for 25-30 beds is considered the most appropriate for ensuring favorable conditions of stay, the successful organization of the treatment process

A ward department is a basic functional element of the hospital

- The ward department usually holds 60 beds, sometimes number of beds may be increased up to 90 – 120 beds, sometimes number of beds may be decreased up to 15 – 45 beds**

All ward departments are divided into 4 groups:

- non-infectious departments for adults, including a psychiatric unit for the treatment of patients with mental illnesses.
- children's non- infectious departments.
- infectious departments.
- radiological departments.

AREA OF WARD IN DIFFERENT DEPARTMENTS

Somatic (therapeutic) departments: <ul style="list-style-type: none">- for adults- for children	7 6
Infectious and tuberculosis: <ul style="list-style-type: none">- for adults- for children	7.5 6.5
Orthopedic and traumatology, neurosurgery (including rehabilitation), ambulatory, radiological: <ul style="list-style-type: none">- for adults and wards for children with day stay mothers- for children with mothers, who stay around the clock	10 13
Intensive care, postoperative	13
For newborns, premature infants and children up to 1 year	3

- Heating, ventilation and air conditioning systems should provide standardized parameters of the microclimate and air environment of the rooms in which medical activities are carried out.

- In aseptic rooms, the air flow should prevail over the hood. In this case, the overflow of polluted air from other rooms to aseptic will be excluded. In the chambers of the infectious diseases ward, the volume of intake air should be greater than the volume of incoming air. This prevents polluted air from flowing from the chambers to other rooms.
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The air environment

- In medical institutions, all medical facilities are distributed according to cleanliness class.
- For each class of medical facilities, levels of permissible microbial air pollution are established.

Classes of cleanliness

Cleanliness class	Sanitary and microbiological indicators	
	The total number of microorganisms in 1 m ³ of air	
	Before work	During work
A Particularly clean	Not more than 200	Not more than 500
B Clean	Not more than 750	Not more than 750
C	not standardized	not standardized
D		

Room type A (particularly clean)

In class **A** premises, manipulations are performed that exclude the presence of pathogenic microbes.

- Operating rooms,
- Delivery rooms
- Aseptic boxes for burn, hematological
- patients

Room type B (clean)

Clean rooms class B include rooms with a special operation mode

- Procedural, dressings,
- Pharmacies
- Resuscitation halls
- Postpartum wards
- Chambers for burn patients
- Aseptic wards
- Gateways in boxes and semi-boxes of infectious departments
- X-ray perforation

Room type C:

Doctor's offices,

Day care facilities for patients,

Functional diagnostics rooms

Room type D:

Reception,

pantry,

dining room and others

Parameters of microclimate

Room	Temperature of the air, C°	Relative air humidity, %	Air velocity, m/s
Hospital wards for adults; wards for women in the children's department	20-26	No more than 60	0,1-0,2
Doctor's consulting room	20-27	No more than 60	0,1-0,2
Operating room, postoperative wards, intensive care unit (ICU), delivery rooms	21-24	No more than 60	0,1-0,2
Laboratory, treatment room	22-26	No more than 60	0,1-0,2
Physical therapy room	18-28	No more than 60	0,1-0,2

Standard artificial lighting

Type of room	Minimum permissible lighting, lx
Wards for adults	100
Wards for children, postoperative wards, intensive care unit (ICU)	200
Operating room	500
Post nurses	300
Delivery rooms	500
Doctor's consulting room	500

Nosocomial infections have been recognized for over a century as a critical problem affecting the quality of health care and a principal source of adverse healthcare outcomes

Among all major complications of hospitalization, nosocomial infections account for 50%; the remaining are medication errors and other noninfectious adverse events

Nosocomial infections

- A **nosocomial infection**, also known as a **hospital-acquired infection (HAI)**, is an infection (either exogenous or endogenous origin) whose development is favoured by a hospital environment.
- Term *nosocomial* comes from Greek which means „hospital“ (*nosos* = illness, *komeo* = take care about...).

Nosocomial infections

- also called “hospital-acquired infections”, are infections acquired during hospital care which are not present or incubating at admission. Infections occurring more than 48 hours after admission are usually considered **nosocomial**
- are different diseases acquired by the patients during their treatment and examinations at hospital for inpatients

On the other hand the **nosocomial infections** that are preventable, perhaps between 30 and 50 percent, are primarily caused by problems in patient care practices, such as the use and care of urinary catheters, and respiratory therapy equipment, as well as hand washing practices and surgical skill.

DEVICE RELATED NOSOCOMIAL INFECTION

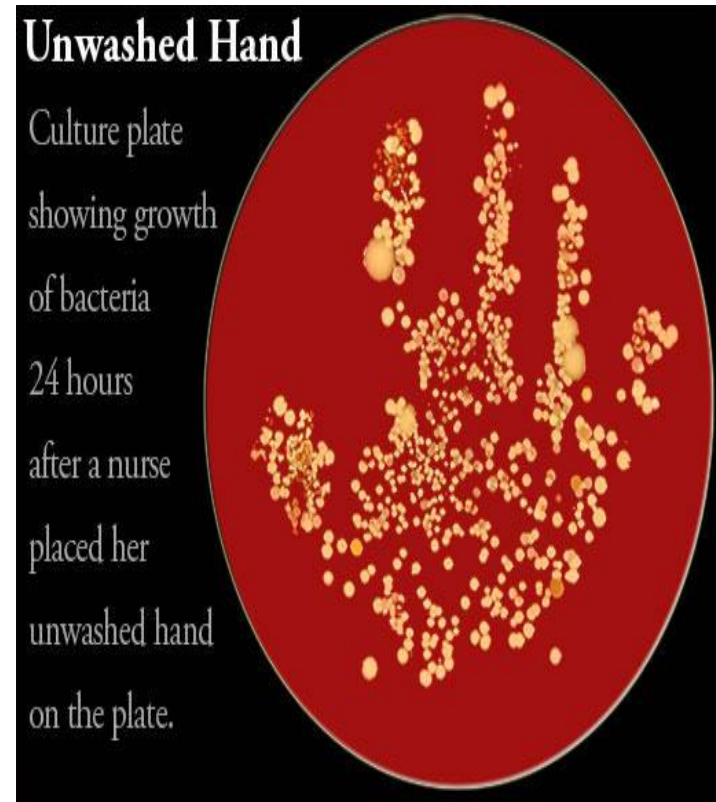
- A device-associated infection is an infection in a patient with a device (i.e., central line, ventilator, or indwelling urinary catheter) that was in use within the 48-hour period before onset of infection.
- If the interval since discontinuation of the device is longer than 48 hours, there must be compelling evidence that infection was associated with device use.

RISK FACTORS

- operative surgery
- intravascular and urinary catheterization
- mechanical ventilation of the respiratory tract
- other risk factors: traumatic injuries, burns, age (elderly or neonates), immunosuppression and existing disease

The sources of the nosocomial infection:

- The bearers (carriers) of microorganisms among the patients and medical staff.
- The patients' visitors are bearers of light forms of infectious diseases.



Factors affecting the development of nosocomial infections

1. Patient susceptibility

- Age, immune status, underlying disease, and diagnostic and therapeutic interventions.
- Patients with chronic disease such as malignant tumours, leukaemia, diabetes mellitus, renal failure, or the acquired immunodeficiency syndrome (AIDS) have an increased susceptibility to infections with opportunistic pathogens.

Factors affecting the development of nosocomial infections

- Immunosuppressive drugs or irradiation may lower resistance to infection.
- Injuries to skin or mucous membranes bypass natural defense mechanisms
- Malnutrition is also a risk
- Many modern diagnostic and therapeutic procedures, such as biopsies, endoscopic examinations, catheterization, intubation/ventilation and surgical procedures increase the risk of infection
- Contaminated objects or substances may be introduced directly into tissues or normally sterile sites such as the urinary tract and the lower respiratory tract.

Environmental factors, which contribute to the development of nosocomial infections

- Crowded conditions within the hospital, frequent transfers of patients from one unit to another
- Concentration of patients highly susceptible to infection in one area (e.g. newborn infants, burn patients, intensive care) all



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Endogenous infection

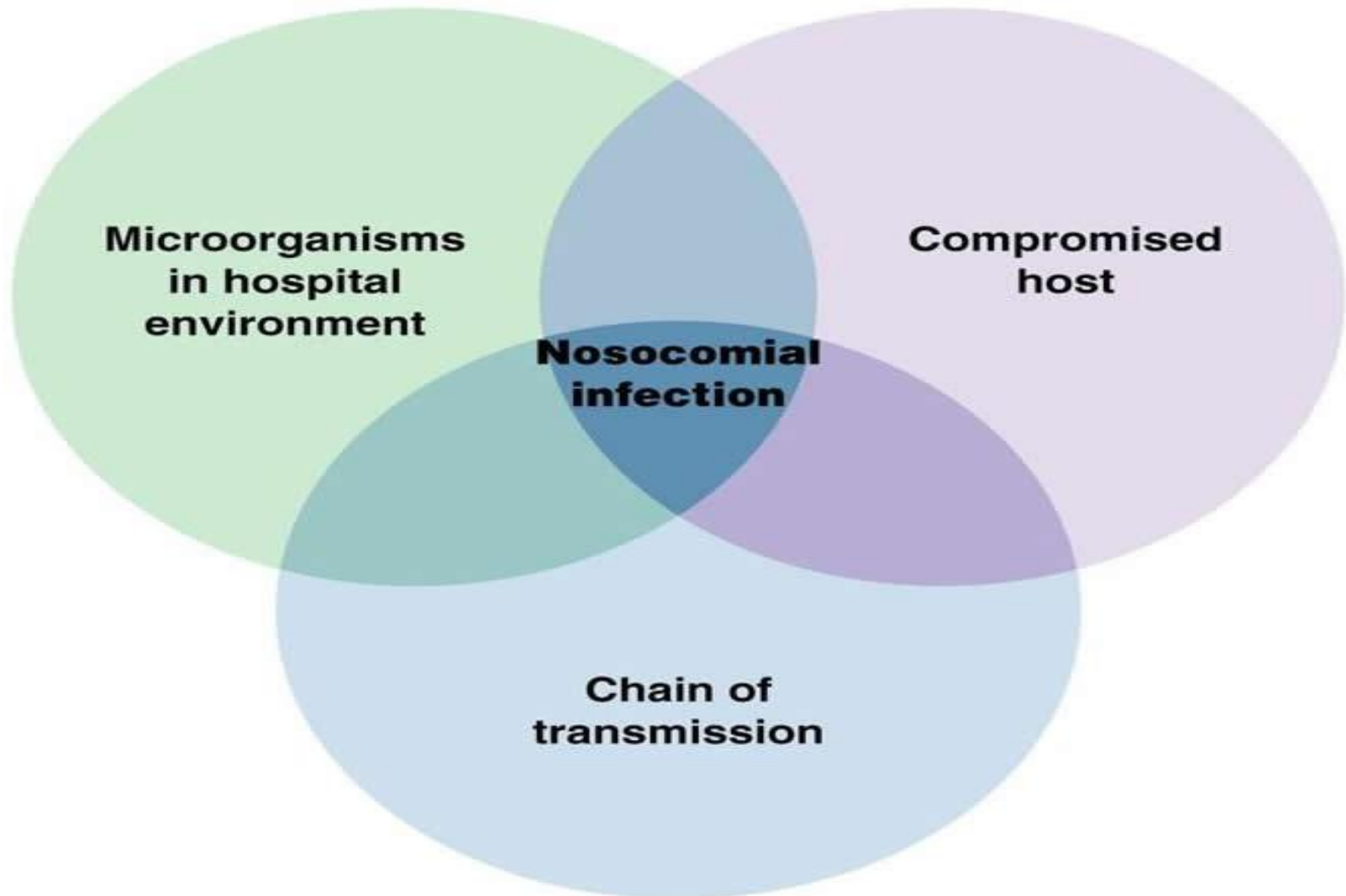
- Bacteria present in the normal flora cause infection because of transmission to sites outside the natural habitat (urinary tract), damage to tissue (wound) or inappropriate antibiotic therapy that allows overgrowth. For example, Gram-negative bacteria in the digestive tract frequently cause surgical site infections after abdominal surgery or urinary tract infection in catheterized patients.

Bacterial resistance

- Methicillin-resistant *Staphylococcus aureus* (MRSA) is a type of bacteria that is resistant to certain antibiotic. These antibiotics include methicillin, oxacillin, penicillin, and amoxicillin. MRSA was at first a healthcare-associated (nosocomial) infection, with only small numbers of community-associated cases.

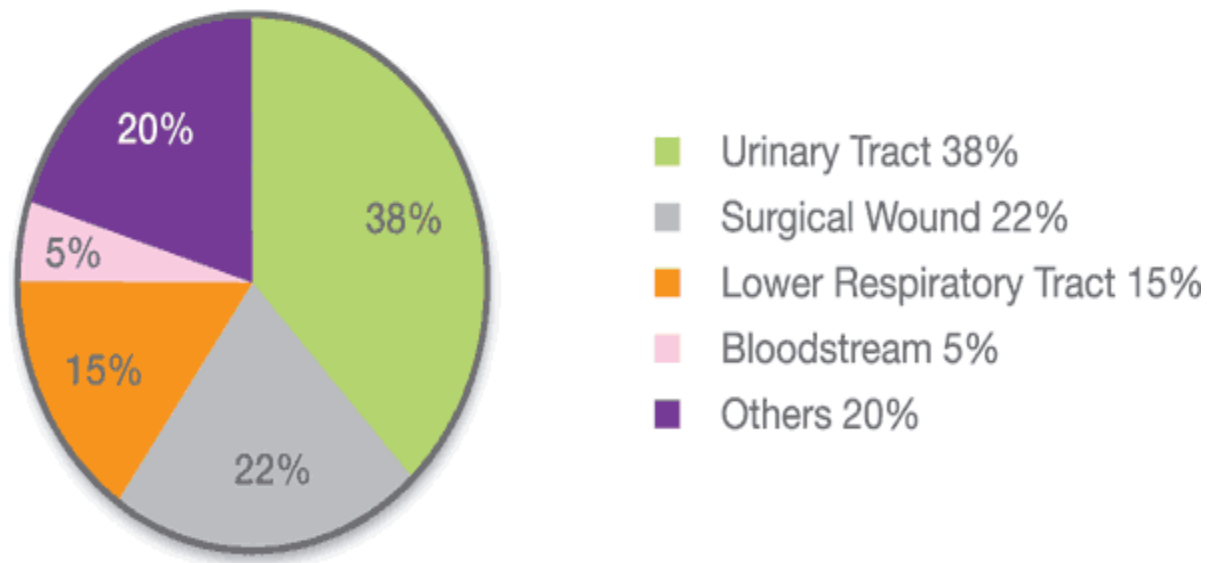


Factors influencing the development of nosocomial infections



The structure nosocomial infections

- air infections (flu, measles, pneumonia)
- urinary infections
- infections of skin, hypodermic cellular, mucous membrane
- post operation purulent inflammatory complication septical diseases
- intestinal infections (salmonella, dysentery)



Prevention of hospital infection



- 1. Specific.
 - 1.1. Planned.
 - - active
 - - passive
 - 1.2. Urgent.
- 2. Non-specific.
 - 2.1. Constructing and planning measures
 - 2.2. Sanitary and technical measures
 - 2.3. Sanitary and antiepidemic measures
 - 2.4. Disinfecting and sterilizing measures

Constructing and planning measures

- isolation of hospital units, hospital wards, operating theatre units; strict division into clean and septic patients; zoning of the hospital area; rational layout of hospital departments on floors



Infected patients must be separated from immunocompromised patients. Similarly, in a central sterilization unit or in a hospital kitchen, contaminated areas must not compromise non-contaminated areas.

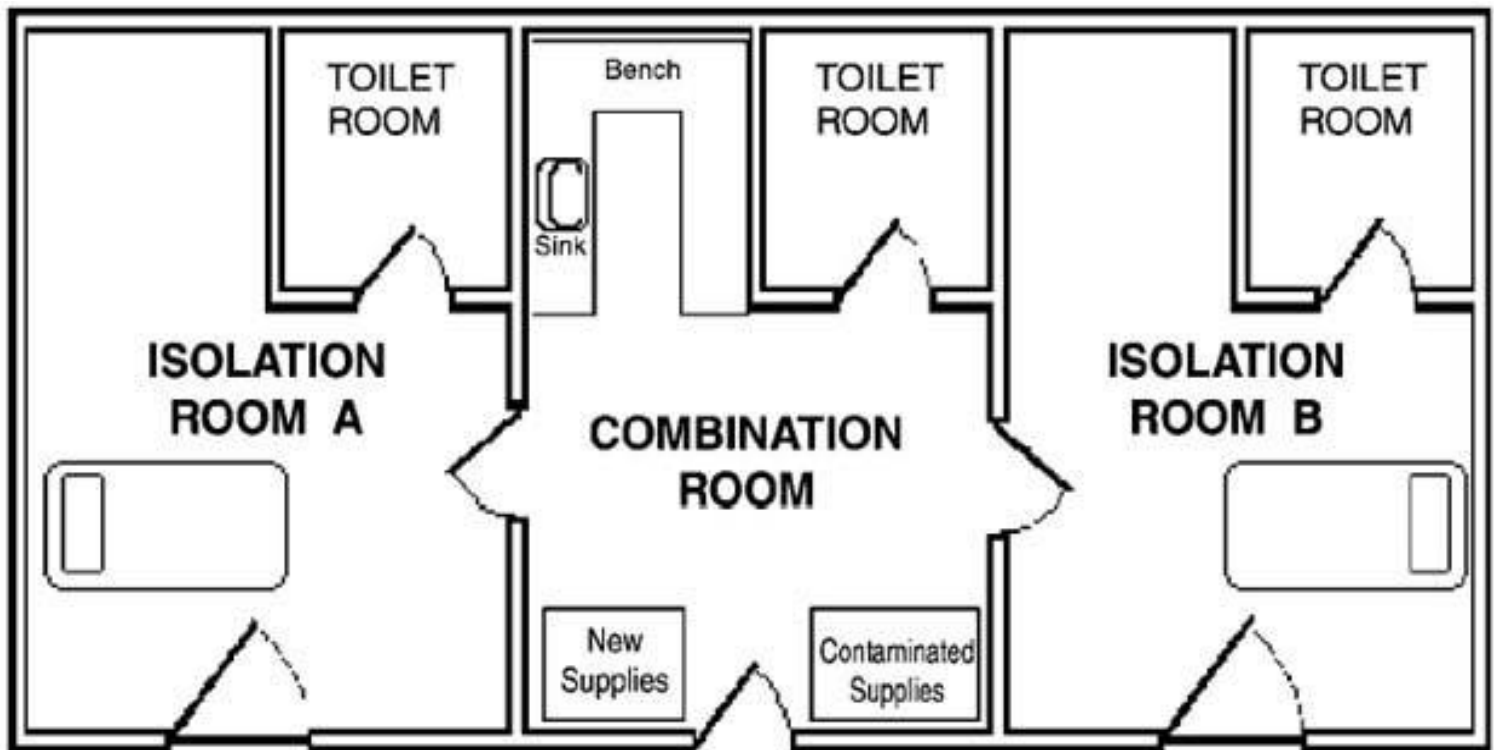


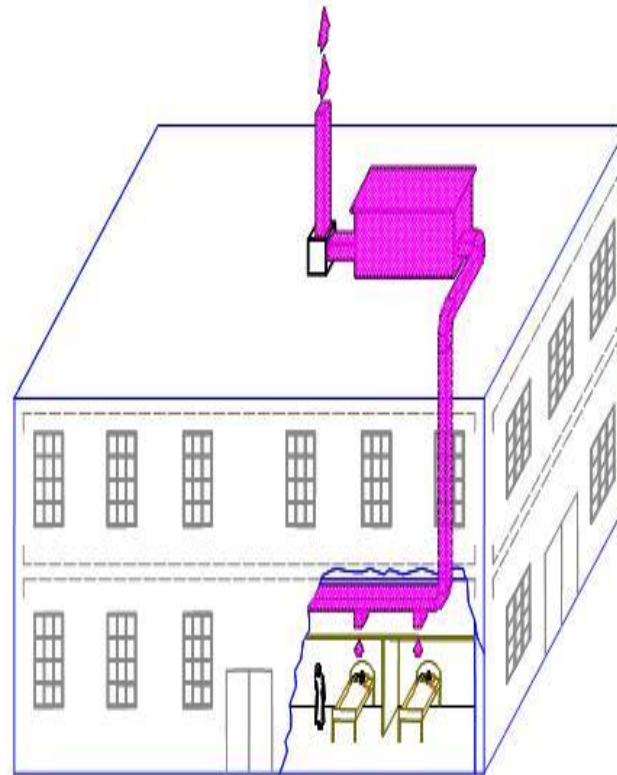
Figure 10 : Creating isolation rooms from existing patients rooms

Sanitary and technical measures

- ventilation; air supply; sanitary devices; air-conditioning



IQAir® systems with InFlow™ & Outflow™ adaptors for the creation of pressure differentials to isolate airborne microorganisms.



Exogenous cross-infection

- Bacteria are transmitted between patients:
- through direct contact between patients (hands, saliva droplets or other body fluids)
- in the air (droplets or dust contaminated by a patient's bacteria)
- via staff contaminated through patient care (hands, clothes, nose and throat) who become transient or permanent carriers, subsequently transmitting bacteria
- to other patients by direct contact during via objects contaminated by the patient (including equipment), the staff's hands, visitors
- or other environmental sources (e.g. water, other fluids, food).



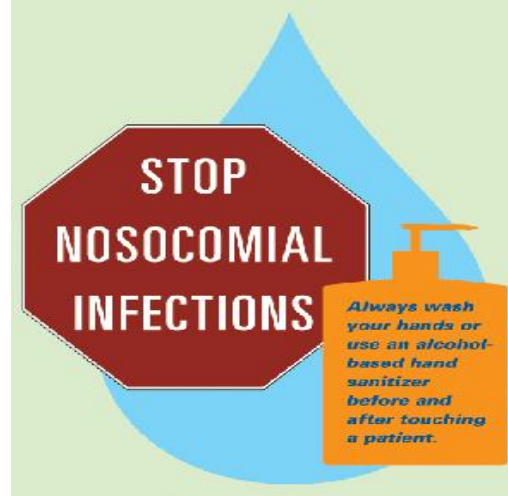
Sanitary and antiepidemic measures

- control over the sanitary conditions in hospital; sanitary and educational work among the medical staff and the patients; the revealing of the carriers among the medical staff and the patients (through bacteriological and daily examinations), control over the bacterial dissemination in the hospital environment.



Disinfecting and sterilizing measures

- physical means (mechanical processing, temperature rise: autoclaving, dry thermal or wet thermal sterilization, UV-radiation, γ -radiation)



Ultraviolet Disinfection

- **Air Sanitation by Ultraviolet Radiation**

Radiation of short wave lengths are more powerful in controlling airborne microorganisms.

Ultraviolet radiation has a wavelength range of 210-328 nm. The maximum microbicidal effect of UV light is considered to be around 260nm. This wavelength is also the peak absorption wavelength for DNA.

