LECTURE No. 2: GLOBAL CLIMATE CHANGE AS A CHALLENGE FOR PUBLIC HEALTH. ENVIRONMENTAL ASPECTS OF MEDICAL ACTIVITY. MEDICAL WASTE, ENERGY CONSUMPTION, WATER USE. PRINCIPLES OF THE "GREEN HOSPITAL"

Duration: 2 academic hours (90 minutes)

INTRODUCTION

Dear students!

In the previous lecture, we talked about the fact that the healthcare sector itself is a source of greenhouse gas emissions and that a physician can contribute to solving this problem. Today we will look at the problem from the other side: how climate change affects the health of your patients. We discussed how climate change affects public health and why physicians must understand this connection. Today we move on to the **practical side of the issue**: what exactly in the activities of a healthcare organization creates an environmental burden and how this burden can be reduced.

The World Health Organization calls climate change **the greatest threat to global health in the 21st century**. Studies show that 3.6 billion people already live in areas exposed to climate risks. It is estimated that between 2030 and 2050, climate change will cause approximately **250,000 additional deaths per year** from malnutrition, malaria, diarrhea, and heat stress alone.

For a physician of any specialty, this means that climate factors are becoming an integral part of the clinical picture. Today we will examine:

1. What pathways of climate impact on health exist?
2. What are climate-sensitive diseases?
3. How does the principle of "climate justice" affect your practice?
4. What adaptation strategies can healthcare offer?

1. PATHWAYS OF CLIMATE CHANGE IMPACT ON HUMAN HEALTH

Climate change affects health both directly and indirectly.

Direct pathways of impact

Extreme weather events cause direct harm to health:

Type of impact	Examples of consequences
Heatwaves	Heat stroke, dehydration, exacerbation of cardiovascular diseases
Floods	Drowning, injuries, wound infection
Storms and hurricanes	Injuries, fractures, psychological trauma

Elderly people over 65 and infants are especially vulnerable.

Indirect pathways of impact

Indirect effects are mediated by changes in ecosystems and social systems:

1. Changes in the spread of infectious diseases

Rising temperatures expand the habitats of vectors. For example, warmer seas have increased the coastal zone suitable for the spread of vibrios (Vibrio) by 329 km each year since 1982, putting 1.4 billion people at risk.

2. Deterioration of air quality

Climate change can increase the mobility of air pollutants, exacerbating respiratory and cardiovascular diseases.

3. Threats to food and water security

In 2021, due to droughts and heatwaves, 127 million more people experienced moderate or severe food insecurity compared to 1981-2010 levels. Two billion people lack access to safe drinking water.

4. Mental disorders

Associated with population displacement, loss of housing and livelihood, and social disorganization.

2. CLIMATE-SENSITIVE DISEASES

Diseases whose frequency, severity, or geographic distribution are affected by climate factors. These include:

Cardiovascular diseases

- Extreme heat increases the load on the cardiovascular system
- Air pollution (PM 2.5) provokes heart attacks and strokes
- Temperature fluctuations cause jumps in blood pressure

Respiratory diseases

- Bronchial asthma (worsened by allergens, air pollution)
- COPD (exacerbations against the background of pollution and extreme weather)
- Respiratory infections (increased contagiousness in conditions of crowding after disasters)

Infectious diseases

- **Vector-borne:** malaria, dengue fever, Japanese encephalitis, hantavirus
- **Intestinal infections:** salmonellosis, campylobacteriosis
- **Zoonoses:** spread of pathogens from animals to humans

Mental disorders

- Post-traumatic stress disorder (after disasters)
- Anxiety disorders (ecological anxiety)
- Depression (loss of housing, livelihood)

Kidney diseases

- Dehydration against the background of heat

- Formation of kidney stones

3. VULNERABLE POPULATION GROUPS

The burden of climate change is distributed unevenly. Vulnerability is determined not only by exposure to a climate factor but also by the ability to adapt.

Vulnerability factors

1. **Demographic:** children, elderly, pregnant women
2. **Social:** low income, social isolation, lack of access to medical care
3. **Housing:** poor housing quality, its instability
4. **Territorial:** residence in regions with high exposure to climate threats
5. **Health:** presence of chronic diseases, disability

In regions exposed to climate risks, the mortality rate from extreme weather events is 15 times higher than in more protected ones.

Climate Justice

Countries with low and middle income contribute minimally to global emissions but bear a disproportionately heavy burden of climate consequences. This creates an **ethical imperative** for physicians: when planning preventive measures, to take into account the social determinants of health and the availability of resources for vulnerable groups.

4. ADAPTATION OF THE HEALTHCARE SYSTEM

Adaptation is actions that adjust practices, processes, and structures to reduce the negative consequences of climate change.

At the level of a healthcare organization

1. **Risk assessment:** every healthcare organization must assess which climate threats are most relevant to it (heat, floods, air pollution)
2. **Continuity planning:** plans for operation during power outages, disruption of supply chains, staff shortages
3. **Early warning systems:** for example, heatwave warning systems for patients from risk groups
4. **Personnel training:** physicians must be able to recognize and treat conditions related to climate impacts and counsel patients

At the level of medical practice

1. **Screening for climate vulnerability** — integration of climate risk assessment into standard history taking
2. **Informed counseling** — recommendations for patients with chronic diseases during periods of heat or air pollution
3. **Preventive focus** — using "teachable moments" to discuss healthy lifestyle and environmental aspects of health

Climate-adapted solutions

There is no universal adaptation model — interventions must be locally adapted and oriented toward specific vulnerable groups.

5. EXPERIENCE OF THE KYRGYZ REPUBLIC: THE LINK BETWEEN CLIMATE, ECOLOGY, AND HEALTH

The Kyrgyz Republic faces climate challenges typical of the Central Asian region. Studies conducted within the framework of the "One Health" approach show that climate change poses a serious threat to public health, especially in rural communities where animal husbandry is the basis of existence.

The situation with medical waste

In Kyrgyzstan, an innovative medical waste management system was developed and implemented, called the **"Naryn Model."** Its key components include:

- Mechanical devices for needle removal
- Sorting using autoclavable containers
- Waste treatment using autoclaves
- Recycling of sterilized plastic and metal parts
- Cement pits for anatomical waste

The implementation of the system showed **33% annual savings** compared to previous waste management costs. By 2015, the system covered 67.3% of all hospital beds.

Legal framework

- Government Decree No. 719 of 2019 "On the management of medical waste and mercury-containing products in healthcare organizations"
- Practical guide "Water supply, sanitation and hygiene in healthcare organizations of the Kyrgyz Republic within the framework of infection control" (June 2021)

6. THE "ONE HEALTH" CONCEPT IN THE CONTEXT OF CLIMATE

Climate change is an existential threat to the health of humans, animals, and ecosystems. The "One Health" concept offers an integrative approach:

Why is this important for a physician?

Sphere	Connection
Food safety	Climate change affects the quality and availability of food
Zoonotic infections	Changing climatic conditions expand vector habitats
Antibiotic resistance	Environmental pressure accelerates the development of resistance
Ecosystem services	Health of nature = health of humans

Practical conclusion for the physician: it is impossible to treat a patient while ignoring ecosystem changes. Prevention must take into account climate factors at the individual and population levels.

Imagine a typical 500-bed hospital. In one day it:

- Consumes as much electricity as a small residential neighborhood
- Uses enough water to fill several Olympic swimming pools per year
- Generates waste, some of which is hazardous to the environment and human health

At the same time, a hospital is a place where we treat people. How can we combine care for patients today with care for the health of future generations? The answer is through the implementation of the principles of the **"green hospital"** (Green Hospital).

Today we will examine three key aspects of the environmental footprint of a healthcare organization:

1. **Medical waste** — classification, risks, modern approaches to management
2. **Energy consumption** — who the main consumers are and how to reduce the load
3. **Water use** — where water is consumed and how to conserve it

1. MEDICAL WASTE: CLASSIFICATION, RISKS, MANAGEMENT

What is medical waste?

Medical waste is all waste generated as a result of the activities of healthcare organizations: hospitals, polyclinics, laboratories, dental offices, pharmacies, and even private medical practices.

According to estimates by the World Health Organization, approximately **75-95% of medical waste** is close in composition to ordinary household waste. It does not pose an increased danger. However, the remaining **5-25% belongs to the category of hazardous** and can cause serious consequences for human health and the environment.

Why does medical waste require special attention?

Problem No. 1: Infectious risk

Needles, scalpels, blood, patient excretions — all of this can contain pathogens. Hepatitis B, hepatitis C, HIV infection — these viruses can persist in the external environment and pose a real threat to personnel involved in disposal.

Practical example from practice:

In the 2000s, an outbreak of hepatitis B among children was recorded in one of the countries of Southeast Asia. The investigation showed that the cause was the use of non-sterile needles that had been removed from garbage containers and resold. This is a tragic example of how improper waste management can cause an epidemic.

Problem No. 2: Chemical and pharmaceutical risk

Expired medications, chemical reagents, disinfectants, mercury from broken thermometers — all of this, when improperly disposed of, enters the soil and water. Especially dangerous are:

- **Antibiotics** — contribute to the development of antibiotic resistance in the environment
- **Cytostatics** (anticancer drugs) — mutagenic and carcinogenic
- **Heavy metals** (mercury, cadmium, lead) — accumulate in food chains

Problem No. 3: Environmental footprint

Incineration of medical waste (incineration) releases dioxins and furans — highly toxic compounds that belong to persistent organic pollutants. They accumulate in adipose tissue, affect the reproductive system, and can cause cancer.

Classification of medical waste in the Kyrgyz Republic

In Kyrgyzstan, a classification based on WHO recommendations is in force. Waste is divided into several classes:

Class	Name	Characteristics	Examples
Class A	Non-hazardous waste	Close to household, does not pose an epidemiological hazard	Food waste, packaging, paper, office supplies
Class B	Hazardous waste	Infected or potentially infected	Used needles, scalpels, dressing material with blood, biological fluids
Class C	Extremely hazardous waste	Contact with particularly dangerous infections	Waste from patients with quarantine infections (plague, cholera, especially dangerous viral fevers)
Class D	Toxicologically hazardous waste	Contain chemical substances, medications, mercury	Expired medications, disinfectants, broken thermometers
Class E	Radioactive waste	Contain radionuclides	Waste from nuclear medicine, radiation therapy

Important clarification for practice:

Mixing waste of different classes is strictly prohibited! If hazardous waste (Class B) gets into a common container with non-hazardous (Class A), the entire volume automatically becomes hazardous. This increases the cost of disposal and creates additional risks.

Modern approaches to medical waste management

Traditional approach (outdated)

- Mixed collection of all waste → Incineration → Landfilling of ash

Disadvantages:

- High dioxin emissions
- Loss of resources (nothing is recycled)
- High cost of incineration

Modern approach (integrated)

Separate collection → Treatment (depending on class) → Recycling/Safe disposal

Stages of modern management:

1. **Separate collection at the source** — color codes for containers (red — hazardous, yellow — infectious, black — non-hazardous)
2. **On-site treatment** — autoclaving, microwave treatment, chemical disinfection
3. **Transportation** — special containers preventing leakage and damage
4. **Final disposal** — recycling (plastic becomes raw material for new products), safe disposal or incineration in specialized installations with high temperature (for pharmaceutical waste)

The "Naryn Model" — experience of Kyrgyzstan

In the Kyrgyz Republic, an innovative medical waste management system was developed and implemented, called the **"Naryn Model."**

Key components of the system:

1. **Needle removal devices** — mechanical devices that allow safe separation of the needle from the syringe, excluding contact of personnel with the sharp part. Needles are collected in a special hermetic container that cannot be punctured.
2. **Sorting in autoclavable containers** — special containers that can be loaded into the autoclave for sterilization without transferring waste. This reduces the risk of contact with infected material.
3. **Treatment in autoclaves** — steam sterilization under pressure at a temperature of 121-134°C. After autoclaving, infectious waste loses its danger.
4. **Recycling of sterilized materials** — after autoclaving, plastic and metals can be recycled. For example, sterilized plastic can be used to produce construction materials or household items (not in contact with food).
5. **Cement pits for anatomical waste** — for safe burial of biological tissues and organs. They are filled with cement, which prevents contact with groundwater and animals.

Results of implementation:

A study published in 2015 showed that the implementation of the system led to **33% annual savings** compared to previous waste management costs. By 2015, the system covered 67.3% of all hospital beds in the country.

Why is this important for a physician?

Every medical worker must know how to properly sort waste at their workplace. This is not "additional paperwork" — it is a direct responsibility on which the safety of patients, personnel, and society depends.

Recommendations for practice

What a physician should do at their workplace:

1. Immediately after use, sort waste into the correct containers
2. Place used needles in protective containers without recapping (the most common cause of personnel injuries!)
3. Do not overfill containers — fill no more than ¾

4. Report any violations in the waste management system to management
5. By personal example, show colleagues the importance of proper disposal

2. ENERGY CONSUMPTION IN HEALTHCARE ORGANIZATIONS

Who are the main energy consumers in a hospital?

Healthcare organizations are among the most energy-intensive buildings. According to research data, hospitals consume 2 to 3 times more energy per square meter than ordinary office buildings.

Main consumers:

Consumer	Share of total energy consumption	Why so much?
Ventilation and air conditioning systems (HVAC)	30-40%	Need to maintain air cleanliness, temperature, humidity in operating rooms, intensive care units, laboratories
Lighting	15-20%	Round-the-clock operation, high lighting requirements (especially in operating rooms)
Medical equipment	15-20%	MRI, CT, X-ray units, laboratory equipment
Sterilization	5-10%	Autoclaves operate at high temperature and pressure
Elevators and escalators	3-5%	Especially in multi-story inpatient facilities
Other	10-15%	Power supply, computers, household appliances for personnel

Why is energy consumption in medicine not just about money?

1. Environmental aspect

In Kyrgyzstan, a significant part of electricity is generated by hydroelectric power plants. But in winter, when rivers become shallow, the country imports coal electricity from neighboring states. Coal combustion is one of the main sources of greenhouse gas emissions and pollution with fine particles (PM 2.5).

A figure for reflection:

A 10% reduction in a hospital's energy consumption can reduce its carbon footprint by hundreds of tons of CO_2 equivalent per year.

2. Economic aspect

In conditions of a healthcare budget deficit, every saved unit of energy is money that can be directed to medications, equipment, or staff salaries.

3. Reliability aspect

Energy-saving measures are often accompanied by modernization of systems, which increases their reliability. Under conditions of unstable energy supply, this is critically important for the operation of life-support medical equipment.

Practical examples of energy saving

Example 1: Replacing lighting with LED

In a 400-bed hospital, fluorescent lamps were replaced with LED. Electricity savings amounted to 40% of what was previously spent on lighting. Payback period — 2 years. Additional bonus: LED lamps do not contain mercury, which simplifies their disposal.

Mechanism:

- Fluorescent lamp 36 W → LED lamp 18 W
- With 24-hour operation, the savings amount to 18 W × 24 hours × 365 days = 157.7 kWh per year per lamp
- For 1000 lamps, the savings amount to 157.7 MWh per year

Example 2: HVAC control automation

Ventilation and air conditioning systems in hospitals operate around the clock, but the intensity can vary. Installation of motion and CO_2 sensors allows automatic reduction of ventilation power at night and on weekends, when the number of personnel and patients is lower.

Mechanism:

- Daytime: 100% power
- Night (23:00-06:00): 60% power
- Savings: up to 25% of HVAC costs

Example 3: Heat recovery

Hospitals constantly operate equipment that generates heat (autoclaves, equipment cooling systems). Installation of heat exchangers allows using this heat to heat water or heat rooms.

Mechanism:

- The autoclave releases hot steam during operation
- The heat exchanger takes the heat and transfers it to the hot water supply system
- Savings on water heating — up to 30%

Energy audit as a basis for action

An energy audit is a systematic analysis of an organization's energy consumption that allows identifying the points of greatest losses and developing a plan of measures.

Stages of an energy audit:

1. **Data collection** — taking meter readings for the year, analyzing bills for electricity, heat, water
2. **Survey** — inspection of buildings, equipment, heating, ventilation systems

3. **Identification of loss points** — poor thermal insulation, outdated equipment, inefficient lamps
4. **Development of recommendations** — what to change, in what order, with calculation of savings and payback

What a physician can do without an energy audit:

- Turn off lights in rooms where no one is present
- Turn off the computer and monitor at night (instead of sleep mode)
- Close windows when the air conditioner is running
- Report malfunctions in heating/cooling systems to management

3. WATER USE IN HEALTHCARE ORGANIZATIONS

Where does water go in a hospital?

Healthcare organizations are among the largest water consumers in the public sector. Water is consumed for:

Purpose	Share of total water consumption	Comment
Domestic and household needs	40-50%	Showers, toilets, cleaning of premises
Medical procedures	15-20%	Sterilization, preparation of solutions, dialysis
Laundry	15-20%	Hospital linen is washed daily at high temperatures
Equipment cooling systems	10-15%	MRI, CT, X-ray units
Laboratories	5-10%	Tests, preparation of reagents, washing of equipment

Water footprint of medical activity

A water footprint is the volume of fresh water used to produce goods or provide services throughout the entire life cycle.

For medicine, this is important because:

- Water is used not only in the hospital itself but also at all stages of the production of medications, disposable products, equipment
- Contaminated hospital wastewater contains chemicals, antibiotics, pathogens that are difficult to remove by conventional treatment methods

Practical example:

The production of one set of surgical gloves requires more than 100 liters of water (from growing rubber trees to processing latex and packaging).

The problem of wastewater from healthcare organizations

Hospital wastewater contains a wide range of pollutants:

1. **Biological:** pathogenic bacteria, viruses, helminth eggs
2. **Chemical:** medications (antibiotics, hormones, cytostatics), disinfectants, heavy metals
3. **Radioactive:** when working with radioactive isotopes

A particular problem is posed by **micropollutants** — pharmaceutical substances in ultra-low concentrations (ng/L - μg/L). Conventional treatment facilities are not designed to remove them.

Mechanism of action:

Antibiotics in wastewater, even in low concentrations, contribute to the development of bacterial resistance in the natural environment. This creates reservoirs of antibiotic resistance genes in the environment that can be transferred to pathogenic bacteria.

Principles of water conservation in a "green hospital"

1. Metering and monitoring

Installation of water meters at all inlets and in departments — the basis for understanding where water is consumed the most.

2. Water-saving plumbing

- Aerators on taps — reduce water consumption by 30-40% without loss of pressure
- Dual-flush toilets — allow choosing the flush volume
- Contactless mixers — eliminate water losses during hand washing

3. Equipment with low water consumption

- Washing machines with economical washing cycles
- Autoclaves with water recirculation
- Cooling systems with a closed loop

4. Rainwater collection

For technical needs (irrigation, flushing), rainwater can be used. This reduces the load on city water supply systems.

5. Reuse

Water used for cooling equipment can be reused in the cooling system after treatment.

Example from practice

A hospital in the Netherlands:

In a large university hospital, a closed-cycle water supply system was introduced:

- Wastewater undergoes membrane treatment
- Treated water is used for cooling equipment and flushing toilets

- Fresh water savings — 40%
- Payback period of the system — 5 years

4. PRINCIPLES OF THE "GREEN HOSPITAL"

What is a "green hospital"?

A **"green hospital"** is a healthcare organization that minimizes the negative impact on the environment while ensuring high quality of medical care and the safety of patients and personnel.

A "green hospital" is not a separate building, but a **systemic approach** covering all aspects of activity.

The four pillars of a "green hospital"

1. Sustainable design and construction

- Use of environmentally friendly materials
- Natural lighting
- Effective thermal insulation
- "Green" roofs (with plants) to reduce thermal load

2. Resource efficiency

- Energy saving
- Water saving
- Waste reduction

3. Quality of the internal environment

- Clean air (filtration, CO_2 control)
- Natural lighting
- Acoustic comfort (noise reduction)
- Use of non-toxic cleaning agents and paints

4. Innovation and personnel involvement

- Introduction of new technologies
- Personnel training
- Participation of patients in "green" initiatives

Principles of a "green hospital" in everyday practice

Principle	What it means in practice	Example
Minimization of waste	Reduction of the number of disposable products where it is safe	Transition to reusable textile surgical caps instead of disposable ones

Eco-friendly procurement	Choice of goods with a smaller environmental footprint	Purchase of cleaning agents without chlorine and phosphates
Sustainable nutrition	Rational menu taking into account the environmental footprint of products	Increasing the share of plant products, reducing food waste
"Green" transport	Encouraging active and eco-friendly transport	Bicycle parking for employees, telemedicine for patients
Climate adaptation	Readiness for climate threats	Plans for heat, floods, power outages

Why is a "green hospital" also a safe hospital?

Studies show that the principles of "green" design improve not only environmental indicators but also clinical outcomes:

- **Natural lighting** accelerates recovery, reduces depression levels in patients, reduces the number of personnel errors
- **Clean air** with proper humidity reduces the risk of nosocomial infections
- **Noise reduction** improves patients' sleep, which positively affects wound healing

Key idea:

Environmental sustainability and quality of medical care are not a contradiction, but complementary goals.

5. WHAT CAN A PHYSICIAN DO TODAY?

Minimum set of actions at the workplace

1. **Sort waste.** Know the color coding of containers and strictly follow it.
2. **Save water.** Do not leave the tap open while washing hands (use contactless mixers or close the tap while lathering).
3. **Save energy.** Turn off monitors, computers, equipment when not in use. Use natural lighting where possible.
4. **Use consumables carefully.** Do not open packages "just in case," use them only for their intended purpose.
5. **Report to management.** If you see problems: leaking taps, non-working automation, overflowing waste containers — report them.

How a physician can influence at the system level

1. **Participation in "green procurement."** When choosing medications and consumables, consider not only the price but also the environmental footprint.
2. **Climate-informed counseling.** Tell patients about the connection between their lifestyle, health, and the state of the environment.
3. **Research work.** Participate in projects to assess the environmental footprint of medical interventions (for example, compare disposable and reusable approaches).

4. **Mentoring.** Train junior medical personnel in the rules of waste sorting and resource conservation.

CONCLUSION

Key conclusions of the lecture

1. **Climate change is a medical diagnosis.** It affects cardiovascular, respiratory, infectious, and mental diseases.
2. **The pathways of impact are diverse.** From direct (heat, floods) to indirect (changes in vectors, air quality, food security).
3. **Vulnerability is uneven.** Social determinants of health determine the ability to adapt.
4. **Adaptation of healthcare systems is necessary.** There is no single model — local solutions are needed.
5. **The physician plays a key role.** Vulnerability screening, climate-informed counseling, participation in adaptation strategies.

QUESTIONS FOR REFLECTION

1. **Medical waste is a problem not only hygienic but also environmental.** Proper sorting at the source is the basis of safe management.
2. **Energy consumption of hospitals is a serious challenge.** Even simple measures (LED lamps, HVAC automation, heat recovery) can bring significant environmental and economic effect.
3. **Water is a valuable resource.** Hospital wastewater contains pollutants that are difficult to remove. Water conservation is everyone's responsibility.
4. **"Green hospital" = safe hospital.** The principles of environmental sustainability do not contradict the quality of medical care but complement it.
5. **Every physician can contribute.** Knowledge, attention to detail, and personal example are the three pillars on which the environmental culture in a healthcare organization is built.
6. **Why are social determinants of health more important than the climate factor for assessing a patient's vulnerability?** Because it is they that determine the ability to avoid exposure and get help.
7. **Which climate-sensitive diseases are most relevant for Kyrgyzstan?** (Think about air pollution in winter, water infections, zoonoses in rural areas, heat in cities).
8. **How can a physician integrate the principle of "climate justice" into their daily practice?** (By taking into account the patient's social status when planning prevention, educational work, participation in public health).
9. **Why does mixing waste of different classes make the entire volume hazardous?** (Because it is impossible to guarantee safety during subsequent treatment, and the cost of disposal increases many times over).
10. **What do you think is the largest source of energy consumption in a typical hospital in Kyrgyzstan? Why?** (Most likely, HVAC — due to the need to maintain temperature

conditions in cold winters with poor thermal insulation of buildings of Soviet construction).

11. **Why are antibiotics in wastewater a problem for public health?** (They create reservoirs of antibiotic resistance in the natural environment, from where resistance genes can be transferred to pathogenic bacteria).

12. **Can a physician influence the environmental sustainability of a hospital without holding a managerial position?** (Yes, through personal example, training colleagues, participation in initiative groups, informing management about problems).

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