| | | |
|---|---|---|
| | Федеральное государственное бюджетное образовательное учреждение<br>высшего образования<br>«Волгоградский государственный медицинский университет» Министерства здравоохранения Российской Федерации<br>Образовательная программа<br>специальности 31.05.01 Лечебное дело (специалитет) | УЧЕБНО-МЕТОДИЧЕСКИЙ КОМПЛЕКС ДИСЦИПЛИНЫ<br><br>«ГИГИЕНА» |

# ТЕМА:
# « HYGIENIC EVALUATION OF THE INDOOR MICROCLIMATE ITS EFFECT ON A PERSON'S HEAT EXCHANGE AND HEALTH CONDITION (part 1,2)»

Methodical recommendations to the lesson
for students in the specialty 31.05.01 "General Medicine"

г. Волгоград, 2020 г.

### *The motivational description of the theme*

Today people spend a lot of time indoors (e.g. at home, work, hospital, etc). The indoor environment is characterized by a variety of factors affecting the human body. They are as follows: lighting, insolation, chemical composition of the air, ionization of the air, noise, etc.

At our practical classes we shall discuss in detail the physical properties of the air such as the temperature of the air and that of the surfaces, air humidity and air velocity. A certain combination of factors makes what we call a microclimate.

Microclimatic factors influence the human body creating certain conditions for heat exchange between a person and the environment. The functional state of a person is referred to as a thermal state. The thermal state of a person accounts for high work capacity and productivity, temperature sensitivity and the general well-being.

The doctor should be able to evaluate the quality of the microclimate and to predict possible changes in the thermal state and health of a person under the impact of the microclimate, catarrhal diseases or complicated chronic inflammatory processes.

**The objective**: to master the techniques of evaluating the indoor microclimate, to learn to perform hygienic evaluation of their integrated effect on people.

### Students' classroom activities

1. Evaluating the quality of the microclimate in a room.
2. Evaluating the thermal state of the body
3. Case problem (type 1, type 2).
4. Presenting and discussing individual students' reports.

### Self-study task

1. The notion of a microclimate. Factors shaping it. Classification of the factors.
2. Hygienic requirements imposed on the microclimate of private and public facilities (e.g. rooms, gyms, wards, etc.) & the documents regulating these requirements.
3. Human thermal homeostasis & thermoregulation. Chemical and physical thermoregulation.
4. Types of thermal states of a person. Physiological indicators of the thermal state of a person.
5. Measures preventing overheating and overcooling.

### Plan of students' independent activities

1. Hygienic evaluation of the microclimate in a room at the Hygiene and Ecology Department.

1.1. Calculating the average temperature of the air and vertical and horizontal temperature gradient.

Measurements are made at three points (at the interior wall, in the centre and at the outer wall of a classroom) at a level of 1.5 and 0.15 m; the arithmetic mean of six temperature values as well as their vertical and horizontal gradients are calculated.
1.2. Determining relative air humidity using an aspirated psychrometer.
1.3. Determining air velocity using a globe katathermometer.
2. Evaluation of a thermal state of a student staying in microclimatic conditions of a certain classroom.
2.1. Measuring skin temperatures (forehead, chest, hand) using an electric thermometer.
2.2. Checking the pulse rate using a standard technique.
2.3. Checking the respiratory rhythm using a standard technique.
2.4. Evaluation of thermal sensations using a seven-point scale (see Reference Information on the theme).
3. Making a conclusion:
state the type of microclimate in a classroom, evaluate a thermal state of the students in this classroom; make a prognosis of their working capacity, health and well-being; if necessary, give recommendations for correcting microclimatic parameters.

## Reference information

*Term descriptions*

MICROCLIMATE is a thermal state of spatially restricted environment conditioned by a variety of physical factors such as the temperature of the air, air humidity, air velocity, radiant heat, etc. which affects heat exchange.
THERMAL STATE is a functional state of a person exposed to certain microclimatic factors.
THERMAL COMFORT is well-being of a person in certain microclimatic conditions that produce the optimal functional state of the body.

### Principles of hygienic standardization of microclimatic parameters in living and public locations.

1. Hygienic rating of the optimal and permissible microclimatic parameters should consider the circadian and seasonal dynamics of the variation of physiological functions as well as people's adjustment to various climatic conditions.

2. Hygienic rating of microclimatic parameters should be different for different age groups of people.

3. When rating the optimal parameters of a microclimate one should consider the level of energy expenditure (physical activities of people staying inside a building) and the level of heat retention properties of the clothes of the corresponding groups of the population.

4. Hygienic rating of microclimatic parameters of health-care settings should also consider the types of diseases treated in a setting and the nature of treatments and procedures performed by the medical staff.

Heating and ventilation systems must create acceptable conditions of the microclimate and indoor air environment. Heating systems must produce even heating of the indoor air over the heating season without making scents, polluting the indoor air with harmful substances emitted while they are in operation. Nor they must make any additional noise. Heating systems must be accessible for servicing and repair.

The difference between the indoor air temperature and that of the wall surfaces should not exceed 3 C°; the difference between the indoor air temperature and that of the floor should not exceed 2 C°.

When hot-water heating is in use, the temperature of the heaters' surfaces should not exceed 90 C°. For the heaters whose surface temperature is over 75 C° protective covers should be fixed.

There are special documents regulating the standard parameters of the microclimate in residential and public buildings, in educational establishments and patient care settings.

Table 1

**Permissible microclimatic parameters on living premises**

| Room type | Temperature of the air, C° | Relative air humidity, % | Air velocity, mps м/с |
|---|---|---|---|
| Cold season | | | |
| Living room | 18-24 | 60 | 0,2 |
| Kitchen, toilet, bathroom | 18-26 | No accepted values | 0,2 |
| Hall connecting flats | 16-22 | 60 | 0,2 |
| Lobby, staircase | 14-20 | No accepted values | 0,3 |
| Warm season | | | |
| Living room | 20-28 | 65 | 0,3 |

Table 2

**Parameters of microclimate in medical settings.**

| Microclimatic parameters | Permissible values |
|---|---|
| *Temperature of the air, C°:* | |
| Hospital wards for adults | 20-26 |
| Intensive care unit | 21-24 |
| Operating room | 21-24 |
| *Relative air humidity, %* | 30-60 |
| *Air velocity, m/s, no more than* | 0,2 |

Table 3

**The temperature of the air in educational settings**

| Room | Temperature of the air, C° |
|---|---|
| Classrooms, psychologist's and speech | 18-24 |

| | |
|---|---|
| therapist's offices, laboratories, school hall, dining hall, rest rooms, library, lobby, cloakroom (depending on climactic conditions) | |
| Gymnasium, rooms for tutorials, workshops | 17-20 |
| Bedroom, game rooms, premises of pre-school educational institutions and boarding schools | 20-24 |
| Doctor's office, cloak-rooms in the gymnasium | 20-22 |
| Shower room | 25 |

In general education institutions the relative air humidity should make 40-60%, the air velocity – no more than 0.1 mps.

Table 4

**Time recommended for cross ventilation of educational setiings depending on the temperature of outdoor air**

| Outdoor temperature, C° | Ventilation time, min. | |
|---|---|---|
| | During a short class break | During a long class break or between shifts |
| From +10 to +6 | 4-10 | 25-35 |
| From +10 to 0 | 3-7 | 20-30 |
| From 0 to – 5 | 2-5 | 15-20 |
| From -5 to -10 | 1-3 | 10-15 |
| Below -10 | 1-1.5 | 5-10 |

Table 5

**Indicators of the microclimate in pre-school establishments**

| Room | Temperature of the air, C° in a certain climatic region | | Relative air humidity, % |
|---|---|---|---|
| | 1st climatic region | 2nd climatic region | |
| A creche room | 23 | 22 | 30-60 |
| A nursery room for different age groups | 22 | 20 | 30-60 |

## Types of a microclimate

*Term descriptions*

AN OPTIMAL MICROCLIMATE is referred to as the conditions of the indoor environment in which the person of a certain age, health condition, etc. feels thermal comfort.

PERMISSIBLE MICROCLIMATE is referred to as the conditions of the indoor environment which can cause some changes in the functional and thermal state of a person.

HEATING MICROCLIMATE is referred to as the conditions of the indoor environment which can cause physiological changes and sometimes result in the development of pathological conditions and diseases (overheating, heat stroke).
COOLING MICROCLIMATE is referred to as the conditions of the indoor environment which can cause overcooling and pathological conditions and diseases associated with it.
Two types of a microclimate can be recognized according to the way of heat release:

- convectional;
- radiant.

**Classification of human thermal states**

*An optimal state* is characterized by the absence of generalized and/or localized uncomfortable thermal sensations, minimal activation of thermoregulatory mechanisms. It is a prerequisite of sustained high working capacity.
*A permissible state* is characterized by insignificant generalized and/or localized uncomfortable thermal sensations, maintenance of thermal stability of a person for the whole working day and involves moderate activation of thermoregulatory mechanisms. A temporary decline in working capacity may occur but it does not impair a person's health.
*A maximum permissible state* is characterized by pronounced generalized and/or localized uncomfortable thermal sensations; it cannot ensure that thermal homeostasis and health are maintained, restricts working capacity.
*An impermissible state* is characterized by excessive activation of thermoregulatory mechanisms which results in impaired health.
Activation of thermoregulatory mechanisms is the activation of responses of various systems of the body aiming to maintain temperature homeostasis. When these responses are evaluated their intensity is considered.
The following **indicators** can be used **to evaluate a thermal state of a person.**

- body temperature;
- topography of skin temperatures;
- temperature gradient of trunk and limb skin;
- water loss value;
- thermal sensations;
- heart rate.

Some other indicators appropriate for a particular situation can be used to fulfill the objectives of a certain study.

Table 6

**Some indices of the optimal thermal state for different levels of energy expenditure**

| Indices | At rest | At work | | |
|---|---|---|---|---|
| | | Easy | Medium | Hard |
| Body temperature, $C^o$. | 36.5-37.2 | 36.7-37.4 | 36.9-37.6 | 37.0-37.8 |
| Temperature gradient of trunk and limb skin | 2-4 | 2-4 | Not typical | |

| | | | | |
|---|---|---|---|---|
| Thermal sensations | 4 | 4 | 4 | 4 |
| Heart rate | Up to 80 | 80-90 | 90-100 | 100-120 |

**Thermal sensations** (generalized and localized) are evaluated according a 7-point scale): cold – 1; cool/chilly – 2; mild cool –3; comfortable – 4; mild warm – 5; warm – 6; hot – 7.

**Appendix**

## Air humidity measurement technique

The relative air humidity can be measured with an Assman psychrometer. A psychrometer consists of two thermometers, notably, a mercury thermometer and an alcoholometer. The reservoir of one of the thermometers is covered with a cloth which is moistened with distilled water. As water vaporizes, the reservoir of the thermometer is cooled. The difference between the temperatures of the dry and moist thermometers is used to evaluate the air humidity, as vaporization depends on the content of water vapors in the air. The reservoirs of the thermometers in the Assaman psychrometer are protected from radiant heat with metallic shields. There are ventilation channels around the reservoirs through which the air passes. To estimate the air humidity, the thermometer covered with the cloth should be moistened with distilled water. It is necessary to start the ventilator and place the thermometer at a designated point. The readings of the dry and moist thermometers should be recorded for 4 – 5 min after the ventilator is launched. The relative air humidity is estimated using psychrometric tables.

## Air velocity measurement technique

If the air velocity is lower than 0. 5 m/s, it can be estimated with the help of a bulb katathermometer. The katathermometer is heated in a glass of hot water above 40 C$^{o}$. It should be dried then and let stay for some minutes. It is noteworthy that the temperature necessary for the katathermometer to cool is from 40 C$^{o}$ to 33 C$^{o}$. Air cooling capacity (per 1 sec.) can be calculated using the following equation:

$$\mathbf{H = F/3 \cdot (40-33) / T},$$

where F is the readings of the katathermometer scale.

To take into account the fact how the cooling of the device depends on the air temperature, one should calculate:

$Q = 36.5^{o} - t^{o}$,

where 36. 5 is the middle point on the katathermometer scale;

$t^{o}$ is the temperature of the air at the given point.

H/Q should be calculated first and according to Table 1, the air velocity at the given point should be determined.

Table 7

***Air velocity (V) at various temperatures of the air***

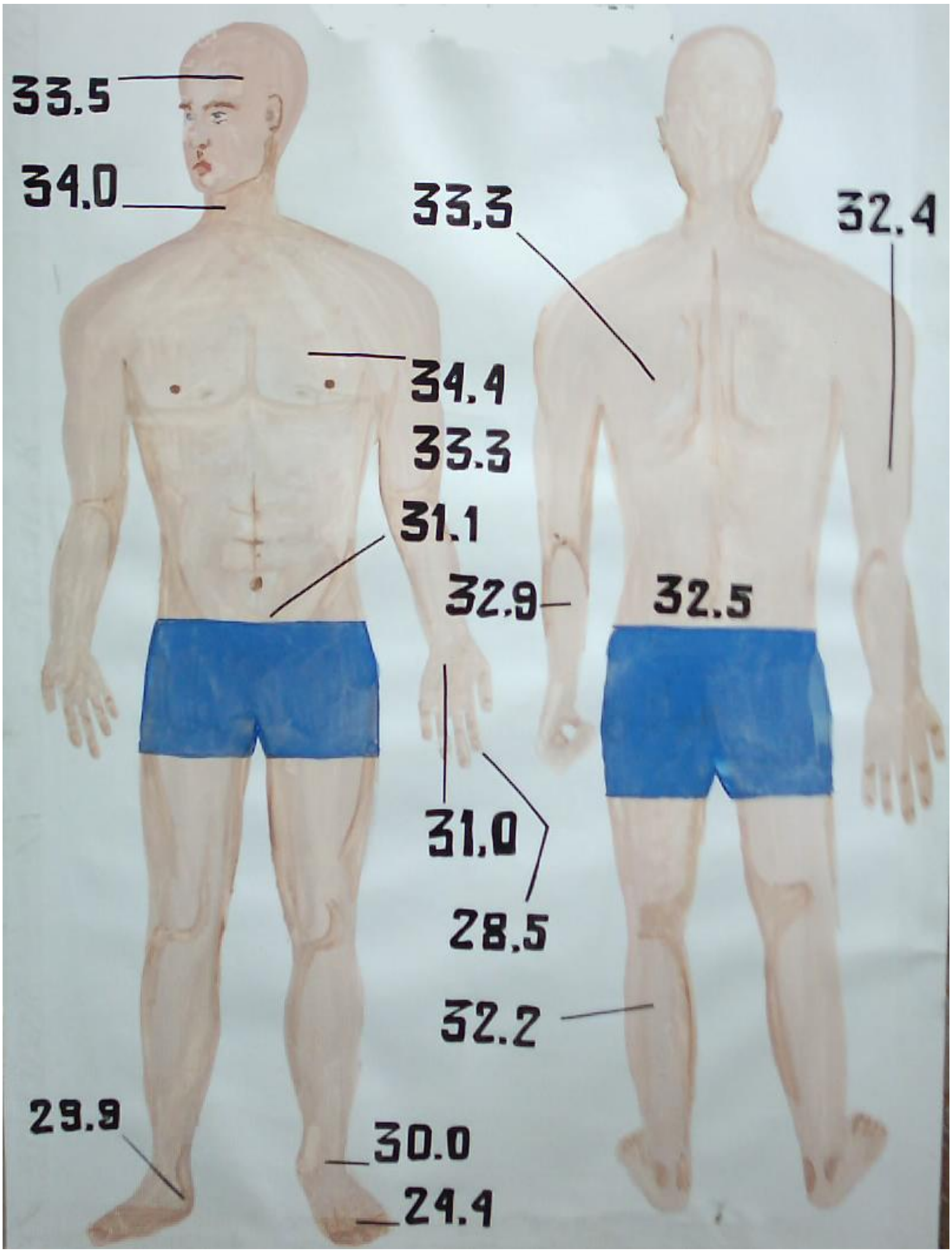
| H/Q | Temperature | | | |
|---|---|---|---|---|

| | of the air, C ° | | | |
|---|---|---|---|---|
| | 17.05 | 20.0 | 22.5 | 25.0 |
| 0.27 | - | 0.041 | 0.047 | 0.051 |
| 0.28 | 0.049 | 0.051 | 0.061 | 0.070 |
| 0.29 | 0.060 | 0.067 | 0.076 | 0.085 |
| 0.30 | 0.073 | 0.082 | 0.091 | 0.101 |
| 0.31 | 0.088 | 0.098 | 0.107 | 0.116 |
| 0.32 | 0.104 | 0.113 | 0.124 | 0.136 |
| 0.33 | 0.119 | 0.128 | 0.140 | 0.153 |
| 0.34 | 0.139 | 0.148 | 0.160 | 0.174 |
| 0.35 | 0.154 | 0.167 | 0.180 | 0.196 |
| 0.36 | 0.179 | 0.192 | 0.206 | 0.220 |
| 0.37 | 0.198 | 0.212 | 0.226 | 0.240 |
| 0.38 | 0.222 | 0.239 | 0.249 | 0.266 |
| 0.39 | 0.244 | 0.257 | 0.274 | 0.293 |
| 0.40 | 0.269 | 0.287 | 0.305 | 0.323 |
| 0.41 | 0.299 | 0.314 | 0.330 | 0.349 |
| 0.42 | 0.325 | 0.343 | 0.363 | 0.379 |
| 0.43 | 0.356 | 0.373 | 0.392 | 0.410 |
| 0.44 | 0.485 | 0.401 | 0.417 | 0.445 |
| 0.45 | 0.412 | 0.429 | 0.449 | 0.471 |

### Measurement of air temperature

Two thermometers should be placed on a stand. The first should be placed 1.5 m above the floor and the second – 0.20 m above the floor. It is necessary to measure the temperature of the air at three main points, notably, at the external wall, in the centre of the room and at the internal wall. On the basis of the difference in the temperatures at different points, the horizontal temperature gradient should be calculated. On the basis of the difference in the readings of the "upper" and "lower" thermometers, the vertical temperature gradient should be calculated.

## Topography of a person's skin temperature




Pic.1