

PRACA POGLĄDOWA
REVIEW ARTICLE

CRITERIA OF ECONOMIC EFFECTIVENESS OF PREVENTIVE MEASURES OF CHRONIC NON-INFECTIOUS DISEASES

ПРЕВЕНЦІЙНИХ МАЖУЧЫХ НА ЦЕЛУ ЗАПОБІГАННЯ ПРЗЕВЛЕКЇМ ХРОБОМ НЕЗАКАЖНИМ

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ABSTRACT

Introduction: Today, Ukraine is among the five largest European countries in terms of population, ranking fifth after Germany, Great Britain, France and Italy. Over the past decades, the number of people in Ukraine has been decreasing, mainly due to the excess of deaths over births. The high mortality rate in Ukraine is burdened by the fact that it concerns people of working age - the standardized mortality rate of the working-age population is 2.4 times higher than that of the EU countries and 1.5 times the average in Europe.

The aim of this article was to determine the rationale for the economic effectiveness of the prevention of chronic non-communicable diseases and criteria for calculating the economic forecast.

Materials and methods: The research was conducted with the help of theoretical and statistical methods, by studying scientific sources and systematic analysis and generalization of the experience of finding economic efficiency of preventive measures of chronic diseases.

Review and conclusions: The analysis of the considered methods of economic evaluation of the prevention and treatment of chronic non-infectious diseases made it possible to draw the following conclusions that the effectiveness of the health care system and individual health care facilities should be considered in a complex manner from the point of view of medical, social and economic efficiency. Economic efficiency, as a rule, is the result of medical and social efficiency. When calculating the cost-effectiveness of treatment and prevention measures, the whole complex of losses and costs associated with illnesses should be taken into account, in particular: direct costs directly related to prevention and treatment; Indirect losses associated with the illness, due to the unprocessed part of the gross domestic product, paid by sick leave. The task of the economic substantiation of medical and preventive measures is to calculate the necessary volume of material and technical and financial resources, as well as their effective use.

KEY WORDS: economic efficiency, medical efficiency, social efficiency, chronic noninfectious diseases, risk factors, quality of medical and diagnostic work

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INTRODUCTION

Currently, Ukraine is among the five largest European countries in terms of population, ranking fifth after Germany, Great Britain, France and Italy. However, over the past decades, the number of people in Ukraine has been decreasing. During 2009-2013, this trend has slowed down somewhat - according to the State Statistics Service of Ukraine, over the years, the population of the country has decreased by 0.9 million people and amounted to (at the beginning of 2014) 45.426 million people. Reducing the number is mainly due to excess mortality over births. The prognostic indicators showed that the trend of increasing the mortality rate in Ukraine up to 17% in 2015 is preserved [1]. This is confirmed. In 2015, 411.8 thousand children were born in Ukraine (excluding Crimea and Sevastopol); died - 594,8 thousand people. As of August 1, 2017, 42.584 million people lived in Ukraine (without taking into account the temporarily occupied Crimean peninsula). During January-July 2017, the population decreased by 128.5 thousand people. Mortality continues to exceed birth rate - 61

deaths per 100 dead. There is a negative trend. The high mortality rate in Ukraine is burdened by the fact that it concerns people of working age - the standardized mortality rate of the working-age population is 2.4 times higher than that of the EU countries and 1.5 times the average in Europe [2]. Unsatisfactory demographic condition is complicated by low birth rates, high prevalence of chronic non-communicable diseases, low life expectancy at birth (66.12 years for men and 76.03 years for women - according to 2013) [3, 4]. In the last five years in Ukraine, there is a decrease in the level of primary morbidity - by 4.85%, while the prevalence rate of illnesses in this period grew somewhat - to 185 462.7 per 100 000 population. Thus, the problem of the accumulation of chronic pathology among all age groups remains group population of Ukraine. The structure of primary morbidity is formed mainly by diseases of the respiratory system, blood circulation, trauma, poisoning and some other consequences of external factors, diseases of the genitourinary system, diseases of the skin and subcutaneous tissue [3, 4]. The leading positions in the formation of the struc-

Table I. Social losses due to arterial hypertension and its complications

| Countries | Number of people | | Years of lost life | | Years with disability to work | |
|------------------------|------------------|------|--------------------|-----|-------------------------------|-----|
| | Thousands | % | Thousands | % | Thousands | % |
| All countries | 2918 | 5,8 | 17665 | 1,9 | 19076 | 4,7 |
| Economically developed | 1405,7 | 12,9 | 6911 | 8,1 | 7577 | 4,7 |
| Developing countries | 1512,3 | 3,8 | 10754 | 1,3 | 11499 | 0,9 |

ture of the prevalence of diseases are diseases of the circulatory system, organs respiration, digestive organs, genitourinary system, musculoskeletal system and connective tissue [5].

THE AIM

To substantiate the economic efficiency of the prevention of chronic non-infectious diseases and to determine the criteria for calculating the economic forecast.

MATERIALS AND METHODS

The research was conducted using theoretical and statistical methods, by studying and analyzing the experience of finding economic effectiveness of preventive measures for chronic diseases.

REVIEW AND DISCUSSION

In the countries of Europe in the first decade of the XXI century there have been changes in the indicators of public health. On the one hand, there are significant achievements: prolonging the average life expectancy, reducing mortality from a number of causes, reducing the prevalence of certain risk factors, and improving some socio-economic determinants. On the other hand, many countries face new challenges and threats to public health related to demographic changes, changes in the prevailing type of pathology from infectious to non-infectious (due to the use of antibiotics), increased manifestations of unhealthy lifestyle, inequalities in health and his protection between the population of individual countries, as well as between its separate strata within countries.

In 2011, the United Nations announced the epidemic of WHO in the world. By 2030, the WHO predicts an increase in deaths from no communicable diseases to 52 million per year. Chronic non-infectious diseases include diseases of the circulatory system, malignant neoplasms, chronic obstructive pulmonary diseases, diabetes mellitus and other diseases. Up to 60% of the adult and almost 20% of the children's population suffer from chronic pathology. Chronic non-communicable diseases (HNVD) cause global socio-economic losses of the population of many countries of the world, including Ukraine. It is they who determine 82.8% of the total mortality of the entire population of our country and 62.4% - the mortality of the working-age population.

Non-communicable diseases (NCDs), such as cardiovascular diseases, cancer, chronic obstructive pulmonary disease (COPD), and mental ill health are a major burden for the economy and health of the population of many countries, including Ukrainians.

For example, the data on the research of I. Tsanko's research, which social losses due to hypertension in the comparative aspect among the economically developed countries and developing countries, are presented in (Table I).

For the diagnosis and treatment of chronic non-infectious diseases (NIZ), a large amount of money is spent annually both by the state and patients and their relatives. Complications due to NCDs that are causing death or disability increase this percentage at a time and lead to significant economic losses from the state.

For example, the data based on the research of I. I. Tsanko, which social losses due to hypertension in the comparative aspect among the economically developed countries and developing countries, are presented in table I [6].

The first place among the NIZ is arterial hypertension. Both the pathology itself and its complications - hypertensive crisis, stroke, and heart attack require significant economic efforts for treatment. According to many studies (Babajanova A., 2013, Kislyak O. A., 2009, Morozova T. E., 2010), low indicators of controlled hypertension are found out in ambulatory conditions, within 7-15%. As a result, the high frequency of hospitalization due to complications of hypertension and the growth of economic costs of treatment. One of the main causes of uncontrolled hypertension is the irregular ingestion of anti-hypertensive. It is clear that with an increase in the frequency of admissions increases the economic performance.

Arterial hypertension among civil servants (DS) ranks first in the structure of the prevalence of circulatory system diseases (CHC) and is the leading cause of complications such as stroke and myocardial infarction, hypertensive crisis.

One of the most common risk factors for hypertension is obesity. The relationship between the increase in total blood cholesterol and mortality in patients with hypertension is proved [7, 8]. Many cross-examination studies have established a positive correlation between elevated blood pressure (AD) and body weight, which is also confirmed by the Fermichhem study among people aged 20-39 who have had excess body weight. In them, the frequency of hypertension was 2 times higher, between the same age group with normal height and weight [9, 10].

The world experience in the fight against hypertension confirms the ability to significantly reduce morbidity, disability and mortality of the population from the main complications of hypertension - a heart attack and stroke. Thus, the implementation of special preventive programs "South Korea" led to a reduction in mortality from these diseases by 2-3 times [11].

Annual inspection of the entire population of the country was introduced in 1983 in the former USSR. At that time, in

developed countries, the economic costs (male) from diseases of the circulatory system at the age of 65 reached from 42% to 86% of the total cost of all diseases. In the prevalence, the first place was AG, which was detected in 23% of those surveyed in the age group from 30 to 54 years old, with a disease of about 57% of patients. The struggle with hypertension was considered a medical and social problem and a priority task of prevention of cardiovascular diseases [12].

Today, the medical world regards obesity as a medical-social disease, due to the increasing prevalence of the disease among the population in all age groups in all countries of the world, increased complications, decreased ability to work, reduction and deterioration of quality of life, increased costs of treatment both the disease itself and its complications.

The socio-economic problem is the prevalence of obesity in children. So, childhood obesity is associated with the risk of developing cardiovascular diseases, diabetes mellitus, diseases of the musculoskeletal system, mental disorders. In terms of prevention, both obesity and its complications, it is important that in most cases, obesity as a disease begins its birth in childhood [13].

Among obese patients in Ukraine, the share of children is 20% - given that four out of five children remain obese in adulthood, the importance of the socio-economic direction of the prevention of this disease and its complications becomes clear. Unfortunately, we have an increase in the incidence of the disease over the last five years, especially at the age of 15-17 years. Although, according to scientists, this figure is underestimated, as official statistics are different from the results of population surveys in Europe and the world [13]. As the authors point out, general practitioners are well aware of the problem of overweight and obesity in children ($95.7 \pm 2.1\%$). In addition, physicians are most often associated with obesity in adults and children with diabetes mellitus ($84.8 \pm 3, 7\%$), diseases of the circulatory system ($77,2 \pm 4,4\%$), endocrine diseases ($25,0 \pm 4,5\%$), diseases of the spine ($23,9 \pm 4,4\%$), diseases of the joints ($15 \pm 3,7\%$), diseases of the digestive system ($8.7 \pm 2,9\%$). Modern data confirm that deep metabolic disorders lead to the development of the above-mentioned complications. By the complications of obesity can be added infertility, fatty hepatose, hyperuricemia, malignant tumors, apnea during sleep. However, from an economic point of view, the prevention of excess body weight in childhood, which subsequently becomes a disease of obesity, is not costly. The obesity prevention strategy is based on the introduction of a healthy lifestyle (sufficient physical activity and dietary nutrition). Drug treatment is only possible in the presence of concomitant diseases. All of the foregoing confirms that from the point of view of the clinical economy, the correct strategy and the programs used to prevent obesity and its complications, will certainly give a significant economic effect. According to the authors among children with obesity 11.2% has myopia, 8.8% acquired flat-rate, 2.4% of diseases of the digestive system, 13.6% - disorders of the autonomic nervous system, which increase in adolescence three times [13]. Children with obesity are at risk for developing complications. So the probability of development of myopia in them is higher in 2 times, flattened in 4 times, spasticity of the sphincter of Oddi in 13 times, disorders of the autonomic nervous system in 3 times.

The need for redistribution of funds towards the direction of increasing the investment of primary health care (PHC) to the basis of general practice - family medicine, where a large percentage will be taken by the preventive work was indicated (Shayman I.M. 1998; Alwan A., Horhby V. 2002; Milewa T.; Calnan, 2000).

The inefficiency of paying the actual amount of medical care in comparison with the payment of the planned volumes of certain types to be determined on the basis of the order of medical services was highlighted by (Liaropoulos L.L., 2001; Trefa G.O. 2002; Lekhan V.M., 2003; Rudy V.M., 2004). Scientists (Novikov V., 2002, Kutsenko V.I., 2002, Ruden V.V., 2003) consider one of the important issues in the reform of the medical sector - the issue of remuneration of medical workers. The tasks to which attention should be paid in principle, as mentioned by (Moskalenko V.E., 2002; Lekhan V.M., 2003, 2005; Rudy V.M., 2003, 2004), are strengthening of the material and technical basis of PMD on the principles of practice of family medicine, the formation of independence and economic independence of the general practitioner-family doctor, the creation of a system of motivation of medical personnel of the institutions of general practice-family medicine to intensive and high-quality work, the effective use of financial, material and human resources and of course, need to be added for the organizations to be investing in preventive actions.

On the efficiency of using limited resources in the medical sector, as one of the main tasks, is indicated at the disposal of the Cabinet of Ministers of Ukraine from 23.06.2010. No. 1724 "A prosperous society, a competitive economy, an effective state." But to date, despite the limited funding of the health sector, the issue of rational use of funds remains unresolved. The attempt of the Ministry of Health of Ukraine (reform of 2017) to reallocate funds to the primary health care costs does not solve the issue of ensuring the treatment of NCDs and their complications. In this regard, the high level of relevance of the problem remains. Although medical reform will begin with changes in the financing of primary health care, the issue of financing preventive measures to prevent the growth of NCDs is also not resolved. There is no clear understanding of the financing of preventive measures and in the concept of health care financing reform, which was approved by the CMU Order No. 1013 of 30.11.2016.

Unfortunately, neither in the main Law of Ukraine № 2801 of 19.11.1992. "Fundamentals of the Ukrainian legislation on health care (hereinafter referred to as the Law No. 2801), neither in the amendments to the Law No. 2801 adopted in 2012, nor, the orders of the Ministry of Health of Ukraine of 28.09.2012. No. 752 "On the Procedure for Quality Control of Medical Aid" and No. 454 of 01.08.2011. "On approval of the concept of quality management of medical care in the field of health care of Ukraine for the period up to 2020" there are no legal mechanisms indicated on which it is possible to apply the "clinical audit" referred to in them which could determine the level of quality (Zharlinskaya R.G., 2017 .)

Given that Ukraine is moving towards market relations in the health sector, indicators are needed to determine the quality of health services and the cost-effectiveness of health services. According to Art. 3 of the Law of Ukraine No. 2801, the activities of physicians should be aimed at prevention. And

there are no effective mechanisms that ensure the economic processes of this movement and which provide the economic result of this work today. Currently, the bodies that carries out the quality control of medical care, are identified clinic expert commissions and medical councils of health care institutions which carry out a selective quality control of medical care (Senyuta I., 2017). But in these bodies there is no examination of preventive measures, either medical, social, or economic. Moreover, the Law of Ukraine "On State Financial Guarantees for the Provision of Medical Services and Medicines" provides for the creation of a single customer for medical services as an additional central body, but there is no list and scope of medical care. If the basic, necessary types of medical care and medical services exist on the territory of Ukraine, that is because this was historically, although there is no state order, preventive measures or planned programs. According to the law, preventive work at the primary level is not economically viable. At the same time, it is proved by (Moskalenko V.F., 2008, Shulyak V.I., 2010) that investing in the development of preventive medicine not only significantly affects the improvement of public health, but also brings a significant economic effect for state as a whole.

An attempt to determine the cost of screening and treatment of NCDs in Ukraine is based on the standards of medical care. Scientists [9, 14] provided data where the cardiology pathology was calculated from the point of view of laboratory and diagnostic examination and treatment of arterial hypertension (AG). Minimum, average and maximum therapies were defined, however, poor outpatient outcomes were shown due to lack of funds. 48% stopped treatment, therefore, increasing the risk of complications

The main goal and direction in the work of doctors is to achieve a medical effect. This vector concerns both the diagnostic and therapeutic process and preventive actions. The effectiveness of health care is a criterion for achieving specific results. [15] The medical effect as a component of public health actively influences the welfare of the whole society. After all, an increase in healthy workers and reduced sick leave payments increases the national income of the state.

Each activity requires some investment. If we consider the healthcare sector as a system for which a certain amount of money is spent by the state, then the economic efficiency of [EE] activity of the health care system, as stated by Kotuzo A.S. with co-authors, the difference between the economic effect and the spent costs. However, the authors believe that the price of the medical program is not the money spent on it, but the medical care that could be provided for the same money, using them more rationally [15]. Continuing this view, one can assume that the price of prevention programs in cash equivalent is the money that would be spent in the treatment of the complications of chronic non-infectious pathology. During the prophylaxis of diseases, the percentage of complications decreases, therefore, funds which are conditionally released, can potentially be used more rationally.

But the concept of the effectiveness of medical care can not be expressed only in monetary terms - having only an economic component. A social component must also be present. And even when there are costs that far exceed the economic effect, with a positive social effect, we can talk about a positive performance indicator.

In the aspect of prevention, the effectiveness of action in healthcare can be expressed in preventing future costs of treatment, the development of infectious diseases, both ordinary and especially dangerous, on the social security of pensioners with disabilities, as well as in increasing the percentage of healthy people, who can work and lead the growth in national income.

When trying to analyze the effectiveness of health care it is evident that it has three components: social, medical and economic efficiency. This relationship can not be torn, since each component may, under certain conditions, be a priority.

According to Ukrainian scientists, the medical effectiveness of health care is a measure of achievement of the set tasks. Social efficiency of healthcare - can be measured by the satisfaction of medical care and return to work and active life - at the patient level. At the industry level - an increase in the life expectancy of the population, a decrease in the level of indicators of mortality and disability, etc. The social effect is measured by indicators such as the level of morbidity of the population, average life expectancy, the mortality rate (especially children's), the number of disabled and prematurely dead. Indicators of social efficiency do not refer to each individual patient (as may be the case for indicators of medical efficiency), but to certain groups of the population.

The magnitude of the social effect of individual treatment and prevention measures can be determined by the formula:

$$E_c = A_0 t_n - (A_1 + A_2 + \dots + A_n),$$

where E_c - the magnitude of the social effect, expressed in the reduction of the number of diseases for a certain period of time;
 A_0 - number of diseases in the base period (before medical and preventive measures);

A_1, A_2, \dots, A_n - number of diseases for each period of medical and preventive measures;

t_n - number of periods of medical and preventive measures.

Economic efficiency of health care is the reduction of economic losses from high morbidity, disability and mortality. Its calculation is always associated with the search for the most economical use of available resources. At the same time, economic efficiency always complements social and medical ones, as the last two are more important in the society.

As a rule, in most cases, social and medical efficiency is accompanied by economic efficiency. In some cases, medical and preventive measures, having medical and social efficiency, are deprived of economic benefits. These may be expensive new treatments that save and prolong the lives of the elderly, but do not justify themselves from an economic point of view. The economic substantiation of medical and preventive measures does not require a compulsory positive economic effect in the presence of medical and social efficiency. The task is to calculate the required volume of material, technical and financial resources, as well as their effective use.

The calculation of economic efficiency of medical and preventive measures can be determined by the formula:

$$E_e = P_1 - P_2,$$

where E_e - the economic efficiency of medical and preventive measures in hryvnas;

P_1 - losses from morbidity, mortality, disability, etc. during the period preceding the current (base period).

P_2 - losses from morbidity, mortality, disability, etc. during the period of medical and preventive measures (current period).

The coefficient of economic efficiency, which determines the amount of savings per unit of expenditure, is calculated by the formula:

$$K_e = \frac{P_1 - P_2}{P_{m,pr}}$$

where K_e – the coefficient of economic efficiency;

$P_{m,pr}$ - funds spent on medical and preventive measures.

The method of calculation of economic efficiency is based on the cost of types of medical care, sanitary and epidemiological services, and on the value of the damage caused by diseases, complications, etc.

The economic effect can be direct - when we have a decrease in price for a particular measure, or indirectly - which is a consequence of the medical and social effect, that is, the result of prevention and treatment. In any case, the economic effect is the difference between the economic damage before the use of medical measures and after. The economic effect can be factual - it's what you got, after the evaluation of the results, and expected – it's what is calculated during planning.

During the calculating of the economic effect, the following indicators are distinguished: [15]

1. The indicator of the economic effect as a result of reducing the incidence of temporary disability (the incidence of working population).

2. Economic effect as a result of reduction of terms of treatment of the entire population.

3. The economic effect of reducing disability.

4. Estimated economic effect of saving the life of a person of working age.

The scientist Kotuzo A.S. with co-authors suggests to calculate the economic efficiency (EE) with the help of the formula:

$$EE = \frac{\text{Economic effect}}{\text{economic losses associated with the medical program}}$$

Medical effectiveness (ME) with the help of the formula:

$$ME = \frac{\text{Number of cases of achieved medical results}}{\text{Number of assessed cases}}$$

Social effectiveness (CE) with the help of the formula:

$$CE = \frac{\text{Number of patients satisfied with medical assistance}}{\text{The number of evaluated cases}}$$

According to the standard (ME), (CE) to which health care providers should seek, 1 is proposed. Criteria, also, are the average indicator for the LPU, and the department; or the dynamics of this indicator in a particular physician, department, LPU.

At the same time, it should be noted that the economic effect couldn't be determined immediately. It may occur after some time. In addition, it is possible to determine economic efficiency only when it is possible to measure the outcome of the measure in health care. Therefore, certain indicators should be used. It must be remembered that the health of both man and nation is influenced not only by health care in the country, but also by the level of growth of national profits, the accumulation of national wealth.

In determining the economic effect of reducing morbidity and mortality, one should remember that not only doctors could influence these processes. 30% falls on the level of material and cultural life of the population, as well as on the safe working conditions.

Estimates of the economic effectiveness of medical and preventive measures are indicative, since they are based on average data and assumptions. To determine the economic effectiveness of medical and prevention measures for the prevention of chronic non-communicable diseases, it is necessary to calculate the losses from morbidity, mortality, disability, etc. in the basic and current periods.

Total losses due to these reasons are calculated by the formula:

$$P_{gen.} = P_{spen.} + P_{m,pr.} + P_c$$

where $P_{gen.}$ - total losses due to morbidity, disability, mortality, etc.;

$P_{spen.}$ - financial losses in manufacturing as a result of loss of working time due to morbidity, disability, mortality in working age and as a result unprocessed production;

$P_{m,pr.}$ - expenses for treatment and prevention of the diseases;

P_c - expenses for sick leave payments.

Industrial losses for the working population occupy the largest proportion of all disease-related illnesses and are calculated by the formula:

$$P_{spen.} = D \times L$$

where D - the cost of products produced in the enterprise or in the economics, in general, one worker within one working day.
 L - total number of days of disability.

Costs for treatment consist of the cost of treatment in the clinic and in the hospital:

$$P_{m,pr.} = P_{th} + P_{tc}$$

where P_{th} - the cost of treatment in hospital;

P_{tc} - the cost of treatment in the clinic.

Three main indicators characterize the cost of treating patients in a hospital:

- the average cost of a bed in a year;
- the average cost of one bed-day;
- the average cost of treatment of one patient.

Indicators of cost of treatment in a hospital are calculated by the formulas:

Average cost of one bed per year:

$$P_b = \frac{P_{th}}{P_{av,b}}$$

where P_b – average cost of one bed per year;
 P_{th} – the sum of all hospital costs per year;
 $K_{av,b}$ – average number of beds.

Average cost per bed day:

$$P_{b/d} = \frac{P_{th}}{I}$$

where $P_{b/d}$ – the average cost of one bed-day;
 I – the number of bed-days spent by patients in a year.

Average cost of treatment for one patient:

$$P_p = \frac{P_{th}}{N}$$

where P_p – average cost of treatment of one patient in a hospital;
 N – the number of treated patients per year.

The cost of bedding in hospitals and the cost of bed-day depend on the profile and capacity of the hospital. Usually, this cost is higher in powerful and highly specialized hospitals. The average cost of treatment for one patient depends on the cost of one bed-day and the duration of treatment, which is determined by the patient's condition and the level of medical care provided.

Three main indicators determine the cost of outpatient-poly-clinic treatment:

- the average cost of maintaining one hospital post;
- the average cost of one visit at the clinic and at home;
- expenses per one inhabitant of the district of the clinical service.

Indicators of the cost of outpatient-polyclinic treatment are calculated according to the formulas:

The average cost of maintaining one hospital post in a clinic:

$$P_{h/p} = \frac{P_{a/ex.}}{L}$$

where $P_{h/p}$ – the cost of maintaining one hospital post in the clinic;

$P_{a/ex.}$ – the total amount of expenses for a clinic for a year;
 L – the average annual number of occupied hospital posts.

Average cost per one visit to the clinic:

$$P_{visits} = \frac{P_{a.n}}{B}$$

where P_{visits} – the average cost per visit to the clinic;
 B – the total number of visits to the clinic for the year.

The average cost of medical and preventive care for one resident of the district of the clinical service:

$$P_{resid} = \frac{P_{a.n}}{P_{a.n}}$$

where P_{resid} – the average cost per inhabitant of the district of the clinical service;

$N_{a.n.r.}$ – the average number of residents in the district of the clinical service.

Expenses for payment of sick leave are determined according to the financial statements of the appropriate authority of the social insurance. The economic effect of medical and preventive measures aimed at reducing the incidence is manifested during the period in which these measures are held. The economic effect of saving a person's life during the working age or preserving a child's life as a result of the prevention of infant mortality is manifested throughout their lives. Thus, measures to reduce infant mortality and mortality in working age are more cost-effective and have a promising orientation.

The economic effect of saving a person's life in working age is determined by the formula:

$$E_{np} = k \times \frac{GNP}{N_{np}} \times t_{np} - F_c \times t_n$$

where E_{np} – economic effect of preserving the life of a person of working age;

k – coefficient taking into account the share of value added in gross national product;

GNP – gross national product;

N_{np} – number of employees in the national economy;

t_{np} – the length of the working period from the moment of life saving to retirement;

F_c – the annual amount of pensions and other social benefits per one pensioner;

t_n – average length of stay at a pension.

The medical and social indicator of disability expresses the health impact on the ability of the population.

The medical and social index of disability is the ratio of a limited number of illnesses or injuries to the number of human-years of future labor activity of a contingent population to the maximum possible number of man-years of future employment of the same population if his participation in work is not limited to the state of health

Medico-social capacity of work (Q) is calculated by the formula:

$$Q = 0,001 \times \left[(1 - g) \sum_{x=16}^{59} L_x^t (1 - q_x^m) + \sum_{x=16}^{54} L_x^t (1 - q_x^f) \right] \times \frac{(1 - H)(1 - W)}{R}$$

where g - the proportion of women among the population,

m, t - indexation by sex,

x - indexation by age

q_x - the proportion of people in the age of x , who do not participate in social production for reasons not related to health.

H - the proportion of the population whose participation in social production is limited by the disability from general and occupational diseases.

W - the proportion of the population that does not participate in social production due to the incidence of temporary disability.

Table II. Gender-age-differentiated indicators of non-participation of the population in social production for reasons not related to the state of health

| Age | Men | | | | Women | | | |
|-----------------|-------|-------|--------|---------|---------|-------|--------|--------|
| | q | 1-q | L | L(1-q) | q | -q | L | L(1-q) |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| 16-19 | 0,624 | 0,376 | 361848 | 136055 | 0,710 | 0,290 | 370266 | 107377 |
| 20-24 | 0,217 | 0,783 | 446391 | 349524 | 0,274 | 0,726 | 458215 | 332664 |
| 25-29 | 0,058 | 0,942 | 439263 | 413786 | 0,103 | 0,897 | 454459 | 407650 |
| 30-34 | 0,020 | 0,980 | 430875 | 422258 | 0,062 | 0,938 | 449138 | 421301 |
| 35-39 | 0,018 | 0,982 | 418971 | 411430 | 0,058 | 0,942 | 444071 | 418315 |
| 40-44 | 0,029 | 0,971 | 407004 | 395201 | 0,076 | 0,924 | 424246 | 392003 |
| 45-49 | 0,033 | 0,967 | 389159 | 376317 | 0,099 | 0,901 | 420985 | 379307 |
| 50-54 | 0,066 | 0,934 | 367503 | 343248 | 0,144 | 0,856 | 418158 | 357943 |
| 55-59 | 0,094 | 0,906 | 337857 | 306098 | 0,738 | 0,262 | - | - |
| $\Sigma L(1-q)$ | | | | 3159117 | 2816560 | | | |

Table III. Conditions for determining the medical and social potential of the population

| Indexes | For the previous period | For the current period |
|--|-------------------------|------------------------|
| Number of people with disabilities (<i>I</i>) | 3572 | 3463 |
| Number of working population (<i>N₁</i> , <i>N₂</i>) | 105918 | 111007 |
| Number of employees (<i>N_{p1}</i> , <i>N_{p2}</i>) | 104945 | 109311 |
| Number of days of disability (<i>M₁</i> , <i>M₂</i>) | 1074217 | 1056378 |

R - the maximum period (the number of years) of a population's participation in social production if it is not limited by illnesses and injuries.

L_x - the number of inhabitants within the five-year intervals, which is one of the calculating indicators of the tables of average life expectancy.

The calculation is made on 100 000 people.

For calculations gender-age-differentiated indicators of non-participation of the population in public production are used for reasons not related to the state of health (table II).

Using the above formula, according to the table we can determine the number of human-years of future work per 100,000 people, if it is not limited to diseases and injuries. We will assume that the work of men and women continues until the retirement age (up to 60 and 55 years respectively)

The data presented in the second column (table II) indicate the proportion of the part of the male population in each age group who, for various causes that are not related to illnesses, does not participate in the work activity. Column 3, respectively, determines the proportion of the population involved in social production. Column 4 (L statement) indicates the number of years that the population of the corresponding age group lives on the basis of 100,000 births.

The result of the product of columns 3 and 4 in each row, which is in column 5, determines the number of human-years of future employment for each age group of the male population. The sum of the fifth column is the number of man-years of future work, not limited to illnesses per 100 000 male people.

We have similar results for the female population.

In order to determine the number of human-years of future employment for 100,000 men and women together, the proportion of women and men in the population should be taken

into account. The g, q indices are independent of health, are constant and are determined by the results of the census.

The number of years of efficiency for men is 44 years (from 16 to 60), for women - 39 years (from 16 to 55). The average period of efficiency is 41.6 years. Given that for reasons not related to the health status, part of the population does not participate in work, then this time is reduced to 35.5 years.

Thus, R is the period (the number of years) of the population's participation in social production, if it is not limited by illness and injury, is 35.5 years.

The proportion of the population whose participation in social production is limited by disability can be defined as the ratio of the number of disabled people who have completely lost their ability to work and taken into account in the social welfare authorities to the population.

$$H = \frac{I_1 + I_2}{N_1 + N_2}$$

where *I₁*, *I₂* - number of persons with disabilities of groups 1 and 2 at the beginning and end of the reporting period

N₁, *N₂* - the number of working population at the beginning and at the end of the reporting period.

The proportion of the population who does not participate in social production as a result of the incidence with temporary disability can be defined as the fraction of the division of the number of days of disability from the incidence during the year by the average annual number of employees multiplied by the number of calendar days per year.

$$W = \frac{M_1 + M_2}{(N_{p1} + N_{p2}) \times 365}$$

where *M₁*, *M₂* - the number of days of disability in the previous and current years,

N_{p1} , N_{p2} - number of employees in the previous and current year.

Example 1.

Determine the medical and social capacity of workability on condition (table III).

According to the formula, the proportion of the population whose work participation is limited by disability is:

$$H = \frac{3572 + 3463}{105918 + 111007} = 0,0324$$

Calculation of indicator W - fraction of the population that does not participate in the production as a result of morbidity, is determined by the formula.

$$W = \frac{1074217 + 1056378}{(104945 + 109311) \times 365} = 0,00272$$

The proportion of women population is 0.488

The coefficient of 0.001 at the beginning of the formula is required to obtain the result in percentage terms.

The medical and social potential of working capacity is convenient to use to determine the additional gross national product (GNP) in the country or industry as a result of raising the level of health of workers (for example, as a result of the implementation of a comprehensive program for the improvement of public health).

The annual additional volume of gross national product (ΔGNP) as a result of increasing the medical-social potential of working capacity is determined by the formula:

$$\Delta GNP = \frac{GNP_n \times N(Q_2 - Q_1)}{100},$$

where GNP_n - gross national product per one working year,

N - average annual number of employees

Q_1 , Q_2 - medical and social capacity of work, before and after implementation of the complex program.

Example 2.

As a result of comprehensive measures to improve the health of the population, the medical-social potential of working capacity increased by 2.87% (from 79.26 to 82.13%). The number of employees in the region is 24,542, production of GNP per one employee is 48,000 UAH.

Clinical and economic analysis is a process of comparing the results and costs of applying two or more methods of medical intervention (drug or non-drug), including non-intervention technology.

Clinical and economic analysis has the purpose of comparative assessment of medical technologies. Its task is to apply, along with clinical arguments, also the economic ones to choose the best medical technologies.

All methods are reduced to the calculation of the correlation between the cost and the resulting effect.

Analysis of the cost-efficiency criterion is the main method. This is the price-to-effect ratio. Moreover, the costs are reflected in the financial indicators in monetary terms, and the effectiveness of the natural indicators of clinical efficacy. For example, costs that should be made to extend the life for one year, or reduce the incidence by 1%, etc. This method is used when only one measure of effectiveness is used to measure the effect. The

method allows comparing different alternative treatments. The indicator is calculated by the formula:

$$CER = \frac{DC + IC}{Ef}$$

where CER (cost- effectiveness) - cost/effectiveness ratio

DC - direct costs

IC - indirect costs

Increase in cost per unit of effectiveness. It is important to investigate the issue of incremental costs for the growth of one efficiency unit, as different intervals of the cost effectiveness indicator are different for improving efficiency.

For example, to reduce mortality by 1% from 14% to 13% from chronic non-communicable diseases in the region it is necessary to spend 300 000 UAH direct and indirect, and to reduce the rate by 1% from 10% to 9%, 700 000 UAH is already needed. This serves as an indicator of the growth of cost effectiveness, which is calculated by the following formula:

$$CER_{\Delta} = \frac{\langle DC_1 + IC_1 \rangle - \langle DC_2 + IC_2 \rangle}{Ef_1 - Ef_2}$$

CER is an incremental growth rate for an increase in one efficiency unit.

DC_1 - direct costs by using technology 1.

IC_1 - indirect costs by using technology 1.

DC_2 and IC_2 - direct and indirect costs by using technology 2.

Ef_1 Ef_2 - effectiveness of treatment and preventive measures using technology 1 and 2.

An analysis of cost minimization is used to compare costs when two or more methods have the same clinical efficacy. Calculation is determined by the formula:

$$CMR = DC_1 - DC_2$$

CMR - Cost Difference Indicator.

DC_1 - direct costs for technology 1.

DC_2 - direct costs for technology 2.

In practice, very rarely, two methods have the same clinical efficacy. Therefore, the use of this method is limited.

Cost-benefit analysis is a special case of cost-effectiveness analysis, when the effectiveness indicator is determined by the non-clinical efficacy, and the patient's judgment of the outcome of the treatment. He answers the question of what is best - to live long, but bad or to live well, but not so long. The indicator is determined by the formula:

$$CUR = \frac{DC + IC}{Ut}$$

CUR - Cost Index per unit of usefulness

DC- direct costs.

IP - indirect costs.

The utility rating (QALY) is based on years of saved life adjusted to its quality. The unit estimates the year of full health, the usefulness or value of other states is compared with the unit. Utility comes from zero (death) to one (full health). The number of QALYs is obtained by multiplying the number of years of saved life by the coefficient of utility of the obtained health condition. For example, if the expected lifetime of a person after the treatment according the standards is 16 years

and the utility is 0.6, then the usefulness of such actions is $16 \times 0.6 = 9.6$ QALY.

Example 3.

The cost of medical technology 1, which extends the life of patients by an average of 12 years, is 120 000 UAH, and the coefficient of life benefit is 0.6, according to the technology of the 2 utility coefficients is 0.8, life expectancy is 10 years, and the cost of treatment is 160 000 UAH. To identify and compare the two technologies in terms of cost-benefit

$$CUR_1 = \frac{120}{12 \times 0,6} = 16,6 \quad CUR_2 = \frac{160}{10 \times 0,8} = 20,0$$

In terms of cost-utility, the first medical technology is more attractive.

There are the following types of clinical and economic analysis:

1. *ABC analysis* - by volume of expenses. The essence of the ABC analysis is to rank the selected positions (medical technologies, medicines, illnesses) at the level of expenses from the largest to the smallest. At the same time, the most expensive technologies are combined into a group, which accounts for 80% of all costs (group "A"). The second group, group B, is a less costly technology, accounting for 15% of all costs. And, finally, the least costly technologies - 5% of all costs - belong to the "C" group.

2. *VEN-analysis* is the ranking of medicines by "importance index": V - medicines that are vital; E - essential; N - non-essential, secondary.

3. *Frequency analysis* is the ranking of selected items (medications) by frequency of use.

All types of clinical and economic analysis should be used in combination with one another. Comparing the cost of treatment with the medical effectiveness of the drug and the frequency with which it is used gives the opportunity to abandon minor appointments, to allocate vital medicines at a moderate price, thereby achieving the desired combination of cost and quality of treatment.

CONCLUSIONS

The results of the analysis of the considered methods of economic evaluation of the prevention and treatment of chronic non-infectious diseases make the following conclusions. The effectiveness of the health care system and individual health care facilities should be considered in a comprehensive manner from the point of view of medical, social and economic efficiency. Economic efficiency, usually, is the result of medical and social efficiency. In most cases, the medical and social effectiveness of therapeutic and prophylactic measures is accompanied by economic efficiency. The economic effectiveness of therapeutic and prophylactic measures is calculated for the future period and is based on statistical forecast indicators and is therefore indicative. The larger the forecast term is the more approximate calculations are. In calculating the cost-effectiveness of therapeutic and preventive measures, the entire complex of losses and costs

associated with illnesses should be taken into account, in particular: direct costs are related to prevention and treatment; indirect losses associated with the illness, due to the unprocessed part of the gross domestic product, paid for the sick leaves.

Each of the considered methods of economic analysis is oriented on certain performance indicators. The choice of the method of economic analysis is determined by the purpose of study in particular:

- economic efficiency - the broadest concept and covers indicators of medical, social and economic efficiency;
- the economic effectiveness of treatment and preventive measures shows the result of the introduction of certain methods of treatment and prevention;
- indicator of medical and social capacity of work characterizes the specific weight of the loss of disability from illness and disability;
- clinical and economic analysis has the purpose of comparative evaluation of medical technologies and the choice among them is optimal in terms of price and quality.

REFERENCES

1. Chepelevskaya L.A., Yashchenko Yu.B., Kondratyuk N.Yu. The state of the demographic situation in Ukraine: the problems and ways of their solution. Ukraine. The health of the nation. 2012.3:251-255
2. Prevention of noncommunicable diseases. Recommendations [Electronic resource]. - Moscow, 2013. - 122 p. - Access mode: <http://www.webmed.irkutsk.ru/doc/pdf/prevent.pdf>
3. Dudnik S. Why and how Ukrainians are sick? [Electronic resource] Yours-life. 2014. 42-43. - Access mode <http://www.vz.kiev.ua/chomu-i-yak-xvoriyut-ukrainci>
4. Kartashova S. S., Timchenko O. I., Omelchenko E. M. Mortality Indicators as Indicators of Health. Ukr. honey. almanac. 2009. 2 (12): 82-84
5. Ostafiychuk Ya.F. Methodology of the formation of valeological competences for students of medical colleges in the process of physical education. Physical Culture, Sport and Health of the Nation: Sb. sciences Ave. - Vinnytsya: Lando LTD., 2014.17:228-237
6. Tsanko I. I. Medico-social substantiation of the model of improvement of the organization of secondary prevention of arterial hypertension [Medyko-sotsialne obrhuntuвання modeli udoskonalennia orhanizatsii vtorynoyi profilaktyky arterialnoi hipertenzii]. "Social medicine", Ministry of Health of Ukraine, Kyiv, 2015.
7. Kvasha E. A. The significance of risk factors for male mortality (prospective epidemiological study) [Znachimost' faktorov riska dlja smertnosti muzhchin (prospektivnoe jepidemiologicheskoe issledovanie)]. Ukrainian Cardiology Magazine, 2008, 2:83-88.
8. Syrenko Y. M., Rekovets O. L., Savitsky S. Y., Pavlyuk Y. A. Metabolic syndrome of patients with arterial hypertension and metabolic effects of various antihypertensive drugs [Metabolichnyy syndrom u patsientiv z arterialnoiu hipertenziiu ta metabolichni efekty riznykh antyhipertenzynyvnykh preparativ]. Arterial hypertension, 2010, 4:42-56.
9. About implementation of the pilot project on the introduction of state regulation of prices for medicines for the treatment of persons with arterial hypertension [Pro realizatsiiu pilotnoho proektu shchodo zaprovadzhennia derzhavnogo rehuliuвання tsin na likarski zasoby dlia likuвання osib z arterialnoiu hipertenziiu]: Resolution of the Cabinet of Ministers of Ukraine dated April 25, 2012 No. 340 [Electronic resource]. - Mode of access: <http://zakon4.rada.gov.ua/laws/show/340-2012-%D0%BF>.

10. Tsanko I. I. Cost of treatment of arterial hypertension by drugs of different manufacturers [Vartist likuvannia arterialnoi hipertenzii preparatamy riznykh vyrobnykiv]. Management of the Health Care Establishment, Kyiv, 2013, 5:34.
11. Syrenko Y. M. Results of one-year dispensary examination of patients with arterial hypertension in Cherkasy region [Rezultaty odnorichnoi dyspanseryzatsii patsientiv z arterialnoiu hipertenziieiu u Cherkaskiy oblasti]. Ukrainian Cardiology Magazine, 2007, 2:26-31.
12. Syrenko Y. M. The results of the survey of doctors treating patients with arterial hypertension [Rezultaty opytuvannia likariv, shcho likuiut patsientiv z arterialnoiu hipertenziieiu]. Ukrainian Cardiology Magazine, 2008, 7: 46-52.
13. Dyachuk D. D., Yaschenko Y. B., Melnyk N. Y, Zabolotna I. E., Iskrenko I. M. Methodical recommendations for conducting medical and sociological surveillance for obesity in children [Metodychni rekomendatsii z provedennia medyko-sotsiologichnoho nahliadu za ozhyrinniam u ditei]. Kyiv, 2017.
14. Svischenko E. P. Detection and Treatment of Arterial Hypertension in Ukraine: Reality and Prospects [Vyiavlennia ta likuvannia arterialnoi hipertenzii v Ukraini: realnist ta perspektyvy]. Ukrainian Cardiology Magazine, 2010, 1:13-16.
15. Kotuz A. S., Semenov I. P., Shmatenko O. P., Strokan A. M., Goncharenko V. M., Tsanko I. I., Pritula R. L. Theoretical Foundations of Clinical-Economic Analysis in medicine and pharmacy [Teoretychni osnovy kliniko-ekonomichnoho analizu v medytsyni ta farmatsii]. Kiev, 2012.

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