

*Розглядається проблема розробки моделей і методів для оцінки кадрового потенціалу закладу охорони здоров'я. Кадровий потенціал розуміється в аспекті надання медичних послуг. Його будемо обчислювати як максимальну кількість окремих видів медичних послуг, які можуть бути надані споживачам за визначений період часу фактичними медичними працівниками закладу. Важливою умовою при цьому є збереження необхідної якості таких послуг. Розрахунок показників кадрового потенціалу закладу охорони здоров'я, зокрема, дозволяє визначити співвідношення між фактичним та нормативним навантаженням на кожного окремого працівника закладу охорони здоров'я. На основі розрахунку оціночних показників навантаження працівників закладів можливим є пошук шляхів вирішення проблеми підвищення ефективності функціонування закладів охорони здоров'я.*

*Відповідно до системної моделі, побудовано вербальні та математичні постановки задач, які виникають. Для аналізу кадрового потенціалу закладу охорони здоров'я пропонується застосовувати поняття кредиту – найменшої умовної одиниці часу відведеної для надання послуг. Конкретизовано розрахункові формули для обчислення нормативного та фактичного навантажень на окремих працівників та закладу в цілому. Вихідними даними для розрахунків є результати експертних опитувань, а також статистичні дані щодо кількості послуг наданих конкретним закладом охорони здоров'я, а також її працівниками. Результатом проведеного дослідження стала інформаційно-аналітична система оцінки кадрового потенціалу закладу охорони здоров'я. Ядром розробленої системи є аналітичний блок, в який входять моделі, методи і алгоритми визначення компетентності експертів, обчислення числової експертної оцінки об'єкта, обчислення нормативного і фактичного навантаження на працівників та закладу тощо. Визначено особливості банку даних інформаційно-аналітичної системи. Наведено її структурну схему. Проведено експериментальну верифікацію результатів дослідження. Показано приклад роботи програми та наведено аналіз результатів.*

*Розроблені моделі та алгоритми можуть успішно використовуватися в процесі прийняття управлінських рішень у сфері охорони здоров'я*

*Ключові слова: інформаційно-аналітична система, кадровий потенціал, експертні оцінки, надання медичних послуг*

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# DEVELOPMENT OF MODELS AND ALGORITHMS FOR ESTIMATING THE POTENTIAL OF PERSONNEL AT HEALTH CARE INSTITUTIONS

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## 1. Introduction

Development and implementation of information technologies in various spheres of human activity are directed to an increase in efficiency of processes of making managerial decisions. Thus, information technologies are successfully used in management, health care, economy, education, etc. [1–6].

The health care sector takes an important place among other types of human activity. Now there is a dynamic development of the market for medical services provided to patients, changes in approaches to diagnosis and treatment of patients and other related factors. This indicates the need for an adequate assessment of the load on health care professionals, as well as assessing the effectiveness of activity of health care establishments [7, 8]. Human potential is considered in terms of rendering medical services. It will be calculated as

the maximum amount of certain types of health services that can be provided to consumers for a defined period of time by actual medical staff of an institution. An important condition in this case is maintaining the required quality of such services. The calculation of the indicators of the personnel potential of a health care institution, in particular, makes it possible to determine the ratio of the actual and standard work load on each employee of a health care institution. Based on the calculation of the evaluation indicators of the workload of employees of institutions, it is possible to find the ways of solving the problem of increasing the efficiency of functioning of health care establishments. This analysis requires a comprehensive approach with the involvement of competent experts. In the process of solving the problems, which thus arise, it is necessary to operate large arrays of retrospective data, to perform a series of mathematical calculations, to ensure the

possibility of visualization of the obtained results. All of this leads to the conclusion that it is a relevant task to develop such models, methods and algorithms for the evaluation of personnel potential for health care institutions, which would become the basis of the corresponding information technology.

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## 2. Literature review and problem statement

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Paper [9] proposed a socio-technical model to develop and implement information technologies in health care. The specific feature of this development is the possibility of its application in complex adaptive systems, in which data are interconnected and interdependent. However, the specified work is theoretical in nature. Research [10] is devoted to the development of the cyber-physical system for patient-oriented applications in health care based on cloud technologies under conditions of working with large data arrays. A detailed analysis of the possibilities of application of technologies of large data arrays in health was made in studies [11, 12]. The paper presents the examples of the implementation of the technology of large data arrays in the branch information technologies and develops a system of guidelines for the application of analysis of large amounts of data in the process of designing information technologies for the health care sector. However, when analyzing the work of separate health care establishments, the necessity to work with large arrays of data does not arise. That is why there is usually no need for the application of such technologies. All these technologies deal with developing the applications to store data about patients and services that were provided. However, these developments do not contain functional possibilities for the analysis of the work load on health care employees.

The next group of scientific sources is formed by the papers devoted to management in health care, as well as the analysis of the problems of determining the personnel potential of a health care institution. Thus, paper [13] contains a substantiation of the relevance of using the system approach in management of health care. This approach should become the basis for information technologies in the health care sector. Research [14] is dedicated to the problem of development and implementation of information technologies in the health care system. This paper determines the list of properties, which should be met by the effective information technology. Paper [15] contains the systematization of the basic functions of the public health system. It is noted that personnel is the most important resource for providing services of public health. That is why an important function of the health system is planning human resources in the health care sector.

Paper [16] deals with the problem of assessing the personnel potential of the health care system. Here are listed the main approaches to assess the level of provision of health care establishments. However, the basis in this work is the ratio of medical professionals and the amount of population. This approach makes it possible only in general to assess the need for health care workers, regardless of the needs of a particular institution. The substantiation of the influence of staffing of health care establishments on the state of health of adult population is contained in [17]. The relation between different indicators of the state of health, network, and staffing of health care institutions was analyzed. It was shown that the level of morbidity of the population depends on the timely response to changing needs for medical staff.

Thus, the conducted analysis of literary sources [9–17] showed that there is a large amount of scientific research

focusing on studying the problems of the development and introduction of information technologies in the sphere of public health. In addition, it was noted that the problem of analysis and planning personnel resources in the health care sector takes an important place among other problems. However, in the scientific literature not enough attention is devoted to the solution of the problem of assessing the personnel potential of health care establishments. That is why the research into the problem of the analysis of human potential of a health care institution is a practically important task. In the course of this research, it is advisable to consider an institution of health care as the production system of the information type [18]. At each stage of the operation of such a system, it is important to plan and monitor its capacity, in particular, the amount of separate health care services that can be provided to consumers for a defined period of time. In this case, the important requirement is to render not only the necessary amount of various medical services, but also to provide a certain level of their quality. Among the approaches, which are used in assessing the personnel potential of a health care institution, the temporal approach based on assessing the duration of each service is relevant [19]. A comparison of the actual and the standard work load on the employees of an institution will allow making managerial decisions on increasing efficiency of an institution and improving the quality of services provided to the clients of an institution.

According to this approach, the following mathematical problems arise in the process of solving the problem of assessing the personnel potential of a health care institution:

- the problem of assessment of the standard and actual load on a health care establishment in general or on its structural subdivision;
- the problem of assessment of the standard and actual load of each employee of the health care institution.

After receiving the specified ratings, the optimization of the activities of an institution of health care will become possible through solving the following tasks:

- the problem of the efficient redistribution of the load between the employees of an institution;
- the problem of planning the expansion or reduction (changing the profile) of staffing of an establishment;
- the problem of redistributing of certain functions (types of medical services) between the employees within a single structural unit of a health care institution, etc.

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## 3. The aim and objectives of the study

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The aim of this study is to develop the models and algorithms for creation of the information technology for evaluation of personnel potential at health care institutions taking into consideration the actual load on each employee of an institution and ensure rendering quality health services to the clients of an institution.

To achieve the aim, the following tasks were set:

- to implement the formalization of the problem of assessment of the standard load on the employees of a health care institution and the institution as a whole;
- to propose the method to calculate the losses of working time, not related to the provision of medical services to clients;
- to develop a mechanism for the consideration of time standards for provision of medical services and the number of clients, to who these services were provided in order to determine the actual load on the employees of a health care institution;

- to develop the information-analytical system for evaluation of the personnel potential of health care establishments;
- to perform the experimental verification of research results.

**4. Models and methods for the evaluation of personnel potential at a health care institution**

At the stage of the construction of mathematical models and methods for the problem of assessing the personnel potential of an institution of health care, we need sequential detailing of problems, which are considered below. In this case, to analyze the personnel potential of a health care institution, it is proposed to apply the concept of credit – the smallest conditional unit of time allotted for the provision of services. The concept of credit is conditional. In particular, each credit can be equal to one minute of working time [20]. The use of the concept of credit makes it possible to perform verbal and mathematical formulations of the specified tasks.

**4.1. A model for estimating the standard load on a health care institution**

By the standard load for a health care establishment, we will imply the maximum number of credits, which all its employees have within their own working time. Thus, when determining the standard load on a health care institution, it is necessary to consistently identify the standard load on each employee of that institution.

The magnitude of the standard load of an employee is influenced by such indicators as: a professional group, position, engagement rate, working hours, losses of working time, etc.

The mathematical problem of the assessment of the standard load on an employee will be stated in the following way:

Assume that the a set of employees of a health care institution is assigned and designated through  $W=\{W_1, W_2, \dots, W_n\}$ . Let each employee  $W_i (i = \overline{1, n})$  be characterized by such two indicators:  $h_i$  – professional group;  $\eta_i$  – engagement rate.

Assume that  $K$  is the number of professional groups of employees according to their speciality and position. Designate through  $I_k (k = \overline{1, K})$  the set of the numbers of the employees who belong to the  $k$ -th professional group. In this case, the following ratios must be satisfied:

$$I_{k_1} \cap I_{k_2} = \emptyset (\forall k_1, k_2 \in \{1, 2, \dots, K\} : k_1 \neq k_2),$$

$$\bigcup_{k=1}^K I_k = \{1, 2, \dots, n\}.$$

To calculate the standard load on an employee for a working month, we will assign function  $f(h, \eta)$ , which will depends on two parameters: a professional group of employees and engagement rate:

$$f : (h, \eta) \rightarrow R^+. \tag{1}$$

Designate the standard load on employee  $W_i$  for the elementary time interval  $t$  through  $r_i$ . Then

$$r_{it} = \lambda(t) \times f(h_i, \eta_i), i = \overline{1, n}, \tag{2}$$

where  $\lambda(t)$  shows how many working months (what part of a working month) time interval  $t$  will take.

Then the standard load of a medical institution for elementary time interval  $t$  will make up:

$$R_t = \sum_{i=1}^n r_{it}. \tag{3}$$

Assessment of standard load on a health care institution involves the sequential calculation of standards loads on each of the employees of this institution and finding the sum of the found magnitudes. Thus, the identification of function (1) is decisive in this process.

**4.2. The algorithm of structural and parametric identification of functions for determining the standard work load on an employee**

Represent the function of determining the standard work load on an employee for a working month (1) as (4):

$$f(h, \eta) = \omega(h)\eta - \psi(h, \eta), \tag{4}$$

where  $\omega(h)$  is the function that determines the load on an employee of professional group  $h$  at engagement rate 1;  $\psi(h, \eta)$  is the function of the assessment of losses of working time, related with fulfillment of errands, internship, temporary losses of working time, etc.

If function  $\omega(h)$  is determined unambiguously, there can be different approaches to identify function  $\psi(h, \eta)$ .

The main source of information for determining function  $\psi(h, \eta)$ , as a rule, are experts. Because the parameters of the function are non-numeric magnitudes, it is advisable to assign it in a tabular form. In paper [21], they proved the effectiveness of the application of the algorithm of identification function  $\psi(h, \eta)$  based on the conclusions of experts, which consists of the following steps:

*Stage 1.*

*Step 1.* Formation of a large expert group from representatives of different professional groups (the number of experts is  $n > 20$ , for example).

*Step 2.* Interviewing experts, determining the competence of experts and compiling the table of the possible values of function  $\psi(h, \eta)$  for different sets of values of  $h$  and  $\eta$ .

*Step 3.* Formation of a group of experts-managers.

*Step 4.* Interviewing experts. Determining the estimated losses of working time through sequential solution of the problems of numerical assessment of an object based on distinct or fuzzy expert estimates, by including the variants obtained at Step 2 to the questionnaire of experts.

**4.3. Models for estimation of actual work load on a health care institution and an individual employee**

In the course of assessment of the actual load on a health care establishment, it is important to take into consideration the volumes of performed works and services rendered by each employee of an institution for the necessary period of time.

To conduct such an assessment, it is necessary to split services into two groups: services, the amount of which depends on the number of clients and services, the amount of which does not depend on this number (for example, making reports for an institution).

In addition, for each service, it is necessary to assign the number of credits required for its high-quality rendering. These indicators are usually determined by regulatory documents or questioning the experts.

Mathematically, the statement of the problem of the assessment of the actual load on an employee will be stated as follows.

Assign a set of services  $S = \{S_1, S_2, \dots, S_m\}$ , for each of which magnitude  $s_j (j=1, m)$  – the number of credits required for its implementation – is assigned. Split all the services into two groups:

- group 1 – services, the volume of which depends on the number of clients;
- group 2 – services, the volume of which does depend on the number of clients.

Designate through  $J_1$  the set of indices of services of group 1 and through  $J_2$  – a set of indices of services of group 2. In this case,  $J_1 \cap J_2 = \emptyset$  and  $J_1 \cup J_2 = \{1, 2, \dots, m\}$ .

For each service of group 1  $S_j (j \in J_1)$  write out a set of indicators that determine the number of patients who received this service free of charge:

$$\begin{aligned} &v_{1t}^{(j)}, v_{1t-1}^{(j)}, \dots, \\ &v_{2t}^{(j)}, v_{2t-1}^{(j)}, \dots, \\ &\dots \\ &v_{L_j t}^{(j)}, v_{L_j t-1}^{(j)}, \dots, \end{aligned} \tag{5}$$

We will determine the function that expresses the volume of service  $s_j$  for period of time  $t$  taking into consideration the values of indicators in previous time periods –  $p_{jt}$ :

$$p_{jt} = \Phi_j \left( v_{1t}^{(j)}, v_{1t-1}^{(j)}, \dots, v_{2t}^{(j)}, v_{2t-1}^{(j)}, \dots, v_{L_j t}^{(j)}, v_{L_j t-1}^{(j)}, \dots \right), \tag{6}$$

where  $v_{lt}^{(j)}$  is the value of the  $l$ -th indicator that determines the volume of the  $j$ -th service ( $l=1, L_j, j \in J_1$ ) in time period  $t$ ;  $L_j$  is the number of indicators that determine the volume of service  $S_j$ .

Assume that we have the matrix of the distribution of services among the employees  $MR = (\alpha_{ij}), i=1, n, j=1, m$ , in this case  $\alpha_{ij} \geq 0, \forall j \in \{1, 2, \dots, m\} \text{ i } \forall i \in \{1, 2, \dots, n\}$ ,

$$\sum_{i=1}^n \alpha_{ij} = 1, \forall j \in \{1, 2, \dots, m\},$$

where  $\alpha_{ij}$  is the part of the  $j$ -th service provided by the  $i$ -th employee.

Then, the volume of credits, that an employee worked  $W_i (i=1, n)$  within the assigned time period  $t$  can be calculated from formula:

$$q_{it} = \sum_{j \in J_1} \alpha_{ij} p_{jt} s_j + \sum_{j \in J_2} \alpha_{ij} s_j. \tag{7}$$

The load on a health care establishment in general within time interval  $t$ , respectively, will be calculated from formula:

$$Q_t = \sum_{i=1}^n \left( \sum_{j \in J_1} \alpha_{ij} p_{jt} s_j + \sum_{j \in J_2} \alpha_{ij} s_j \right). \tag{8}$$

It is the analysis of indicators, calculated according to formulas (7), (8), that is the essence of the process of assessing the effectiveness of a health care institution.

### 5. Information and analytical system for evaluation of the personnel potential at a health care institution

Based on the developed models and algorithms, we designed the information and ana-

lytical system (IAS). Formally, the structure of the IAS can be represented in this form (Fig. 1).

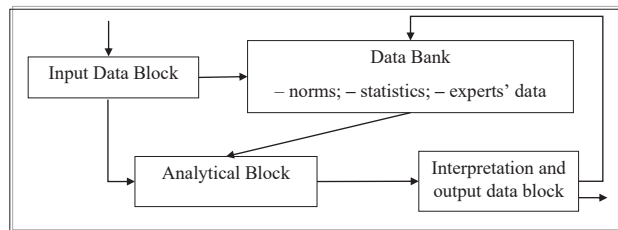


Fig. 1. Block diagram of the information-analytical system

As we can see from Fig. 1, the basis of IAS is the analytical unit, which includes the implementation of methods and algorithms for the solution of problems that arise in the process of assessing personnel potential of a health care institution and were described above.

Since when assessing the personnel potential of a health care institution, it is necessary to process the conclusions of experts, an important part of the analytical unit is the module, which implements the statistical methods of numerical evaluation of an object, as well as the documentary method for determining the competence of an expert [22]. The choice of such methods for processing expert information is associated with the specificity of the problem. The experts, who take part in the interviews, as a rule, are not acquainted with each other, and the surveys of this kind are rare.

The data bank of the developed IAS creates a system of tables and records that contain results of expert interviews, standards of loads on employees, quantitative characteristics of medical services, etc.

The interaction between users and the information-analytical system occurs through the user interface. The system can simultaneously contain the data about any number of establishments and works in the data edit and data analysis mode (Fig. 2, 3).

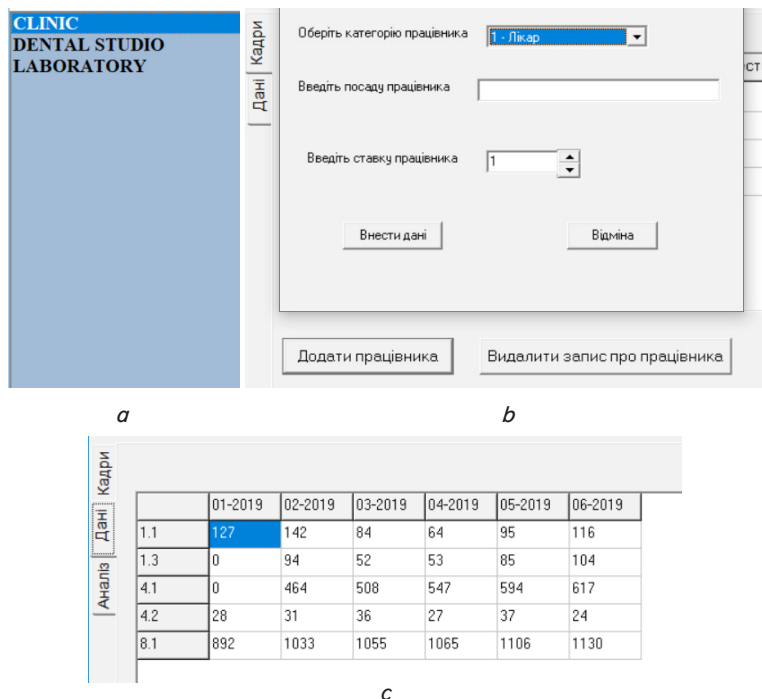


Fig. 2. Windows of user interface: a, b, c – data edit mode

N°	Position	Engagement rate	Norm on the cre	Worked actu	Different
1	Doctor	1	35251,2	98898,6	-63647,4
2	Doctor	1	35251,2	11654,09	23597,11
3	Nurse	1	27157,68	22998,27	4159,41
4	Nurse	1	27157,68	6045,36	21112,32
	Total		124817,76	139596,32	-14778,56

Fig. 3. Window of user interface: fragment of displaying the results of analysis of personnel potential

The system is configurable to each type of an institution separately with regard to the specificity of an institution and medical services provided in it. The decision maker – administrative official, based on clinical protocols, norms and standards, identifies the functions that characterize the dependence of volumes of provided services on the number of clients who applied for them (for example, a service after it was applied for can be provided each day within a specified number of days; the case is possible when a service is extended in time etc.). In addition, the functions for the calculation of the standard load on each group of employees are identified, based on the conducted expert interviews and taking into consideration the norms of labor.

After the execution of the specified configurations, the IAS can be used by managers to analyze the personnel potential of health care establishments.

### 6. Experimental verification of research results

The developed models and algorithms of estimation of the personnel potential of a health care institution, as well as the information-analytical system, can be successfully used as an auxiliary tool in the process of decision making in the health care sector. For example, the following cases are possible:

- if  $Q_t > R_t$ , it is possible to make a conclusion that in the interval  $t$  the institution will be overloaded with work;
- if  $Q_t$  is considerably lower than  $R_t$ , evidently, the amount of services that will be provided by the employees of the institution is much less than the norm.

Here is an example of the system operation. We will model the work of a health care institution, which provides 5 services. Table 1 shows the amount of services provided by the employees of the institution:

Table 2 shows the list of the employees and the matrix of the distribution of services between the employees of an institution. The code of the position and the load are presented for each employee. It is worth noting that service 1 has 2 stages, so in Table 2 this service is represented by two columns, besides, there appeared service 6, which does not depend on the number of clients of an institution and is aimed at ensuring the institution functioning. In addition, Table 2 shows the size of credits that are allocated to servicing one client for the appropriate service. These magnitudes are determined by previous expert interviews [21].

We also experimentally established the number of credits, equivalent to working time for

each group of employees: group 1 – 35,251.2 credits, group 2 – 27,157.68 credits.

Experts-doctors additionally identified the functions (6) that determine the volumes of provided services, depending on the number of clients that apply for them. To simplify the model example, it was found that the number of rendered services is equal to the number of clients who applied for them. However, the IAS itself makes it possible to determine any relationship between these indicators.

Table 1

The number of clients who applied for the provision of a service by the employees of an institution in the period from 01.2019 to 06.2019

No. of service	Amount of provided services					
	January	February	March	April	May	June
1	127	142	84	64	95	116
2	0	94	52	53	85	104
3	0	464	508	547	594	617
4	28	31	36	27	37	24
5	892	1,033	1,055	1,065	1,106	1,130

Table 2

Matrix of distribution of services between the employees in percentage

No. of employee	Position code	Engagement rate	Service number						
			1.1	1.2	2	3	4	5	6
1	1	1	0	0	0	90	100	0	45
2	1	1	100	0	100	0	0	0	45
3	2	1	0	0	0	10	0	100	5
4	2	1	0	100	0	0	0	0	5
Credits			10.3	9.42	10.36	33.7	81	2.2	432

All these data were entered into the program and the analysis of load on a health care institution was carried out. The results of the analysis performed by the IAS were entered in Table 3.

Thus, it is possible to conclude from Table 3 that employee 1 provided 2.8 times more services than it was indicated in the norm. In turn, employee 2, who belongs to the same category, did not fulfill the plan completely. Thus, the internal redistribution of responsibilities within the same institution can make it possible to change this situation. In addition, employee 4, who provides only two services, does not fulfill the plan on the workload completely, while employee 3 is loaded almost by 85 %. This can be graphically represented as (Fig. 4).

Table 3

The results of operation of the information-analytical system

Employee number	Norm for credits	Worked actually	Service number						
			1.1	1.2	2	3	4	5	6
1	35,251.2	98,898.6	0	0	0	82,909.2	148,23	0	1,166.4
2	35,251.2	11,654.09	6,468.4	0	4,019.29	0	0	0	1,166.4
3	27,157.68	22,998.27	0	0	0	9,212.13	0	13,656.53	129.6
4	27,157.68	6,045.36	0	5,915.76	0	0	0	0	129.6
Total	124,817.76	139,596.32	6,468.4	5,915.76	4,019.29	92,121.33	14,823	13,656.53	2,592

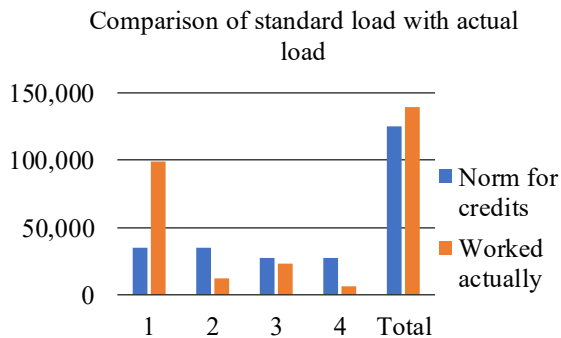


Fig. 4. Results of comparison of the standard and actual load

Thus, using the developed IAS, in which the proposed models and algorithms were implemented, it is possible to perform analysis of the load on separate employees of a health care institution and, if necessary, to solve the problem of redistribution of the load between them. So, the ratio of the standard load on an employee to his actual load clearly indicates the existence or overloading of an employee. This can lead to a decrease in quality of medical or non-medical services that are provided to patients or to irrational use of existing working time of a certain employee (production downtime). Obtaining results of such analysis gives grounds for making managerial decisions on optimization of the use of existing personnel potential of a health institution as a whole or its separate structural unit. Thus, there are grounds to make certain functionally-organizational changes in the operation of a structural unit. For example, the redistribution of separate functions among the employees:

- optimization of the flows of patients within a health care institution or its structural unit;
- optimization of the work schedule of both a structural unit and separate employees, etc. The same data can be used for planning the expansion or optimization of staffing of a health care establishment, planning, training and retraining of existing employees and the search for new employees with certain qualification. At the regional level, the obtained data allow planning the development of the branch in terms of the development of a network of health care establishments. In addition, it is possible to redistribute their functional content. For example, the reorganization of one type of health care establishments into the other; merging with the aim of consolidation; the change of the territorial location for the purpose of approximation of services to the patient, etc.

### 7. Discussion of results of development of models and algorithms for estimation of personnel potential at a health care institution

Existing methods for assessing the personnel potential of health care establishments are based only on the existing standards of rendering medical services, developed by departments and head offices [8]. Unlike such approaches, the models and algorithms suggested in this paper make it possible to perform the assessment of personnel potential, based on the indicators of the duration of services necessary to ensure their high-quality rendering. This is achieved due to separate research into two kinds of numerical indicators – the standard and actual load on an institution and separate employees.

The proposed model for estimation of the standard load on a health care institution and the employees of an institu-

tion is based on taking into consideration the estimates of the indicators of working hours of various groups of health care workers, depending on the positions and engagement rates that they occupy. An increase in the objectivity of evaluations of standard load is provided by using the algorithm of structural and parametric identification of functions to calculate such a load. The specified algorithm is based on the procedure of identification of function of losses of working time, related to an increase in qualification of workers, their recreation, etc. As shown in [21], the proposed algorithm of the two-stage expert estimation of losses of working time is effective. Its specific characteristic and advantage is taking into consideration the conclusions of the representatives of each group of medical workers on the studied issue.

The specific feature of the created model and the algorithm is that the accuracy of the estimates obtained with their use will increase with an increase in the studied period of time. For example, most employees have a holiday once per calendar year, and losses associated with it, are distributed evenly for smaller time periods.

The proposed model for estimation of the actual work load on employees of a health care institution makes it possible to take into consideration the normative duration of each service, its repeatability and extension, as well as the amounts of services provided by employees over the period of time under consideration.

Practical implementation of the models and algorithms, realized in the IAS, makes it possible to perform the assessment of the personnel potential of health care institutions, regardless of their type and the specifics, which was demonstrated on the model example.

The practical importance of the developed models, algorithms and software is that the method for analysis of the activity of health care establishments was developed through the lens of the temporal approach. This analysis will allow managers to reveal, for example, systemic problems with overloading of employees, which can lead to the deterioration of the quality of medical services and take steps to improve this situation.

A promising area of research is forecasting the needs for medical workers in the region.

### 8. Conclusions

1. Formalization of the problem of assessment of the standard load on employees of a health care institution and the institution in general was performed. It was proposed to imply by the standard load the maximum number of credits – conventional units of time that the staff has. It was determined that the standard work load of an employee depends on his professional group, position and engagement rate. The practical value of the obtained model is that the procedure, which makes it possible to unify and automate the process of determining the standard work load, was described at the formal level.

2. The algorithm of calculation of the losses of working time, not related to the provision of medical services to clients was developed. The scientific outcome of the decision involves the proposed method of conducting expert interviews at two stages. Stage 1 covers a wide range of medical experts of different professional groups. The numeric scores obtained at Stage 1 are the base for the formation of an

expert's questionnaire to complete Stage 2 of the expert examination, which is held among the narrower circle of experts-managers. This approach makes it possible maximally to take into consideration the standards established by labor norms, as well as personal professional experience of medical workers of different professional groups as for the losses of working time related to qualification upgrading, recreation, rest, etc.

3. The developed model for the estimation of the actual work load on employees of a health care institution is based on the conditional division of medical services into two groups: the services, the volume of which depends on the number of clients, and those that do not depend on it. Calculation of the load itself is carried out taking into consideration the time standards of rendering medical services, the number of clients, to who these services were rendered and specific features of such services. The scientific result of development is the proposed mechanism of operating the credits, which ensures its universality in terms of the content of the services themselves and, therefore, this model can be used for the analysis of activity of employees of a health care institution of any type.

4. Based on the developed models and algorithms, the information-analytical system for the evaluation of personnel potential of health care establishments was designed. The practical value of the IAS is that it is suitable for the analysis of activity of medical institutions of different types. The IAS requires configuration to a certain institution only at the initial stage of its use by performing the identification

of functions to determine the losses of working time and the establishment of the relationship between the amount of services rendered and the number of customers that applied for it. Subsequently, the IAS can be used by managers in the process of making managerial decisions regarding the staffing of health care establishments.

5. The model example of functioning of a health care institution within six months was developed. It was shown how to estimate the difference between the actual and standard load on the employees of an institution based on the statistical data about the number of clients of an institution. It was demonstrated that in the case of uneven distribution of duties between the employees of one profession, there may be cases, in which the actual load on one of the employees is several times higher than his normal load, which can result into lower quality of provided services. In turn, the actual load of the second employee of the same profession is less than his standard load. Therefore, the execution of the redistribution of duties between employees in the modeled case can ensure maintaining the proper quality of medical services.

Due to the experimental verification of the model example, it was proved that in assessing the activities of a health care institution in general, it is important to perform assessment of the activity of each employee of an institution. In addition, it was shown that owing to the developed models, algorithms, and the IAS, it is possible to identify internal personnel resources to redistribute the load among the employees to ensure the quality of rendered services.

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