Epidemiological dental examination of cadets using digital technology as a factor in the human capital’s development of military personnel

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Abstract. In terms of health, the main objective of the reproduction of the qualitative military personnel’s human capital is the prevention of diseases, including dental ones. The effectiveness of preventive measures for dental diseases depends on the timeliness of the epidemiological dental examination. In the context of medicine digitalization and the opportunity to process large amounts of data, the military personnel’s dental health status can be quickly monitored using digital technologies, starting from the early age - the period of cadet schools. The goal of improving the informatization of the medical support system is to increase the availability and quality of medical care to pupils of educational institutions of the Ministry of Defense of Russia based on the automation of information interaction between organizations of the RF Armed Forces. We have developed an electronic map for examining the patients’ dental health and integrated into the Dental Health Workstation program with the formation of a single electronic patient registry. The resulting database allows us to trace the state of dental health of patients who experience an annual in-depth medical examination throughout the training period, to conduct a medical-statistical analysis, and to determine the factors that reduce dental morbidity. Using the electronic registry improves the quality of dental care for students.

1. Introduction

A review of publications in the human capital area both domestic and foreign authors has revealed an increase in the number of scientific research in the field of health capital over the past decade, as a number of authors highlight health as one of the human capital components: RWFogel [1], E. Duflo [2], P. Howitt [3], G.I. Sinitsyna [4], N.S. Matveeva [5], Y.L. Minaev [6], A.I. Babenko [7]; a part of the authors - as its basis I.V. Ilyinsky [8], O.V. Kiseleva [9], D.I. Shmakov [10]. The "capital of health" concept was developed in the Michael Grossman’s work, where he considered the dual nature of the “health” concept: as a consumer benefit and as a mean to profit [11]. In the USA, the “Health as Human Capital Foundation”, which mission is to promote the importance of considering health as a component of human capital, has been operating for about 15 years [3].

In the context of the Human Capital Theory, the health status of a military man can be considered as capital, which is hereditary on the one hand and is acquired on the other. During the course of the military service, the depreciation of this capital accelerates with the age of military personnel.
Investments associated with preventive measures in the field of health can slow down the pace of this process [12].

Under the implementation of the national projects “Healthcare” and “Digital Economy” [13; 14; 15], one task of which is “the creation of a single digital circuit in healthcare based on a unified state health information system (EHISE)” for a period till 2024, there is an active introduction of digital technologies in military medical organizations. This process is being held with the implementation of electronic medical records, and military personnel’s electronic medical books. Moreover, there is a gradual transition to electronic databases and registries. Digital medicine technologies are designed to reduce the “administrative work” of medical personnel, as well as to serve as a decision-making support system in the field of healthcare [16].

The creation of personalized databases and registers according to the human health can significantly increase the effectiveness of medical support, and provide various types of medical care for military personnel who need medical care most of all. For example, the problem of allocating expensive medical treatment by creating a personalized register of patients who need some additional medication was solved. In the list of diseases is the following: hemophilia, multiple sclerosis, diabetes mellitus and others [17].

Research [18; 19] has showed the current need for monitoring the dental health of children with subsequent monitoring and correction. The study of dental morbidity, in particular the children’s ones, is an integral part of improving the dental care system, which in turn allows determining the correct priorities and more effectively use the available tools to solve problems aimed at improving dental health.

The regular epidemiological dental examinations with data entered in the single register with subsequent analysis and forecasting allows monitoring the prevalence and intensity of major dental diseases. During the examinations, it is possible to get a real picture with reliable initial data that will form the basis of the departmental model, with an assessment of the need for strength and means of providing the dental care.

The purpose of this study of the epidemiological dental examination of pupils is the development of an adapted electronic map for assessing the dental status of pupils of pre-university educational institutions according to the WHO guidelines “Dental Examination - Basic Methods”, 5th edition, 2013. This map has an electronic form and a number of necessary additions based on the specifics of training at these institutions.

2. Methods

We have developed an electronic modified map for assessing the dental status of pupils of pre-university educational institutions of the Ministry of Defense of Russia according to the WHO guidelines “Dental Examination - Basic Methods”, 5th edition, 2013. This map has an electronic form and a number of necessary additions based on the specifics of training at these institutions.

Departmental epidemiological dental examination is carried out as a part of research work of category 1 and covered all pre-university educational organizations of the Ministry of Defense of Russia (31 institutions) throughout the Russian Federation. All dentists of educational institutions have
been trained and calibrated to ensure the same interpretation, understanding and codes for assessing various dental diseases and conditions that are aimed to detection and registration.

According to the departmental guidance documents, governing the annual in-depth medical examination, the epidemiological dental examination did not take extra time, and allowed an assessment in dynamics over the entire period of student learning.

Due to the fact that all pre-university educational organizations have switched to seven-year education, the age structure of pupils is from 10 to 18 years. The recommended age groups of WHO, which include children: 12 years old - the key age group for monitoring the prevalence and intensity of caries, when all permanent teeth erupt with the exception of third molar; 15 years - is the key age group for assessing indicators of periodontal tissue damage. Other age groups of up to 6 years, 35–44 and 65–74 years old are not entered in the survey.

According to WHO recommendations, if we want to obtain representative results, the sample in each key age group of particular geographical area should be at least 50 people. In our case, the sample has amounted to at least 100 people in each age group of particular geographical area; 20 people per day were examined with a time cost of 5-10 minutes per subject. The function of the medical record administrator, who records the results of the examination in a special electronic card, was performed by the nurse of the dental office.

To register the data of the epidemiological dental examination, there has been developed the Dental Health AWP, which contains all the necessary information for:

- descriptions of dental status of the first and subsequent years of study;
- determining the need of dental care;
- monitoring and correction of the organization of dental care.

AWP “Dental Health” includes 265 fields, containing the accepted digital or letter codes, consists of the following sections:

- general information: the date of examination, the examinee’s identification number, the researcher’s code, the examination - primary or repeated, the last name and initials, gender, the date of birth, the age, ethnicity, the place of birth, the region of residence before arrival at the educational institution, the conducting dental preventive examinations before admission in an educational institution, a health group and the conclusion of a military medical commission, the type of dental bite and the presence of dentoalveolar anomalies;
- the assessment of the condition of hard teeth tissues;
- the assessment of the condition of periodontal tissues;
- the assessment of the presence or absence of enamel spotting (limited or diffuse), hypoplasia, fluorosis;
  - the loss of epithelial attachment of the gums;
  - the assessment of the condition of the temporomandibular joint (the presence of pain and difficulty opening the mouth, the clicking in the composition, the limiting of the mobility of the lower jaw) and the dental bite;
  - the assessment of the condition of the oral mucosa: the presence of pathological signs (ZNO, leukoplakia, lichen planus, stomatitis, gingivitis, candidiasis, abscesses and other diseases) and their localization;
  - the assessment of the hygiene index with the determination of the level of oral hygiene;
  - the need for dental care and referral to specialists.

Therefore, the set of input data reflects at least the necessary for:

- the study of the prevalence and intensity of major dental diseases among students in pre-university educational organizations of the Ministry of Defense of Russia;
- the creation of a departmental register with the definition of the initial picture of the need of students in all types of dental care;
- the development and implementation of a model for the prevention of dental diseases, based on the initial dental status and age groups.
3. Results and Discussion
Since this work is the first experience of using a computer information system to automate the processing of data on the state of dental health within the Ministry of Defense of the Russian Federation, we did not set a goal to cover the entire dental specialty. The design uniqueness of information input forms implies the possibility of introducing new data and additional information fields without programming (Figure 1). There has been created a system of input forms for the developed “Dental Health” workstation. It allows the user to use the mouse to determine the places for the information input fields on the empty form. Field options are selected from the general list, which can be immediately expanded or edited. (Figure 2) The size of the fields on the form is easily determined by the mouse with the input of the unlimited amount of data.
Figure 3. Editing of information fields of the AWP

Figure 4. The main menu of the AWP “Dental Health” functions

Figure 5. Choosing the options for filling in the AWP “Dental Health” fields

As a field type, we can define one of the following options:
- single-line for input;
- multiline for input;
- switch;
- menu;
- function;
- table.

Work with the obtained data has been based on the map we developed, containing a set of input parameters. The parameters can also be divided into several large groups: general information, data on the teeth condition, mucous membranes, teeth bite, and others. In addition, the operator can determine the possibility of changing information in the certain field, which protects the data from any accidental damage.

The multivariate data entry, if necessary, is connected to any field for organizing the selection and a predefined list of options. This significantly speeds up the entry of repeated data (for example: nationality, gender, age, etc.) in order to create a single patient registry.

The universality of the developed automated database is due to the possibilities of the database structure free formation. That is, if required, you can create a new database with an original list of fields defined by the user for a short time, without leaving the package. During preparing the package, the main efforts were aimed at achieving the maximum simplicity of work: the user was not supposed to have any specific knowledge in the programming field; there were the layered nature of the built-in hints, the development of a system of drop-down menus and error diagnostics.

The registry provides the necessary confidentiality and security of stored data. This is achieved by the two-level password system (administrator level and user level), as well as the available capabilities for encrypting data stored on external storage media.

A two-level password system is installed for the package, implying the simultaneous existence of two passwords. Passwords respectively define two available levels of patients in the patient registry: the first level is the “normal user of the package”. At this level, the possibilities of obtaining any information from the database as well as printing any documents are available. However, the users of this level have no right to change information in the database; they cannot access record operations in the database. The second level is the “system administrator”. A user who knows the password of this level can access any database operations. It is possible to set free access (without entering a password) for each level, as well as to change existing passwords (the administrator can set both passwords, and the user has only their own). The main modes of the software package are (Fig.1): entering new data; editing information in the database; data search; data analysis; printing the formalized documents; change the main folder with the database; system configuration; development of the new database structure. The current order of the database fields used in the package (Fig.2) can be easily replaced by the user in a special registry operation mode “Development of the new database structure”, and this requires no special knowledge and programming skills.

For AWP “Dental Health”, a special internal programming language has been developed in order to write the new unintended information processing functions, which allows accessing information fields from the built-in function and perform medical-statistical data processing.

Consequently, the conducted epidemiological examination with the formation of dental status register of students provides us a possibility to significantly increase the effectiveness of medical care, timely deliver medical care to people who need medical care most of all. The created automated database (the basis of the future registry) for these patients contains all the necessary information of the dental status and patients’ examination data about the quality of dental care.

The necessity to take into account the dental health of pupils of educational institutions of the Ministry of Defense of Russia as one of the components of the military personnel’s human capital is justified by the following arguments:

1) Health gain increases the level of labor productivity, reducing the costs of inoperability caused by dental diseases;

2) Investments to the health maintenance (including treatment and prevention of dental diseases) reduce the depreciation of human capital associated with the aging of the body, and extend the period of military personnel’s work [20].
In view of the foregoing, the obtained data open up great opportunities for accounting and planning the financing and treatment costs of these contingents, which in turn is a solution to the problem of providing free dental care to the Ministry of Defense of Russia.

4. Conclusions

According to the results of the survey, an automated database of students in the Dental Health Workstation has been created, which contains all the necessary information on their dental health status, as well as questionnaire data. This information is sufficient to form a single electronic registry of the pupils’ dental status throughout the entire period of study.

The obtained data greatly facilitate the control of the timeliness and completeness of the dental care provision. The dynamics data of the pupils' dental status can be quickly and accurately controlled, covering the entire training period.

We have finally come to the following conclusions:

1. The development of an electronic dental status registry based on an epidemiological examination of pupils and integrated into the AWP “Dental Health” increases the effectiveness of medical support.
2. The created automated database in the AWP “Dental Health” contains all the necessary information and can be used subsequently to predict and correct dental morbidity at the departmental level.
3. With the implementing the patient register, wide possibilities are realized for recording and planning the medical supply for educational institutions.
4. The process of controlling the timeliness and completeness of the dental care provision to military personnel is greatly facilitated.
5. The developed automated registry database in the AWP “Dental Health” provides opportunities for data protecting and encrypting, as well as correcting the information fields list.
6. The academic-research search for effective digital technologies of the organization and management of health care for pupils of educational institutions of the Ministry of Defense of Russia contributes to the increase in the human capital of military personnel.

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