Our Steps To The Heights Of Digital Medicine: Development Of Software Package And Databases With Personal Data Protection For Ukrainian Polissya Region

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Abstract. Results of some works done at EMBS - Elbrus Medical and Biological Station of the National Academy of Sciences of Ukraine will be demonstrated. Continuation of these researches traditions in contemporary Ukraine – is the development of "EcoIS" information system with medical subsystem for monitoring of the health of population in Ukrainian Polissya Region affected by Chernobyl accident.

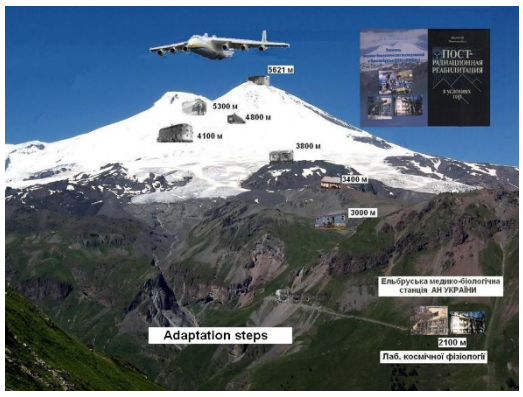

Fig.1. EMBS NASU at the way to m.Elbrus

Introduction. These investigations started at Elbrus Medical and Biological Station of the National Academy of Sciences of Ukraine [1] (EMBS NASU, in Caucasus Mountains, now – at the territory of Russia); and then they were continued in Ukraine. There, in Caucasus highlands, we investigated the adaptation processes to hypoxia for various contingents (rescuers, athletes, astronauts, patients with different diseases, others) (Figs.1-3). Huge amounts of medical data were obtained during these research and observations, and they had to be ordered for processing. All this stimulated us - physicians, biologists - to use mathematical and novel digital technologies.

Fig.2. Shelter-laboratory at Eastern peak of m.Elbrus (1967, historical archive)

Fig.3 EMBS, one of laboratory buildings (XXI c.)

In the laboratory of space physiology of the National Academy of Sciences of Ukraine (NASU), at Elbrus expeditions during 1958-1970, at the Elbrus Medical and Biological Station (EMBS) of the NASU, the employees for the first time conducted such researches as: studying the effects of acceleration on organism, adaptation of biological organisms to mountain meteorological factors and to the extreme factors of space flight, regeneration and disposal of wastes in isolated ecological system to ensure the viability of the organism during the long-term space flights; studying of the space dust in order to determine its composition and possibility of its use for lichens, fungi, algae growing; modeling of the life at the Moon surface in crater of the Eastern peak of Elbrus Mountain (1962-1964). There were studied also the possibility of resuscitation of organism in 16-25 min. after clinical death due to explosive decompression, acceleration, electric shock, acute blood loss, drowning in sea water; the influence on organism of partial weightlessness that occurs when immersed in water, the possibility and prospects of hypothermia, investigation of anabiosis with the purpose to use it during the flights in outer space; the effect of adaptation to alpine climate on the duration of hibernation, the thermal state of the testers-volunteers, who were for an hour at "altitude" of 6000 m a.s.l. at temperature of - 50 ° C (the last program was done together with the Institute of Biophysics and IBS (Moscow); conditions of hypoxia as well as hypoxia effects by themselves, and etc. Numerous inventions and their realizations have been made in the course of these researches. All these great projects with some exceptions were carried out until 2006. Finally, the substantiation of need for the development of new science - space pharmacology was done. In process of these investigations well-known scientific school – school leaded by Academician, Prof. Sirotinin MM was formed. Prof. Beloshitsky Pavel, one of the authors of present poster became EMBS Director after him for approximately 40 years, other author – Dr. Klyuchko Olena (Elena) assists and helps him in some of such projects, and now they continue some of these works in contemporary changed reality.

Continuation of the works in contemporary conditions. Today the technical part of these works is continued in National Aviation University (NAU), Kyiv (Ukraine). Great volume of obtained results were processed, analyzed and used for the new tasks solution. Because of the great problems with ecological pollution in contemporary industrial reality, we decided to direct the efforts to the development of methods and systems of ecological monitoring of environment, influences of chemical pollution on living organisms and, especially, on human. The scientific basis and the newest technical system for eco-monitoring were developed: it used a new type of the sensor groups as a technical means for the state of the environment monitoring. Accompanying laboratory, experimental methods and appropriate researches were done. The sensor model as part of a technical system for the diagnosis and testing of ecotoxins was elaborated; the corresponding software had been developed. The developed monitoring system functions in three time intervals: from immediately examination to long-term monitoring of environment; and these results already had been presented last year during DigiHealthDay2020 in Pfarrkirchen (Germany). There were demonstrated that the original information systems (IS) with databases (DB) were elaborated and suggested for the use in ecological scientific and academic practice, for environment protection. It was original developed information system for large-scale monitoring of environment "EcoIS" [2-5] together with included automated work places, expert subsystem [4, 5], and medical subsystem [6] (Klyuchko OM, 2014-2021). This new specialized computer-based information system permits to monitor the changes in organisms as result of chemical environmental pollution in wide time ranges (from 0 to few years after the influence) [2, 3] using modern information and computer technologies, on the base of novel databases and detector groups [3-5]. For the complex of these works **21 patents of Ukraine** were obtained.

Medical subsystem of "EcoIS" (Figs. 4-7). The task of "medical" part of this work was to develop a "medical subsystem" of "EcoIS" information system for monitoring the number of medical indicators of public health, biochemical indicators of human organism; to develop the electronic medical databases with patient records, and etc. This direction of the works was initiated for Ukrainian Polissya region which was affected by pollution after the Chernobyl accident. Also, it was necessary to develop an adequate way to protect information in such system. This medical subsystem was based on "General Medical Database" (GMDB) where the results of monitoring of human health indicators, including biochemical indicators of organism functioning were ordered. Medical subsystem was developed by Klyuchko OM together with talented engineer Tsal-Tsalko VI primarily for Ukrainian Polissya residents, affected in the result of Chornobyl accident (1986). Complex of the works done was following: creating of electronic medical cards for patients; development of software package "General Medical Database" as part of "EcoIS"; development of electronic medical databases also as part of "EcoIS"; elaboration of MySQL tables and C# interaction with database; and elaboration of electronic hardware key for patients' for the purpose of their personal medical data protection. In framework of these works were developed original program supply, databases, and codes. For GMDB the original program based on database controlling system, and its protection with hardware key using AVR ATmega8 microcontroller were developed. The block diagram of forms interactions of program was suggested, and connection of C# language and MySQL system for databases control by means of MySQL Connector was done. Almost dozen programs-applications were involved in development of the project. Developed program can be installed on service portable computers and used for connection with databases in remote locations from clinics and hospitals.

Review of some results of development of "EcoIS" medical subsystem with data protection.

– A set of methods and techniques were used for the elaboration of the networked, Internet-based medical information system with databases. Relational databases technology was applied, used diagnostic information was of DICOM standard. As software were used C# and MySQL;

– During the development of electronic system for the protection of software complex "General Medical Database" as part of "EcoIS", its own original program based on database managing system (DBMS) and its protection using a hardware key based on the microcontroller AVR ATmega8 were developed;

– The main moments of realization of the software complex "General Medical Database" were described in [6], other our publications (see below). The block diagram of interactions of forms of the program was shown and the connection of C# language and MySQL database management system by means of MySQL Connector was explained;

– The main stages of designing of hardware key used to protect personal medical data in the database was described in [6]. Its wiring diagram and software were presented using the AVR Studio programming environment. The binding of electronic key to software package using the LibUSBdotNET library was grounded (the library is standard in C and C++ programming languages);

– The developed databases can store all prescriptions prescribed by doctors, their forgery is impossible and therefore, all information can be checked by pharmacists;

– Almost dozen applications were used during the project development. The main program for Windows 8 on the .NET Framework 4.5 was implemented. The developed program can be installed on service laptops and use distantly the connection to the database in remote locations from hospitals and clinics;

– Applying the methods of object-oriented programming for results processing and for the design of object-oriented databases was offered;

– Methods of eco-monitoring of the state of health of the population on the regions of Ukrainian Polissya affected by pollutants were offered with use of "EcoIS" system and taking into account foreign experience of carrying out such works;

– The electronic system for the protection of the software complex "General Medical Database" as a part of "EcoIS" was developed. For this purpose the own original program on the basis of DBMS and its protection by means of hardware key on the basis of the AVR ATmega8 microcontroller was developed (Fig.8).

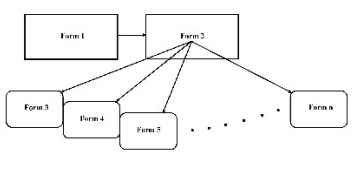

Fig.4. Medical subsystem-structure of program complex

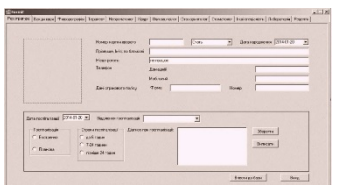

Fig.5. Form 2, the tab «Registration»

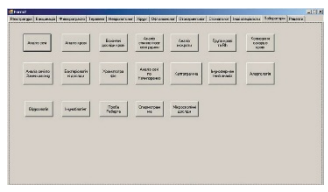

Fig.6. Form 3, the tab «Laboratory» (for biochemical laboratory)

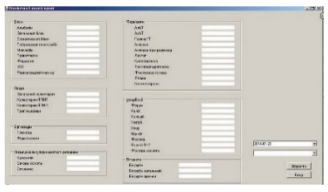

Fig.7. Form 5, the tab «Biochemical analysis of the blood»

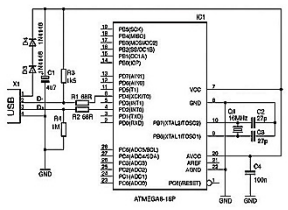

Fig.8. The principle scheme of hardware key

References

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[6] Klyuchko O. M. Medical information system for monitoring of the health state of population with personal data protection. Medical informatics and engineering, 2020, V.49. – №1 – P. 17-28 (In Ukrainian)

Conclusions. Results of the development of new medical networked, Internet-based information system with databases for monitoring of numerical indicators of public health are presented. This medical system is a part of "EcoIS" information system for monitoring of chemical pollution of environment in three time intervals (from "0" moment to long-term monitoring); it is based on distributed databases, and it is developed and suggested for the use in public health, ecological and scientific practice, as well as for the purposes of environment protection.

Original program supply was developed for "EcoIS" and it medical sector. Patients' personal data protection in this information system was realized using original electronic hardware key