PROSPECTS FOR INTRODUCTION OF HOME-MADE EQUIPMENT FOR RADIONUCLIDE DIAGNOSTICS

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Abstract

The radionuclide diagnostics allows the most of diseases to be diagnosed at a very early stage and therefore it has received much attention over the last years. The current concept of the radionuclide diagnostics advancement takes into account Russia geographic and demographic features, and supports the introduction of the home-made equipment into practice. As a basis, the concept assumes the establishment of regional diagnostic centers at large hospitals in each Russian Federal district. Each such a center should be equipped with a cyclotron of the CC-18/9 model, modules for radiopharmaceuticals' synthesis, single-photon emission (SPECT) and positron (PET) scanners. The yield of radiopharmaceuticals' production will satisfy the needs of such a center and of 30-35 SPECT-"satellites" located in diagnostic departments of hospitals situated up to 1000 km from the center. In future, autonomous PET- centers, each equipped with specialized CC-12 cyclotrons, modules for radiopharmaceuticals' synthesis and with 3-4 PET scanners can be established on the basis of these diagnostic departments. The implementation of the Federal Targeted Program on the serial production of cyclotrons and SPECT will require 5-6 years to increase the number of the people examined per year up to 1.0-1.2 million.

Nowadays in Russia the radionuclide diagnostics based on the use of radioactive isotopes is beyond the reach of the majority of people. In accordance with the program of the Ministry of Health and Social Development of the Russian Federation in force at present, three large federal medical high-technology centers are to be built in Dimitrovograd, Obninsk and Tomsk; PET-centers and radionuclide therapy departments are to be built in Krasnoyarsk, Nizhniy Novgorod and Novorossisk. The higher yield of radioisotopic products should be provided in Moscow, Obninsk and Tomsk.

The suggested construction of federal high-tech medical centers in the vicinity of the nuclear-power industry facilities offer definite advantages due to the location of the sources of radioactive products close to consumers. However, there are serious disadvantages connected with necessary staffing these federal centers with a qualified medical and technical personnel and a large volume of capital construction. It is sufficient to note that thousands of patients and accompanying persons from all regions of the Russian Federation will come to these center,s and all these people will need a place to live in. For example, Dimitrovgrad or Obninsk, towns with a population of 100-120 thousand people, will have to accommodate tens of thousands of people per year who need diagnostics and treatment. In this context, a developed infrastructure is needed including hospitals with medical and auxiliary personnel, hotels, public catering, transport, etc. The total number of tomographs functioning in three federal centers will be much lower than it is required for Russia in compliance with the world standards.

So, this program does not take into account geographic and demographic features of our country and in view of large volumes of necessary capital construction, including residential housing, and serious staff problems, the delivery of modern therapies to the majority of people will be postponed for an indefinite period of time. There are grounds to suppose that an expensive import equipment will be purchased to equip these centers, and interests of the national manufactures will be completely ignored.

NIIEFA in cooperation with other organizations can manage to completely equip radionuclide diagnostic centers mostly with home-made equipment by analogy with the operating PET center in the Russian Research Center for Radiology and Surgical Technologies, Pesochnyi, St. Petersburg [1].

In NIIEFA the designing of a new series of cyclotrons, the CC-12, CC-18/9 and MCC-30/15, has been finished and prototypes of these machines have been manufactured (digits here denote the design energy of proton/ deuterium ion beams). When designing these machines, the following innovations were realized: the acceleration of negative hydrogen ions generated by an external source and extraction of beams of accelerated protons and deuterons by recharging on thin carbon foils. Three CC-18/9 and one MCC-30/15 cyclotrons have been manufactured and put into operation. These machines are used for production of a wide set of ultra short-lived and short-lived radionuclides used in medicine for PET and SPECT diagnostics. The CC-18/9 and MCC-30/15 cyclotrons also produce short-lived radionuclides for the contact radiation therapy. The CC-12 cyclotron specialized only in production of ultra short-lived radionuclides is nowadays under tests at a test facility in NIIEFA.

A prototype of the double-detector single-photon emission computerized tomograph "EFATOM" has been designed and manufactured [1]. After successful technical and clinical tests, the "EFATOM" was put on the list of the medical equipment allowed to be produced in Russia.

So, prototypes of the major equipment, cyclotrons and tomographs, to be used in the present-day radionuclide diagnostics have been designed and manufactured in

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NIIEFA. A Federal Targeted Program on the serial production of cyclotrons and single-photon tomographs has been approved, which allows the problem of centralized supplies of competitive home-made equipment to medical institutions of Russia to be successfully solved.

Nowadays, the State Corporation "ROSATOM" is conducting negotiations with a number of firms on the joint production of PET tomographs, radiopharmaceuticals synthesis and packing modules and protective boxes.

Taking into account vast territories of Russia and comparatively short half-life of the radionuclides used for diagnostics, it is reasonable to build regional centers for the radionuclide diagnostics in each federal district of Russia [2]. This will allow a decentralized production of short-lived radiopharmaceuticals and location of SPECT and PET tomographs proportionally to the population density. These centers should be established on the basis of large medical institutions (medical scientific and therapeutical centers, republican, regional and municipal hospitals, oncologic dispensaries), which have a well-developed local infrastructure. In these institutions, diagnostics of cardiological, oncological and neurological patients is a routine practice and they are staffed with qualified medical and technical personnel experienced in diagnostics and treatment of similar diseases.

Each of the regional centers of the radionuclide diagnostics shall be equipped with a cyclotron of the CC-18/9 type, radio-chemical laboratory with radiopharmaceuticals synthesis and quality control modules and two types of tomographs, SPECT and PET. The centers can be equipped with home-made equipment on a centralized basis. The radiopharmaceuticals for PET and SPECT tomography will be produced in these centers, and examinations of patients will be carried out. Alongside with positron and single-photon isotopes produced on cyclotrons, comparatively long-lived "reactor" isotopes will be also used for these purposes. In addition to the own needs, each center can provide functioning of up to 30-35 SPECT- "satellites" located in republican, regional and district hospitals located at a distance of up to 1000 km from the center. After the identification of a disease, therapy to patients will be administered in the hospitals, which have functioning rooms of the radionuclide diagnostics. To equip such rooms all over the country, the total number of SPECT needed is estimated to be 325-330 apparatus.

In future, up to 50-60 autonomic PET centers can be established in largest hospitals on the basis of similar rooms of the radionuclide diagnostics. Such a PET center shall include the following equipment: CC-12 cyclotrons, modules for ultra-short-lived radiopharmaceuticals synthesis and positron scanners. Yields of the radiopharmaceuticals produced on a CC-12 cyclotron provide functioning of 2-3 PET scanners located in the vicinity of each cyclotron. Over the whole country, the number of functioning scanners can reach up to 120-140 apparatus.

The aforementioned number of regional and autonomic centers will bring the radionuclide diagnostics in RF within the reach to all levels of the country population, and the situation will be similar to countries with developed economy. In 5-6 years, the scale of examinations will be 1.0-1.2 millions patients per year.

Thus, to reach the world level in medical services, 130-140 PET scanners and 320-330 SPECT scanners, 10 cyclotrons of the CC-18/9 model, 50-60 cyclotrons of the CC-12 model and 3-4 machines of the MCC-30/15 should be introduced to the national clinics and hospitals. The MCC-30/15 cyclotrons are used for large-scale production of various radionuclide products, for medicine included. [3].

In view of qualified personnel, raduonuclide products available in federal regions, scales and limited terms for the introduction of new equipment, it is reasonable to start practical implementation of the program in the Federal Northwestern District as the most ready for this purpose. We think that installation of single-photon tomographs in St. Petersburg (in several hospitals and dispensaries), Kaliningrad, Arkhangelsk, Cherepovets, Vologda, Murmansk, Petrozavodsk, Syktyvkar, Velikiy Novgorod, Pskov and Severodvinsk will be sufficient to provide the population of the Federal Northwestern District with modern medical diagnostic apparatus. For this purpose in large hospitals of the aforementioned cities and towns, rooms for isotopic diagnostics equipped with SPECT and other necessary equipment should be established in accordance with a standard plan. Simultaneously, hospitals should be re-equipped, as far as possible, with new medical equipment, staffed with qualified attending personnel and provided with a storage bank of data on the health level of the RF population.

In compliance with the effective world standards, the Northwestern Federal District should be equipped with up to 34 SPECT and up to 13 PET tomographs. At present, there are 12 and 4 functioning apparatus, respectively, all in St. Petersburg.

Ready radiopharmaceuticals labeled with I-123, Ga-67, In-111, Tc-99m and other isotopes will be supplied to new diagnostic rooms from St. Petersburg (produced on the CC-18/9 cyclotrons and three MGC-20 cyclotrons), Gatchina and Sosnovyi Bor (Mo-99/Tc-99m reactor generators).

Personnel training can be organized in the Russian Research Center for Radiology and Surgical Technology (RRC RCT), where functions a large system consisting of two cyclotrons, target devices, modules of radiopharmaceuticals' synthesis and quality control. It should be noted that home-made equipment is also applied. The RRC RCT provides their own needs and, in addition, regularly supplies ultra short-lived radiopharmaceuticals to St. Petersburg and short-lived radiopharmaceuticals to Moscow.

The RRC RCT is one of the leading medical centers in Russia, and it can promptly and effectively deliver consultation services for the patients in the Northwestern District.

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In conclusion we should to draw attention to a profound economical and social effect to be produced by the introduction of the nuclear medicine methods into the national Healthcare Service as the state of health, higher quality of life and larger life span of millions of people are concerned.

The suggested concept of the radionuclide diagnostics advancement on the basis of regional centers established in each Federal district fits well into the existing today organization of medical services to the population of the Russian Federation. The concept gives proper weight to geographic and demographic features of the country, and within the shortest time and in the most cost-effective way will allow the majority of the RF population to be provided with modern medical diagnostics and subsequent therapy mostly using the home-made medical equipment

The main customer of the new production for medicine is the state. Therefore, in the case of expansion of a high-tech equipment production in Russia, the expenditures of the state budget for purchasing medical equipment abroad will be substantially reduced. An additional saving can be obtained due to the use of the PET-center standard plan designed by the State Corporation "ROSATOM".

The production of the high-tech home-made equipment for the nuclear medicine will result in a larger number of worksites and higher qualification level of the personnel; will give an impetus to progress in adjacent fields of science and engineering. So this will stimulate higher technological development of our country.

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