The use of an electronic register in monitoring the incidence of osteoporosis among residents of the north

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Abstract. The article deals with operating the systems for preventing low-energy fractures in patients older than 50 years with signs of osteoporosis, complemented by trauma and therapeutic services. The current paradigm of osteoporosis diagnostics is to identify and follow up on patients with high risk of osteoporotic fractures – on the basis of clinical factors for 10-year absolute risk according to FRAX international scale. Further, the article presents the results of work to develop the electronic register to record information about patients with signs of osteoporosis, hosted by the endocrinological center at E.E. Volosevich First Municipal Clinical hospital in Arkhangelsk. The developed register includes six sections allowing to enter data on patients; results of laboratory research; x-ray osteodensitometry; and the osteoporosis therapy prescribed. The rationale is presented for the need in the development of such a monitoring system for more effective collection of epidemiological data on osteoporosis in Arkhangelsk and Arkhangelsk Region, as well as in more objective assessment of health services quality.

1. Introduction

According to the World Health Organization, due to its high prevalence, medical, social and economic consequences caused by osteoporotic bone fractures, osteoporosis is one of the major socially significant diseases among all other chronic, non-infectious diseases. [1]. Osteoporosis is a progressive systemic disease of the skeleton, characterized by a decrease in bone mass, microarchitectural disorders of bone tissue, leading to an increase in bone fragility and an increased risk of low-energy fractures [2, 3].

According to epidemiological studies, osteoporosis is diagnosed in patients of all countries and ethnicities. In Russia and globally, osteoporosis is seen as one of the gravest public health problems, as it affects, on average, every second female and every fourth male resident over 50 [4].

The only essential clinical manifestation of osteoporosis is low-energy fractures, which are defined as fractures of different localization that occur in 50+ year old people from falling from a height which
is less than their own height. The current strategies for osteoporosis therapy are based on the postulate that for better osteoporosis therapy efficiency it should be prescribed to those patients who have already had a fracture, especially in the thigh or vertebra, as well as patients who may be prone to fracture based on their individual risk factors [5, 6].

Fractures that have developed with minimal trauma represent not only a clinical manifestation of osteoporosis, but also a major risk factor for secondary fractures. For example, a forearm fracture suffered by a woman over 50 increases the risk of spinal fracture by 72% and the probability of proximal femur fracture by 43%. In general, the risk of a re-fracture increases two-fold after any fracture suffered, remaining high for 10 years, being maximum in the first year after the fracture occurred [7].

The role of primary health care physicians in prevention, diagnostics and treatment of this disease is quite high, given that 80% of patients seek medical care in primary health care institutions [8]. However, as the numerous surveys among general practitioners have revealed, there exists a lack of awareness of the problem of osteoporosis, as well as the lack of the holistic vision of the disease, despite the availability of national recommendations for diagnostics, prevention and treatment of osteoporosis. To some extent, this is due to the fact that the management of osteoporosis patients is mainly the responsibility of specialist doctors (traumatologists, orthopedists, rheumatologists, endocrinologists) [9].

It should also be noted that orthopedic traumatologists do not differentiate fractures according to the cause of injury: they do not distinguish fractures received from minimal traumatic effects, which are the main clinical manifestations of osteoporosis. The survey conducted on the problem of osteoporosis among orthopedic traumatologists in all the federal districts of the Russian Federation, has shown that osteoporosis is registered as an independent clinical entity with separate code on the International Classification of Diseases only rarely, by only 23% of the doctors surveyed [10].

In addition, there is low adherence among Russian patients to the pathogenetic treatment of osteoporosis: only 14% start the recommended treatment, of whom 16% stop it, mainly in the first six months from the start of taking drugs, because they do not see any prominent result of their therapy; and only 40% follow the therapy consistently [11].

FRAX (Fraction Risk Assessment Tool) – the globally introduced algorithm for calculating the 10-year absolute risk of the main osteoporotic fractures (femur, vertebrae, forearm and humerus) – allows to determine the probability of fracture occurrence in a particular patient based on their age, sex, body mass index, concomitant conditions, and data on mineral density of the femoral neck, where osteodensitometry is available [12]. Thus, a new international diagnostics paradigm for osteoporosis is currently being developed, which consists in identifying patients with higher risk of low-energy fractures based on the clinical risk factors [13].

Since osteoporosis is diagnosed mainly based on previous low-energy fracture suffered, the International Osteoporosis Foundation (IOF) has, in recent years, been focusing its attention on the establishment of global secondary prevention services for osteoporotic bone fractures which would be based on existing health care resources. In many developed countries, the system for preventing repeated fractures is already in place, with trauma and therapeutic services, and primary health care doctors as its component. The analysis was conducted by the dedicated working group at the International Osteoporosis Foundation into the international experience in implementing the various models of repeated fractures prevention system, which has made it possible to identify core principles of the effective operation of such systems. At the same time, it was found that follow-up of patients should commence in the trauma center, as a significant proportion of osteoporosis patients can be identified at this stage [14].

The essence of the system for repeated fractures prevention consist in continuous follow-up of 50+ year old patients with fractures caused by osteoporosis, by trauma and therapeutic services together. The most important outcome of the analysis is the conclusion that the secondary prevention system for osteoporosis-related fractures should be multi-component and introduce coordinator – the core
prerequisite for efficiency. The coordinator is designed to be link between trauma services, the primary health care and other specialists [15].

The effectiveness of the secondary prevention systems for osteoporosis-related fractures, which are assisted by coordinators, has been proven in many different countries [16, 17]. These systems have been found to have a positive impact on patient adherence: 74% to 88% of patients who were supervised after fracture were following therapy up to its 12th months, and 64% to 75 % up to the 24th month. These data suggest that fracture patients tend to be following the instruction more in the period immediately after receiving the fracture, a fact that should be taken into account by the prevention system in general [18].

Within the framework of the target program of the Russian Association for Osteoporosis "Prometheus", there have been established the first domestic services for repeated fractures prevention, organized in Yaroslavl [15] and St. Petersburg – at Municipal Polyclinic №96 [19] and Vreden RNIITO [20]. The analysis of their initial performance has confirmed the high demand in their services, having highlighted also a number of challenges, primarily of organizational nature.

It is obvious that the repeated fractures prevention services should incorporate, among others, an organized system for collecting patient data in order to achieve a comprehensive picture of the clinical practice – diagnostics, prevention and treatment of osteoporosis. Experience with the use of computer-based systems shows that one of the most efficient tools for patient data collection, processing, comparison, and storage is electronic register [21].

The endocrinological center at E.E. Volosevich First Municipal Clinical Hospital in Arkhangelsk hosts, since 2016, the official office for prevention and treatment of osteoporosis, designed also for low-energy fracture patients routing (School of Osteoporosis). The official osteoporosis incidence in Arkhangelsk Region is low (2010 – 50 per 100 K; 2015 – 73 per 100 K). Over the recent period, however, it has increased 46%. A similar trend is observed in the rest of Russian regions and, in particular, North-Western Federal District (7.8% and 8.3%, respectively). These low rates are only the "top of the iceberg", indicating a low detectability of this multidisciplinary disease [22].

2. Purpose of the study
Based on the above, the relevance of the electronic register on patients with signs of osteoporosis is justified by the need to improve health care services in general and the need to optimize osteoporosis patients follow-up in particular.

3. Materials and methods
The object-oriented programming language «C#» was used to create the electronic register. The core of the system is an information database containing information on patients with signs of osteoporosis. The work to develop records database employed MySQL relational database. The electronic register is designed to be compatible with Windows 7 to 10.

4. Results
The electronic register we have developed has an intuitive interface that allows for fast entering of data by coordinator and includes six sections for various details on 50+ year old patients, diagnostic investigations and therapy.

Figure 1 is block diagram showing information representation in the electronic register.
Figure 1: The block diagram showing information representation in the electronic register.

The main dialog window of the electronic register is presented in Figure 2 and displays a list of existing records in the database.

Figure 2: The main dialog window of the electronic register.
The register of patients with signs of osteoporosis provides an opportunity to obtain, automatically, the 10-year probability of osteoporotic fracture, using the web resource of FRAX international model (Fig. 3). This eliminates the need for multiple visits to the network resource during the day and for manual entry of the patient data into the fields of the web page, which ultimately saves coordinator the time, increasing the overall performance of the office for osteoporosis of prevention, diagnostics and treatment.

It should be noted that FRAX instrument is not validated for patients who have previously received or are receiving at the time of treatment, pharmacotherapy for osteoporosis. However, patients who stopped taking medicine 2 or more years ago may be considered untreated.

![Figure 3: Dialog window for assessing the 10-year probability of osteoporotic fracture on FRAX international scale.](image)

In the differential diagnostics of primary osteoporosis and other metabolic diseases of the skeleton, laboratory investigations are mandatory. They also help clarify the cause of secondary osteoporosis. The list of laboratory investigations presented in the register covers biochemical parameters, markers of bone remodeling, and vitamin D content.

The dynamic monitoring of the drug therapy for osteoporosis can be carried out according to the results of densitometry as the most accurate instrumental method. The relevant section includes bone mineral density (BMD) and its T- and Z-criterion-based evaluation.

Section "Hospital Treatment" includes data from the medical record of patients operated on for low-energy fracture continuity, enabling one to estimate the continuity of patient follow-up after discharge.

The register provides for automatic generation of reporting forms and prompt receipt of information over the period of time in question. It should be also noted that its software operates a statistical unit with a graphical and tabular representation of the information based on user request. This unit allows for the analysis of composition of the cohort who applied the endocrinological center for medical care, as well for the assessment of annual increase in osteoporosis incidence. The obtained data can be used to forecast morbidity and the community’s need in preventive care.

5. Conclusion
The developed electronic register allows for the computer-based monitoring which enables to:
- identify patients with high risk of low-energy fractures on the basis of FRAX international probabilistic scale of risk factors; and provide preventive care;
- prescribe therapy for osteoporosis, evaluate its effectiveness and, if necessary, introduce corrections, based on the results of lab investigations and densitometry;
- assess patient compliance by monitoring their adherence to ant osteoporotic therapy;
- develop optimal algorithms for the prevention of repeated fractures;
- reduce low-energy fractures expectancy; and
- schedule the performance of the services for repeated, osteoporosis-related fractures prevention.

No less significant among the outcomes of introducing the electronic register into the office for prevention, diagnostics and treatment of osteoporosis, is the resulting availability of data on the outcomes of the disease depending on its severity, as well as the availability of database of Arkhangelsk residents with signs of osteoporosis.

Thus, the work to create the local electronic register, hosted by the endocrinological center, is expected to lead to better-performing monitoring of epidemiological data on osteoporosis in Arkhangelsk and Arkhangelsk Region, as well as to more objective assessments of the organization and quality of health care services.

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