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How to use methods designed for fracture risk assessment in daily practice

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Abstract

Introduction: The aim of the study was to present the optimal way of use in daily practice the methods designed for fracture risk assessment.
Material and methods: The study presents methods designed for fracture risk assessment. Among the long list of available methods, only some may be recommended for use in daily practice. Obvious necessity of simplicity, short duration of calculation of fracture risk, and reliability of method clearly indicate that only algorithms available as Webpage fulfil these expectations. Algorithms FRAX, Garvan, Qfracture, and POL-RISK allow for quick assessment according to the described conditions. Fracture risk is commonly established for the next 10 years for hip, major, or any fractures and expressed by percent of risk.
Results: The essential conditions of optimal use of methods for fracture risk assessment were presented and discussed. The following points were included: methodology, conformity, and recommended thresholds as medical and economic considerations.
Conclusions: The optimal use of methods designed for fracture risk assessment require several steps. Independently of these essential conditions, one should remember that always in management each patient must be individually assessed. The pharmacologic therapy should always be started according to the level of fracture risk and other factors not included in the assessment of fracture risk.
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Keywords: *fracture probability; fracture risk; osteoporosis; women*

Introduction

Involutional osteoporosis is one of the most common diseases in elderly subjects. Due to a lack of obvious clinical signs of the process of bone loss, osteoporosis is called the "silent bone thief". The number of affected individuals is large; according to the report presented by the National Health Service, the total number of patients in Poland is 2.2 million [1]. Therefore, osteoporosis is also called the 'silent epidemic' due to the great number of affected subjects. Osteoporosis is a disease closely connected with social changes common in civilization. Such factors as prolonged lifetime duration, low level of physical activity, common use of several medications (glucocorticosteroids, anticonvulsants, protein pump inhibitors, etc.), changes in diet habits including low calcium intake and high concentration of phosphates, which diminish calcium intestine absorption, smoking, and alcohol abuse contribute to bone loss. Frequently osteoporosis is compared with atherosclerosis, another clinically silent, common disease in modern societies.

The crucial problem of osteoporosis is fractures caused by low-energy trauma, commonly by a fall from a standing height. Some fractures (spine, ribs) may occur without any fall. The most common are fractures at spine, hip, forearm, and arm, called "major osteoporotic fractures". According to the earlier mentioned report presented by the National Health Service, annually in Poland in the years 2013–2024 the average number of typical osteoporotic fractures was 130,000 [1]. Generally, fractures depend on two main reasons: the degree of bone loss, which diminishes skeletal resistance to external forces, and the affected functional status, which increases the fall rate. Because of the long-term silent clinical course of osteoporosis and great number of patients, the most important point is the assessment of fracture risk. Early detection of high fracture risk should allow therapy to be started, which would diminish general fracture risk. The therapy should begin before the first osteoporotic fracture because a prior fracture significantly increases the risk of subsequent fracture [2].

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Several methods designed for fracture risk assessment were proposed, but still the problem of their optimal use is a matter of discussion and evaluation. In a review manuscript, 48 different tools designed for fracture risk assessment were shown [3], 20 of which were externally validated, and only six had been tested more than once in a population-based setting with acceptable methodological quality [3].

Fracture risk is commonly established for the next 10 years for hip, major, or any fractures and is expressed by percent of risk. Obviously, it is not possible to reach 100% accuracy in fracture risk assessment. Another problem concerns the level of risk as a threshold for initiation of pharmacologic therapy. Usually, the risk of 3% for hip and 10-20% for major (hip, spine, arm, forearm) or any fractures is recommended [4]. As well as the level of risk, the ease and time needed to establish fracture risk is important for practitioners. Therefore, the most expected are methods available as Web calculator. FRAX [5], Garvan algorithm [6, 7], Qfracture method [8], and POL-RISK [9, 10] are the methods established for fracture risk assessment available as Web calculator. Such features are essential for practitioners who need a reliable and quick response regarding fracture risk in individual patients.

In the current manuscript we present available methods for the assessment of fracture risk dedicated for daily use. We also include recommendations on how to use these methods in daily work with patients.

Methods available as Web calculator

FRAX

FRAX concerns males and females aged 40–90 years. Fracture risk is expressed as probability for major and hip fractures for 10 years. Several clinical risk factors are included, but previous falls are not considered. Patient height and weight are used. The calculation is possible with and without femoral neck Bone Mineral Density (BMD). FRAX is designed on the basis of epidemiological data instead of true prospective observation. Versions for several countries are available.

QFracture

This algorithm allows the calculation of fracture risk in males and females aged 30–99 years. Fracture risk concerns major and hip fractures for 10 years. A long list of potential clinical risk factors is included, and patient height and weight are necessary. History of falls is

Table 1. *Specific features for FRAX, Qfracture, Garvan algorithm and POL-RISK*

Specific feature	FRAX	Qfracture	Garvan	POL-RISK
Gender	Male, female	Male, female	Male, female	Female
Assessment of all fractures	No	No	Yes	Yes
Assessment of major fractures	Yes	Yes	No	No
Assessment of hip fracture	Yes	Yes	Yes	No
Falls included	No	Yes	Yes	Yes
Multiple falls included	No	No	Yes	No
Assessment of fracture risk	No	Yes	Yes	Yes
Assessment of fracture probability	Yes	No	No	No
Age range [years]	40–90	30–99	55–96	> 55
Use of femoral neck BMD	Yes	No	Yes	Yes
Calculation without femoral neck BMD	Yes	Yes	Yes	No
Use of weight	Yes	Yes	No	No
Use of height	Yes	Yes	No	No
Use of prior fracture	Yes	No	Yes	Yes
Use of prior multiple fractures	No	No	Yes	No
Medical thresholds for therapeutic decision included	No	No	No	No
Economic thresholds for therapeutic decision included	No	No	Yes	No
Assessment for 5 years	No	No	Yes	No
Assessment for 10 years	Yes	Yes	Yes	Yes
Assessment of population	Several	English, Welsh, Scottish	Australian	Polish
Design: prospective observation	No	No	Yes	Yes
Design: data analysis	Yes	Yes	No	No

also included. The calculation is possible only without femoral BMD, and densitometry results are not used. Qfracture is designed on the basis of epidemiological data obtained from an enormous number of data from general practitioners in the UK and is recommended for use only in England, Scotland, and Wales.

Garvan

This algorithm is designed in Australia and is based on a long-term prospective observation of a great epidemiological sample of males and females (DUBBO Study). The fracture risk calculation is possible for ages 50–96 years. Algorithm takes into consideration four risk factors: age; prior fracture of low-trauma character after the age of 50 years and the number of fractures, falls, and number of falls in the prior 12 months; and femoral BMD. Risk concerns the period of 5 and 10 years for hip and any fractures. The website also includes ranges of risk approved for prescription of reimbursed medications in Australia. For any fractures it is possible if the risk exceeds 26%, below 14% is not possible, and in the range 14–26% Australian physicians may prescribe reimbursed therapy if additional risk factors not included in the algorithm are also present. Respective thresholds for hip fractures are 3% and 9%.

POL-RISK

This algorithm is designed according to data gathered in a prospective 10-year observation of an epidemiological cohort of postmenopausal females aged at baseline at least 55 years. The number of women recruited at baseline was 978. This study received the acronym RAC-OST-POL, and the population studied was previously described [11]. The risk for any fractures concerns only postmenopausal women aged over 55 years. The upper age limit is not stated. Separate hip fracture risk is not available because the number of hip fractures observed during a period of observation was too low. POL-RISK takes into consideration four risk factors: age; prior fracture of low-trauma character after the age of 40 years and their number; falls in prior 12 months; and femoral BMD expressed as T-score. Calculation without BMD is not possible.

Table 1 presents specific features of the 4 algorithms designed for fracture risk assessment.

Discussion

The problem of accurate and reliable measurement of fracture risk is a crucial issue for practitioners conducting therapy in osteoporotic patients. One may expect that besides accuracy and reliability, duration of calculation is also important, so the methods available as Web calculator are necessary. Despite the value of fracture risk assessment, individualization of the management is always recommended. Below we discuss several important points concerning models and their use in daily practice.

Methodology

Usually, fracture risk is established for next decade. Such information may be obtained in a prospective observation with a duration of ten years or as mathematical analysis of epidemiological data. Obviously, the most reliable data are provided by a prospective observation of large, epidemiologically representative populations. Among the four methods described in the manuscript, only Garvan and POL-RISK fulfil this essential condition. In recent recommendations of a group of experts, it was suggested that the best method is based on observation in local populations [12]. Therefore, the optimal method in Australia is the Garvan algorithm and in Poland the POL-RISK. One should also take into consideration the role of level of bone mass expressed by densitometry measurements. For FRAX, Garvan the risk may be established with and without BMD measurements. The final result is commonly close with and without the use of densitometry. However, it seems to be more appropriate for daily work with patients to use algorithms including BMD measurements. The performance of densitometric measurements is important for patients and helps enhance patients' adherence to the therapy.

Conformity

The problem of conformity between results of fracture risk given by various methods was a matter of interest of several authors [13–20]. Most studies showed comparisons between FRAX and Garvan algorithms. Generally, the conformity is high, but one should remember that the methodologies are different, and various risk factors served for fracture risk calculation. For example, FRAX expresses fracture probability, and Garvan shows fracture risk. Furthermore, FRAX concerns only major fractures, and Garvan presents fracture risk also for other fracture skeletal sites. Also, the age range of patients differs between methods. These methodological differences indicate that the conformity never will reach 100%.

Besides direct conformity, the level of risk in regard to implementation of therapy is most important. Such a concept was verified in two of our studies [21, 22]. The thresholds of 3% of risk for hip and 20% for any fractures were used. For example, when one method revealed a risk for hip fracture of 1% and another of 2% the results are in concordance because both results are below the threshold of 3%. For any fractures the therapeutic threshold was 20%. In the mentioned studies

conformity of FRAX and Garvan algorithms were close to 80%, which is a very good result.

Recommended thresholds — medical consideration

Another important point concerns optimal thresholds for accurate fracture prediction. One may expect that each patient with a high level of risk will incur a fracture, and all with low level of risk will avoid a fracture. In daily life such expectations are not realistic. In our recent study this problem was a matter of interest, and a level of risk 18% by POL-RISK was the optimal threshold [23]. A longitudinal retrospective study of 457 patients has shown that in 70% of patients with high baseline risk fracture occurred in the period of observation or did not occur in those who had low baseline fracture risk.

Recommended thresholds — economic considerations

Besides the true medical point of view, economic conditions are also important for the implementation of algorithms in daily use. This problem was recently discussed in "Endokrynologia Polska" regarding POL-RISK [24]. The prescription of reimbursed medications must be in concordance with the health system, and the thresholds of fracture risk should also include economic aspects. The common analysis of both medical and economic aspects indicates the optimal level of risk recommended for practitioners. Currently, in Poland such a threshold for use of reimbursed therapy has not been established.

Probably the best idea is presented by the Garvan algorithm. The threshold of risk of 26% for any fracture is a level of risk that allows the prescription of reimbursed medication. The respective value for hip fracture is 9%. If the respective risk is lower than 14% for any fracture and 3% for hip fracture, reimbursed medications are not allowed. Additionally, a wide range for individualization is proposed (3–9% for hip and 14–26% for any fractures). The presented recommendations are a compromise between true medical and economical aspects, and individualization is also included.

Practical considerations for POL-RISK

We propose the following steps for practitioners in their daily practice to establish the optimal choice in patient management:

1. Measurements of height and weight.
2. Gathering data on clinical risk factors for fractures.
3. Performing bone densitometry (usually at spine and hip, femoral neck BMD is directly used for calculation of fracture risk, and spine BMD should be used as an additional risk factor).
4. Calculation of fracture risk — risk exceeding 18% by POL-RISK in postmenopausal women suggests the necessity of therapy.
5. The final decision on the start of pharmacologic therapy should include several points, especially those that are not included in the method used for calculation of fracture risk (either clinical feature or diagnostic finding). It means that the assessment of fracture risk should be considered as an important criterion in management, but individualization is always necessary.

Conclusions

The optimal choice of method designed for fracture risk assessment requires several steps. Independently of these essential conditions, one should remember that always in the management each patient must be individually assessed. The pharmacologic therapy should always be started according to the level of fracture risk and other factors not included in the assessment of fracture risk.

Author contributions

R.H. — writing the first manuscript; W.P. — critical review of the manuscript; H.H. — selection and the review of literature.

Conflict of interest

The authors declare no conflict of interest.

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