Features of the application of the digital clinical calculator of cardiovascular risk in elderly patients

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Abstract

Aim – evaluation of the features of using a digital clinical calculator for an objective assessment of the cardiovascular risk in elderly patients in a routine outpatient practice.

Material and methods. The methodology for calculating the value of cardiovascular risk used in the calculator is based on the recommendations for the prevention of CVD of the European Society of Cardiology (2021). The program provides the functionality of calculating the personalized quantitative value of the probability of fatal and non-fatal cardiovascular events over a period of 10 years.

Results. The calculator matrix uses five significant initial variables: patient's age, gender, smoking, systolic blood pressure and low-density lipoprotein cholesterol. The program provides for use directly in outpatient settings, works in any browser, does not require downloading to a device, can be used in a mobile phone version, and allows the user to form a conclusion for printing and saving on electronic media.

Conclusion. The calculation of an objective numerical indicator of risk of CVD, which lends itself to accurate mathematical and statistical assessment, allows the calculator to be used to solve the following tasks: monitoring and reclassification of cardiovascular risk in elderly patients, a weighted assessment of indications for correction of modifying factors and intensification of treatment, dynamic control of the effectiveness of the treatment methods used; the result of the calculator is stored as an electronic medical document. The program can be used in any medical information system as a module of the medical decision support system through the integration subsystem.

Keywords: elderly patient, cardiovascular risk, clinical calculator, digital assessment method, evidence-based medicine, medical decision support system.

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Особенности прикладного применения цифрового клинического калькулятора кардиоваскулярного риска у пациентов пожилого возраста

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Аннотация

Цель – определить особенности применения цифрового клинического калькулятора объективной оценки значения кардиоваскулярного риска пожилого пациента в условиях рутинной амбулаторной практики.

Материал и методы. Методология расчета значения кардиоваскулярного риска, использованная в калькуляторе, основана на рекомендациях по профилактике АССЗ Европейского общества кардиологов (2021). Программа позволяет рассчитать персонализированное количественное значение вероятности фатального и нефатального сердечно-сосудистого события в течение 10 лет.

Результаты. Матрица калькулятора использует пять существенных исходных переменных: возраст пациента, пол, курение, систолическое артериальное давление и уровень холестерина липопротеидов невысокой плотности. Программа предусматривает применение непосредственно в условиях амбулаторного приема, работает в любом браузере, не требует скачивания на устройство, может быть использована в версии для мобильного телефона, позволяет формировать заключение для вывода на печать и сохранения на электронном носителе.

Заключение. Расчет объективного численного показателя риска АССЗ, который поддается точной математической и статистической оценке, позволяет применять калькулятор для решения следующих задач: мониторинга и реклассификации кардиоваскулярного риска пожилого пациента, взвешенной оценки показаний к коррекции модифицирующих факторов и интенсификации лечения, динамического контроля эффективности применяемых методов лечения; результат работы калькулятора сохраняется в виде электронного медицинского документа; программа может быть использована в любой медицинской информационной системе в качестве модуля системы поддержки принятия врачебных решений через подсистему интеграции.

Ключевые слова: пожилой пациент, кардиоваскулярный риск, клинический калькулятор, цифровой метод оценки, доказательная медицина, система поддержки принятия врачебных решений.

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INTRODUCTION

The global demographic trend of ageing population is a serious challenge faced by the modern healthcare system. According to WHO information, by the year 2050 the share of people aged over 60 may reach 38% and become greater than the share of people aged 10–24 (2.1 billion vs. 2.0 billion) [1]. In 2018, the number of elderly people in the total population of the Russians reached 25.4%[1]; according to the official forecast, in 20 the number will exceed 37.3 million people (26.9% of the population)[2].

The average elderly patient with atherosclerotic cardiovascular diseases (ASCVD) and chronic heart failure (CHF), which may be regarded as a clinical outcome, tends to be considerably older, much like the overall population. The data of large national and international randomized controlled trials (RCTs) with long-term prospective follow-up confirm this fact, e.g. EPOCH CHF in the Russian Federation [2] and the study of Claire A. Lawson *et al*. (2020) in Great Britain [3]. They demonstrated significant dynamics of increase of average age of CHF patients; particularly, in Great Britain, the relative share of people aged over 60 in the CHF cohort reached 65%. This emphasized the importance of evaluation of cardiovascular risks in elderly patients.

The European Society of Cardiology (ESC) suggests personalized phased strategies of management for individual patients optimized in accordance with the ASCVD risk evaluation using the SCORE2 and SCORE2-OP scales.

Whereas the SCORE scale, used earlier, evaluated the 10-year risk of ASCVD death, the SCORE2 considers a wider range of clinical outcomes including not only mortality rates from ASCVD, but morbidity outcomes as well (non-fatal myocardial infarction, non-fatal stroke) [4]. This approach provides a more precise picture of the adverse burden of the cardiovascular pathology on the patient's condition.

For patients aged over 70, a separate scale SCORE2-OP was developed [5] that included the so-called 'competing risks'. A 'competing risk' is vital in the older age, since it provides a significant impact on the relative survival of patients without ASCVD in the general cohort of older patients, which results in the corruption of the evaluation of the actual 10-year risk of ASCVD upwards [6].

It is to be noted that the proper use of the SCORE2 and SCORE2-OP scales is limited exclusively to a group of healthy patients. According to the ESC consensus, this group includes outwardly healthy individuals without confirmed ASCVD, type II diabetes mellitus (T2DM), chronic kidney disease (CKD) and other severe comorbidities that were not treated before or whose clinical condition remained stable for several years. At the same time, the recommendations make it a point that the SCORE2 algorithm may be recommended for use in patients with comorbid pathologies, other risk modifiers, and clinical conditions, including T2DM, as the all-purpose tool for the objective assessment of cardiovascular risks and clarification of efficiency of various therapeutic measures with systematic follow-up [7].

Thus, one of the initial logical prerequisites of the ESC is that any therapeutic intervention affects the risk of ASCVD development. Since the SCORE2 and SCORE2-OP algorithms provide for an objective quantitative assessment of ASCVD risks, the medical impact is assessed from the position of measuring its value. Thus, the cardiovascular risk is seen as a dynamic calculation indicator that requires regular follow-up and re-classification depending on the treatment methods, correction of risk factors and clinical condition of the patient [8, 9]. Of course, personalized phased approach to assessment of ASCVD risk increases the workload on the doctor and requires extra working time. Systematic assessment of ASCVD risk under the SCORE2 algorithm in the conditions of limited time of a hospital admission poses some difficulties for the medical practitioner. This justifies the high practical value of the calculator we developed.

AIM

Evaluation of the features of using a digital clinical calculator for an objective assessment of the cardiovascular risk in elderly patients in a routine outpatient practice.

MATERIAL AND METHODS

The methodology of calculation of cardiovascular risks in elderly patients used in the calculator is based on the ESC recommendations as amended in 2021 [10], validated in the Russian Federation [11].

SCORE2 and SCORE2-OP scales are deeply formalized; therefore, only five principal factors of cardiovascular risks are used as independent variables (4 clinical and anamnestic and 1 laboratory): age, sex, smoking status, systolic blood pressure (BP), and non-high-density cholesterol level (non-HDL-C) (**Table 1**).

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[1] Federal Service of National Statistics. Senior citizens (demographic indicators). Link valid as of 26.06.2024. Available online: https://www.gks.ru/folder/13877

[2] Updated demographic forecast of the Russian Statistics Agency until the year 2046. Available online: https://rosstat.gov.ru/folder/313/document/220709

The calculator processes the input data and finds the numeric value of the probability of development of fatal or non-fatal cardiovascular event (infarction or stroke) within 10 years in per cent, indicated in the respective cells of the SCORE2 and SCORE2-OP tables, which determines the patient's belonging to some group of cardiovascular risk or other.

Individuals aged 60–69: ≥10% is 'very high risk', an absolute indication for treatment of ASCVD risk factors; 5–10% stands for 'high risk' that requires correction of ASCVD risk factors with consideration to risk modifiers, lifetime risk and lifetime benefit of treatment, as well as the patient's preferences; below 5% stands for 'moderate risk' that does not require correction of risk factors, as a rule.

Individuals aged 70: ≥ 15% is 'very high risk', an absolute indication for treatment of ASCVD risk factors; 7.5–15% stands for 'high risk' that requires correction of ASCVD risk factors with consideration to risk modifiers, lifetime risk and lifetime benefit of treatment, as well as possible sarcopenia, poly-pragmasy and the patient's preferences; below 7.5% stands for 'moderate risk' that does not require correction of risk factors, as a rule.

For those clinical cases, in which the non-HDL-C level values are not available to the doctor, the calculator provides an alternative method. Since the non-HDL-C levels have been used in wide clinical practice only recently, not all medical institutions measure it within a standard lipid profile. For this purpose, the calculator integrates a module to calculate the value using the inverse Friedewald equation [12]. The following are used as independent laboratory values: LDL-C and triglyceride (TG) levels. The laboratory method of measurement the LDL-C and TG levels is a part of standard outpatient monitoring in dyslipidemia. The direct Friedewald equation is used to calculate the LDL-C levels based on the total cholesterol, triglyceride and HDL-C values, calculated in the vast majority of laboratories. The precision of LDL-C level measurement is comparable with reference methods provided that the following conditions are met: TG plasma concentration below 4.5 mmol/L; LDL level above 1.3 mmol/L, which is taken into account in the argument ranges of the calculator [13].

The algorithm for calculating cardiovascular risk in elderly patients is based on a risk scale validated in Russia for very high-risk countries [14]. The SCORE2 and SCORE2-OP charts are geographically calibrated according to national ASCVD mortality rates and categorize countries into four risk groups: low-risk countries, moderate-risk countries, high-risk countries, and very high-risk countries. Russia is classified in the fourth group (very high risk).

The calculator has limitations in practical application and cannot be used to calculate individual cardiovascular risk values in the following cases: for patients younger than 60 years; for hyperaldosteronism; for familial hypercholesterolemia; for plasma TG greater than 4.5 mmol/L; for plasma LDL less than 1.3 mmol/L.

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■ RESULTS AND DISCUSSION

When clinically applying the calculator, several critical considerations must be addressed, particularly for elderly patients. The stratification of the population into two age groups (60-69 years [15] and ≥70 years [5]), as implemented in the original study, results in abrupt increases in threshold values for defining moderate-, high-, and very-high-risk categories in individuals aged 70 and above. This occurs because calculated cardiovascular risk values in the ≥70 cohort nearly always exceed general population thresholds, rendering them inadequate for risk stratification purposes. Moreover, when assessing the lifetime benefit of therapeutic intervention in terms of additional years lived without ASCVD, this benefit objectively demonstrates lower magnitude in very elderly populations. While the LIFE-CVDK[1] scale enables calculation of cardiovascular disease-free life expectancy accounting for comorbidities and specific pharmacological interventions (statins, anticoagulants), unfortunately, this tool does not support the Russian language.

A patient's assignment to a specific risk category primarily determines the optimal intensity of therapeutic intervention. Since the patient's age is a fixed value at any given time, a reasonable assessment of decision-making thresholds in actual clinical practice requires physicians to conduct a comprehensive evaluation of geriatric status and maintain clinical flexibility, particularly for patients now over the 70-year age threshold.

The determination of a particular risk category in an individual patient does not mean unconditional and automatic initiation or intensification of drug therapy. The physician must necessarily take into account other factors affecting the risk of ASCVD in old age, in particular the category of the patient's functional dependence, as well as the presence of such specific geriatric syndromes as senile asthenia, sarcopenia, and polymorbidity [16]. The higher risk stratification threshold in the 70+ cohort helps avoid overtreatment and polypharmacy, which is particularly common in very elderly multimorbid patients. Another key

Variable	Unit	Range
Age	Years	60–120
Sex	Nominal	M/F
Smoking status	Nominal	Y/N
Systolic BP	mmHg	99–180
non-HDL-C	mmol/L	3.0–6.9

Table 1. *Essential features of the clinical calculator of cardiovascular risk in elderly patients*

Таблица 1. *Существенные признаки клинического калькулятора значения кардиоваскулярного риска у пожилых пациентов*

clinical rationale for separating the over-70 group in the algorithm is the significant weakening of the correlation gradient between ASCVD risk and classical modifiable risk factors, such as non-HDL cholesterol levels and systolic blood pressure, with advancing age [17].

Despite the fact that SCORE2 algorithms are designed to assess cardiovascular risk in apparently healthy individuals, their absolute value remains important and relevant even for patients with comorbidities (T2DM, CKD, CAD), as they enable tracking of risk category transitions (e.g., from "very high" to "high") when applying specific treatment methods (e.g., when intensifying lipid-lowering therapy). This calculator specifically emphasizes calculating the quantitative probability of adverse cardiovascular events (expressed as a percentage) rather than assigning patients to formalized risk categories (a qualitative characteristic). This approach is particularly relevant for very high ASCVD-risk countries. An objective numerical indicator lends itself better to mathematical and statistical evaluation, enabling its application across a wide range of practical tasks, from balanced assessment of indications for modifying factor correction to dynamic monitoring of pharmacotherapy effectiveness.

A key advantage of the calculator is that all source independent variables are included in the standard follow-up protocol for elderly patients [18] and are recorded by physicians during routine outpatient visits. When digitization tools are used[1], the calculator may be used as a module of medical decision-making support system and calculate the values of cardiovascular risk in elderly patients automatically in the process of provision of outpatient medical care. Given that the obtained data are stored and systematized in digital format, this addresses the need for systematic monitoring and reclassification of ASCVD risk categories based on the patient's current clinical status, while trends in absolute risk values provide insights into the effectiveness of administered treatments.

The calculator is registered at the Federal Institute of Industrial Property[2]. It is written using the TypeScript language, the size of the program code is 500 Kb; it has no specific requirements to hardware and software; the program requires no installation and can work on any computer with a browser (Google Chrome 127 and higher, Mozilla Firefox 128 and higher), or an a mobile phone. The calculator is available for doctors of any specialization on the website of doctors' digital assistants[3] or through the QR-code for mobile devices (**Fig. 1**).

Reliability of the calculator was verified through validation using clinical cases from routine outpatient practice.

Clinical case. From the outpatient visit sample, a male patient XXX1955 aged 69 years was randomly selected, with a harmful habit (smoking), SBP 155 mmHg, LDL-C level 3.5 mmol/L, TG level 2.3 mmol/L; calculated
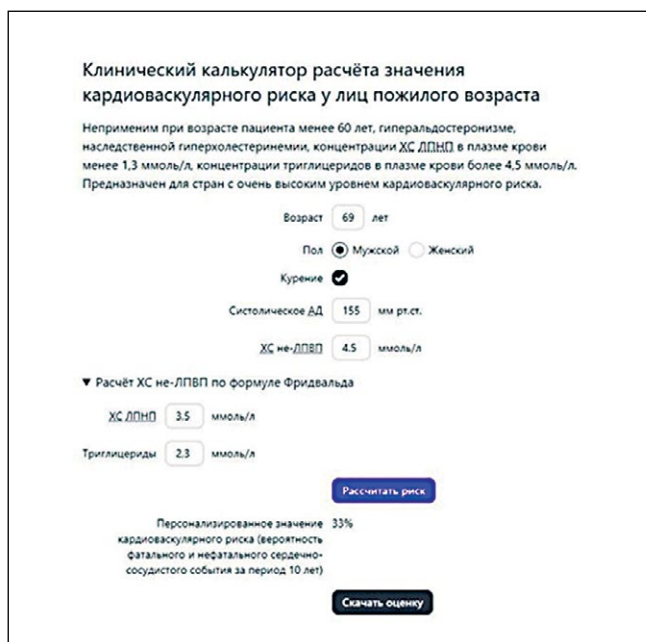

Figure 1. *QR code of the CVD Risk Assessment Calculator for elderly patients.*
Рисунок 1. *QR-код калькулятора определения значения кардиоваскулярного риска пожилых пациентов.*

non-HDL-C level using the inverse Friedewald formula: 4.5 mmol/L.

The personalized cardiovascular risk value (probability of fatal and non-fatal cardiovascular events over a 10-year period) was calculated at 33% (**Fig. 2**).

To demonstrate the capabilities of the calculator for objective ASCVD risk monitoring, the personalized risk score was recalculated for the same patient XXX1955 after modifying factor adjustment. The therapeutic interventions (smoking cessation and optimization of antihypertensive therapy) reduced the probability of fatal/

Figure 2. *A clinical example of the application CVD Risk Assessment Calculator for elderly patients.*
Рисунок 2. *Клинический пример прикладного применения калькулятора оценки риска АССЗ пожилых пациентов.*
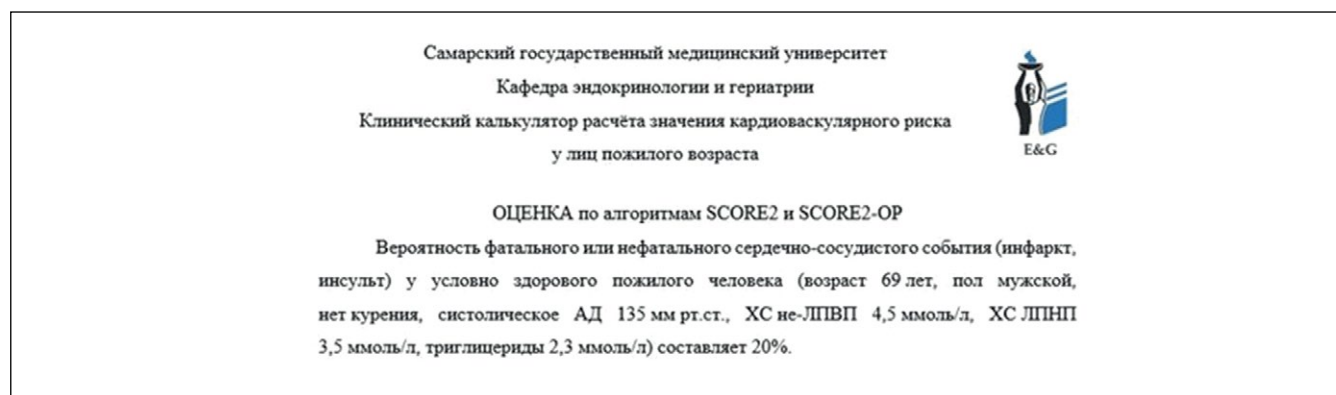
Figure 3. *Protocol for assessing the value of cardiovascular risk in an elderly patient.*
Рисунок 3. *Протокол оценки значения кардиоваскулярного риска пожилого пациента.*

non-fatal cardiovascular events in the patient XXX1955 by 13% to 20%, clearly demonstrating its effectiveness. Furthermore, this tangible outcome helps physicians convincingly motivate patients to continue treatment and adhere to recommendations, thereby ensuring compliance, a particularly crucial factor for elderly patients [19].

Personalized cardiovascular risk assessment results can be downloaded from the calculator as a Microsoft Word (.docx) file to a personal computer or mobile device. Physicians can either save this file as an electronic medical record or print it for inclusion in paper-based outpatient charts or medical histories (**Fig. 3**).

Practical application of the calculator in routine clinical practice enables dynamic assessment of personalized metrics that may be used both as an objective tool for determining optimal therapeutic strategies in specific elderly patients and as an indicator of their medical and economic effectiveness.

■ **CONCLUSIONS**

1. Assessment of the probability of fatal and non-fatal cardiovascular events over a 10-year period reflects the overall burden of negative impact of ASCVDs on a patient's health status with more accuracy than mortality indicators.

2. Assessment of cardiovascular risk is of special importance for elderly patients: in making a decision on therapeutic intervention, the doctor must take into account the specific geriatric syndromes: senile asthenia, sarcopenia, cognitive disorders and polymorbidity as well as poly-pragmasy mediated by them.

3. The objective digital assessment of numerical cardiovascular risk values using a validated methodology allows using the calculator for weighted assessment of indications for modifying factors correction, intensification of drug therapy, as well as for dynamic control of treatment effectiveness.

4. The results of the calculation are available for download as an outpatient chart protocol and are also saved as an electronic medical record, enabling their use in other MIS as a clinical decision support system module via the integration subsystem. ◢

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