



PreventS-MD[®]: a New Digital Technology to Maintain Cardiovascular Prevention in Routine Clinical Practice

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Abstract

Stroke, myocardial infarction (MI), and other main non-communicable diseases (NCDs) remain major causes of mortality and disability globally. Up to 80% of cardiovascular events and up to 60% of NCDs are associated with potentially controlled risk factors (RFs). State-of-the-art digital technologies can help bridge the gap between evidence-based prevention methods and their critically low availability in routine clinical practice. An innovative digital platform named PreventS-MD[®] is a specially developed tool for healthcare professionals to be used under time constraints. With PreventS-MD[®], clinicians can estimate patient's 10-year cardiovascular risk within several minutes. Then, they automatically get adapted results and recommendations to address identified RFs as well as graphical representation of specific RF contribution to overall stroke and MI risks. If some additional time is available, the clinician and the patient can collaboratively set customized achievable goals to correct modifiable RFs. An integrated analytical module provides healthcare managers with current digital risk profiles of the relevant population to evaluate prevention effectiveness and to forecast the load throughout the healthcare levels.

PreventS-MD[®] has several unique advantages, including time-saving design, the function to activate motivated RF correction, individually tailored recommendations, and information on personally changed digital profiles of vascular risks. As cardiovascular diseases and main NCDs have a lot of common RFs, PreventS-MD[®] implemented into routine clinical practice will utilize a complex approach to the prevention of main NCDs, decreasing both stroke and MI burden and addressing complications of chronic pulmonary and kidney disease, tumors of any type, dementia, etc.

Keywords: stroke; myocardial infarction; risk factors; prevention; software

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ПревентС-Врач® – новая цифровая технология поддержки мероприятий по профилактике сердечно-сосудистых заболеваний в рутинной клинической практике

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Аннотация

Инсульт, инфаркт миокарда и другие основные неинфекционные заболевания (НИЗ) продолжают оставаться ведущими причинами смерти и инвалидизации во всём мире. До 80% сердечно-сосудистых событий и до 60% НИЗ ассоциированы с потенциально контролируемыми факторами риска (ФР). Современные цифровые технологии способны помочь преодолеть разрыв между научно доказанными методами профилактики и катастрофически низкой степенью их внедрения в повседневную клиническую практику.

Инновационная цифровая платформа ПревентС-Врач® является инструментом, специально разработанным для применения в условиях ограниченного рабочего времени врача. С помощью системы ПревентС-Врач® у доктора появляется возможность в течение нескольких минут получить оценку 10-летних рисков развития у пациента основных сердечно-сосудистых заболеваний (ССЗ). В автоматическом режиме формируется адаптированное для неспециалиста описание результатов, рекомендации по коррекции выявленных ФР, а также графическое представление вклада отдельных ФР в суммарные риски инсульта и инфаркта миокарда. При наличии дополнительного времени врач совместно с пациентом могут воспользоваться функцией установки персонально приемлемых и достижимых целей по коррекции модифицируемых ФР. Встроенный в систему модуль аналитики предоставляет руководителям учреждений здравоохранения актуальную информацию о цифровом профиле риска обслуживаемой популяции, позволяет оценивать эффективность проводимых профилактических мероприятий и прогнозировать нагрузку на разные звенья медицинской службы.

ПревентС-Врач® имеет ряд уникальных преимуществ: экономия рабочего времени врача дизайн системы; функционал активации мотивационных механизмов коррекции ФР; гибкая персонализация рекомендаций; предоставление данных об индивидуальной динамике цифрового профиля сосудистого риска. В связи с тем что ССЗ и основные НИЗ имеют много общих ФР, внедрение ПревентС-Врач® в рутинную клиническую практику позволяет реализовать интегрированный подход к профилактике основных НИЗ – способствовать не только снижению бремени от инсультов и инфарктов миокарда, но и уменьшению последствий от хронических заболеваний лёгких и почек, онкологических заболеваний различной локализации, деменции и др.

Ключевые слова: инсульт; инфаркт миокарда; факторы риска; профилактика; программное обеспечение

Источник финансирования. Авторы заявляют об отсутствии внешних источников финансирования при проведении исследования.

Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов, связанных с публикацией настоящей статьи.

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Introduction

Cardiovascular disease (CVD) is a leading cause of early death and disability globally. Available prevention approaches are not sufficiently effective due to constantly

increasing absolute burden of stroke and myocardial infarction (MI) despite improving relative CVD mortality and prevalence rates globally. With digitization and the methods of behavioral psychology, with the coverage of all the risk groups, and with time-saving design, the development

and the implementation of new technologies for preventive interventions can drastically decrease CVD and other main non-communicable disease (NCD) burden.

Major Issues of Prevention Delivery

Low availability of prevention measures in routine clinical practice is a global challenge. In prevention, primary clinician's limitation is insufficient amount of time. Other most common reasons include inadequate insurer's compensation of preventive visits, patients' refusal to discuss or follow recommendations, and low clinician's qualification in terms of preventive consulting [5, 8–11].

It appears that general prevention strategy needs to be reviewed by healthcare institutions. Nowadays, prevention is focused on identifying individuals already at high risk. Prevention guidelines aim to do this, and most risk assessment and stratification scales have been developed from this perspective. A high-risk strategy is intuitively clear for both clinicians and patients because it implies identifying significant health abnormalities that should be managed immediately. However, this approach results in 2 of 3 individuals with a low to moderate 10-year risk of cardiovascular events missing the time of a gradual risk increase for prevention. If the risk were calculated in individuals immediately before their stroke or a MI, most of them would be at high risk. The pool of risk factors (RFs) that determine the total risk is shaped as a result of long-term interaction between genetic, behavioral, environmental, and other factors rather than at once. Thus, there is an evident need to complement the high-risk strategy with methods that are independent of absolute risk for large-scale intervention in the continuum of cardiovascular risk development [13].

Many countries spend significant funds on preventive screenings [7]. Nevertheless, the literature suggests their low effectiveness [6]. The causes include focus on the above high-risk strategy in screening and almost no use of prevention methods psychologically based on health-related behavior.

Prevention is dramatically complicated by the population's lack of active interest in their health. According to the literature, up to 70% of patients seek medical care only in significant deterioration of their health [4]. An integral goal of prevention is people's indoctrination with an idea of the need to change their lifestyle. The task requires the repeated and versatile popularization of adapted information.

Brief history of PreventS-MD® development

The Research Center of Neurology (former Institute of Neurology under the Russian Academy of Medical Sciences) have studied epidemiology and prevention of brain

vascular diseases for over 40 years. In 2014, the Center initiated collaboration with the National Institute for Stroke and Applied Neurosciences (Auckland, New Zealand) led by Prof. V.L. Feigin (Stroke Riskometer Project), which resulted in the free mobile application adapted for Russian-speaking individuals [3]. Further work in the area resulted in articulating the main limitations of current approaches to CVD prevention and in getting a new concept of the motivational preventive strategy covering the entire population and taking into account individual, relative rather than absolute vascular risk. This approach can reasonably cover a much larger proportion of the population by prevention in emerging vascular risk when prevention is the most effective [15].

In 2021, the Research Center of Neurology and Regional United System of Medical Informatization, a Russian company dealing with medical online technologies for years, launched pilot works to establish the concept of a software product for cardiovascular risk management across medical institutions, PreventS-MD®. Their objective was to complement and expand the preventive intervention options provided to the public via the Stroke Riskometer App.

In 2023, the development of the software product was completed. The Research Center of Neurology and the National Institute for Stroke and Applied Neurosciences tested system usability with clinicians from 27 countries [12]. Currently, the system is being clinically validated.

System functionality

PreventS-MD® is module-based software including an input module (questionnaire), a risk assessment module for clinicians, a summary module for patients, a behavior change support module, and an analytical module (Fig. 1). PreventS-MD® is a WEB application deployed on secure servers and accessed from authorized devices via an encrypted browser protocol. A desktop computer, a tablet, or a smartphone can be used to operate the system in various clinical scenarios.

Input module

In order to maximize obtained risk information, one should enter 24 parameters including: age (date of birth); sex; ethnicity; height; weight; smoking and alcohol consumption statuses; fruit and vegetable intake; physical activity level; average systolic blood pressure (SBP); continuous antihypertensive treatment status; presence of chronic stress or depression; family history of stroke or MI; levels of total cholesterol, high-density lipid cholesterol, and blood glucose; and history of diabetes, ischemic heart disease, and/or atherosclerosis of large peripheral arteries, left ventricular hypertrophy, atrial fibrillation, dementia, moderate cogni-

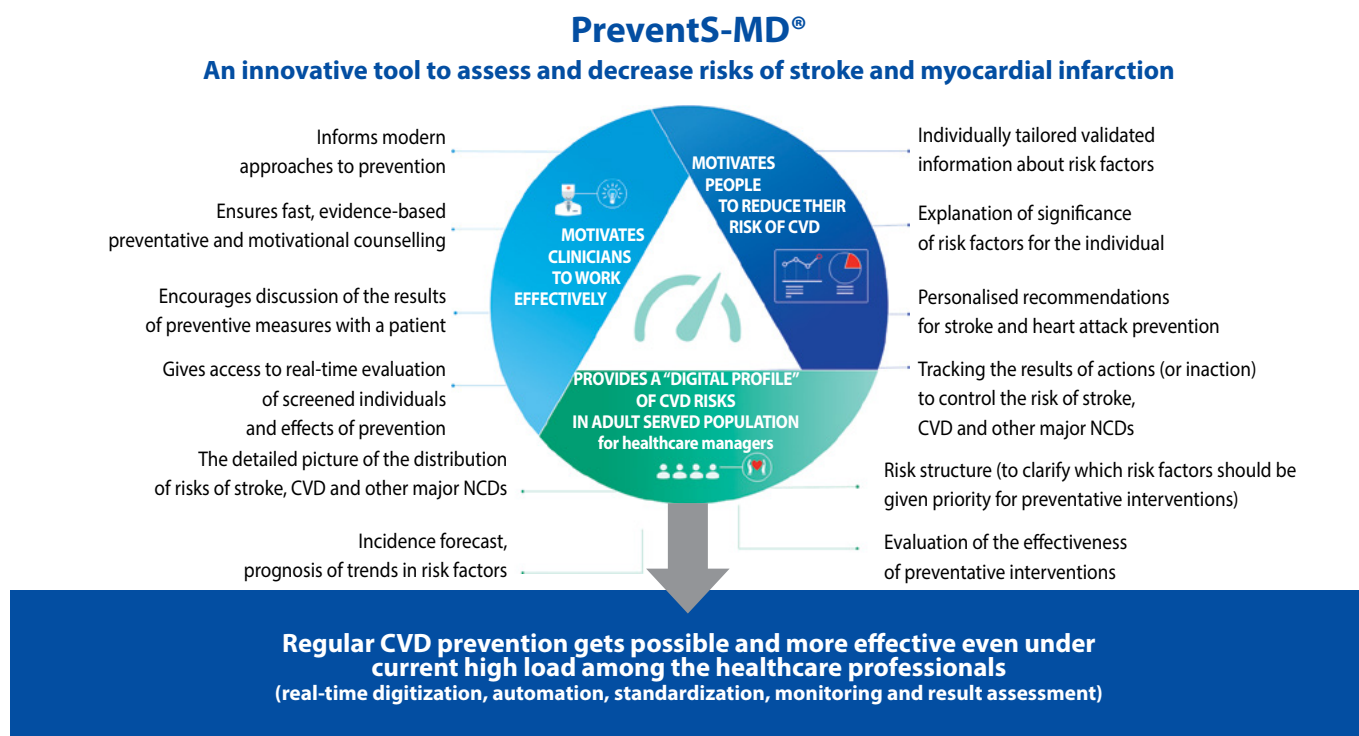


Fig. 1. PreventS-MD®'s main features.*

tive impairment, head injury, and stroke or transient ischemic attack. Additionally, the upper limit of the reference SBP level can be entered for display in the individual progress graph in the report materials.

In order to facilitate and speed up data entry, the mandatory fields include gender, age, ethnicity, and levels of the mean and upper limit of reference blood pressure. Other fields can be automatically filled with the value "Unknown". So, the questionnaire can be pre-filled, e.g. by nursing staff at the emergency department, or preliminary risk can be pre-assessed to be finally assessed once the remaining data have been entered. Another, preferable data entry option is integration with existing electronic medical records. In this case, most fields can be filled semi-automatically from existing Electronic Health Records (EHR). The ability and the extent of integration depends on the specifics of EHR software. The clinician only has to confirm the results of the automatic input and, if necessary, make some adjustments. The initial testing of the patient in the system is the most time-consuming (10–15 min) as, during repeated risk assessments, all the questionnaire fields are automatically filled with the results of the previous examination and the clinician only has to update the answers (3–5 min).

In order to facilitate data entry for each question, there are a brief summary on the entry form and an expanded one in the electronic user guide, with summary for each RF relationship to total cardiovascular risk and references

to scientific publications. Therefore, active use of the PreventS-MD® may become an additional option to increase clinicians' awareness on the significance of certain RFs.

Risk assessment module for clinicians

PreventS-MD® incorporates a number of algorithms to get: 5-year and 10-year absolute and relative risks of stroke through the Stroke Riskometer [14]; 10-year absolute and relative risks of coronary events through the Framingham Risk Score [18]; Life's Simple 7 (LS7) scores [16], [14]; and original Healthy Lifestyle Scale scores (Fig. 2 and 3). Information on the stroke and MI risks is primarily needed as basic rationale to initiate preventive counseling. The concept of risk is difficult to understand for non-professionals on the whole. Additionally, absolute stroke and MI risks, even high-risk thresholds (> 10–15% over 10 years), appear to be slightly significant for general public. Recently, there has been increasing discussion about the need to refrain from using absolute risk indicators as the sole criterion for determining the need for preventive intervention [14]. When communicating with a patient, we suggest using a relative increase in absolute risk, which more clearly allows to show the necessity of controlling RFs even in young individuals and in the presence of few RFs.

Individual contribution of each RF is identified to the total stroke and MI risk is calculated in addition to absolute and relative vascular risks (Fig. 4). Thus, the clinician can discuss with the patient which of the RFs are the most

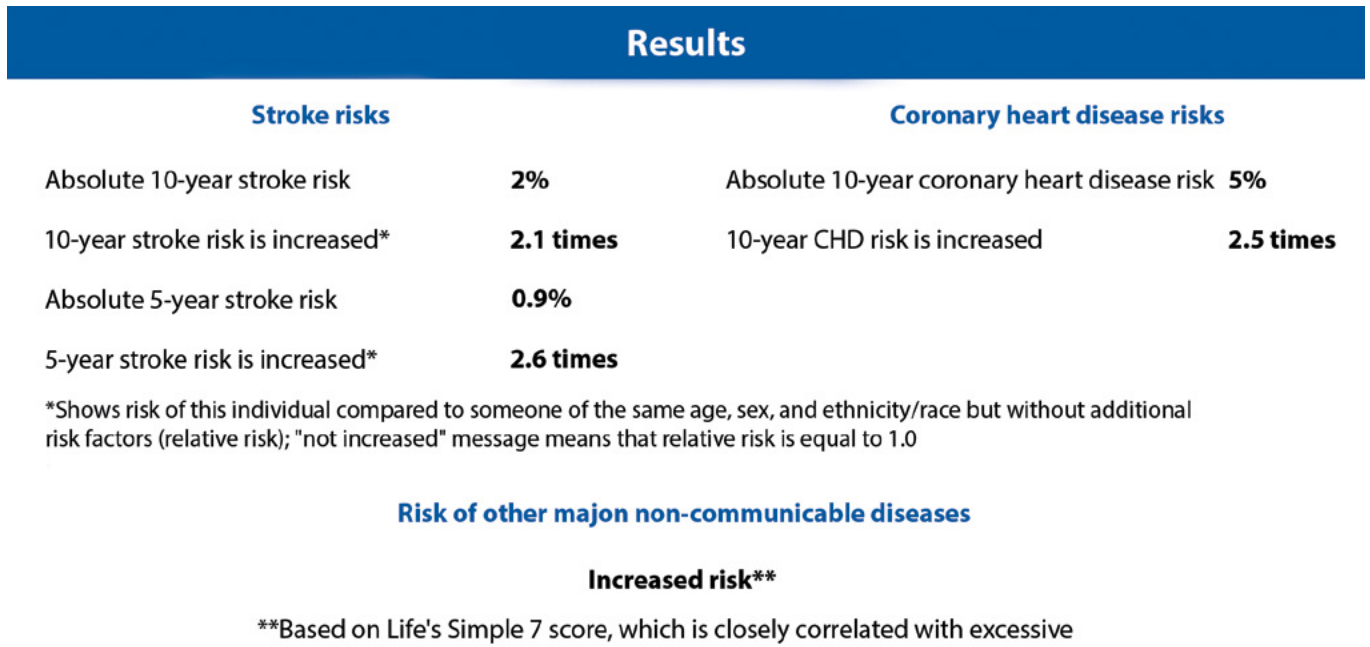


Fig. 2. Risk assessment output for professionals.

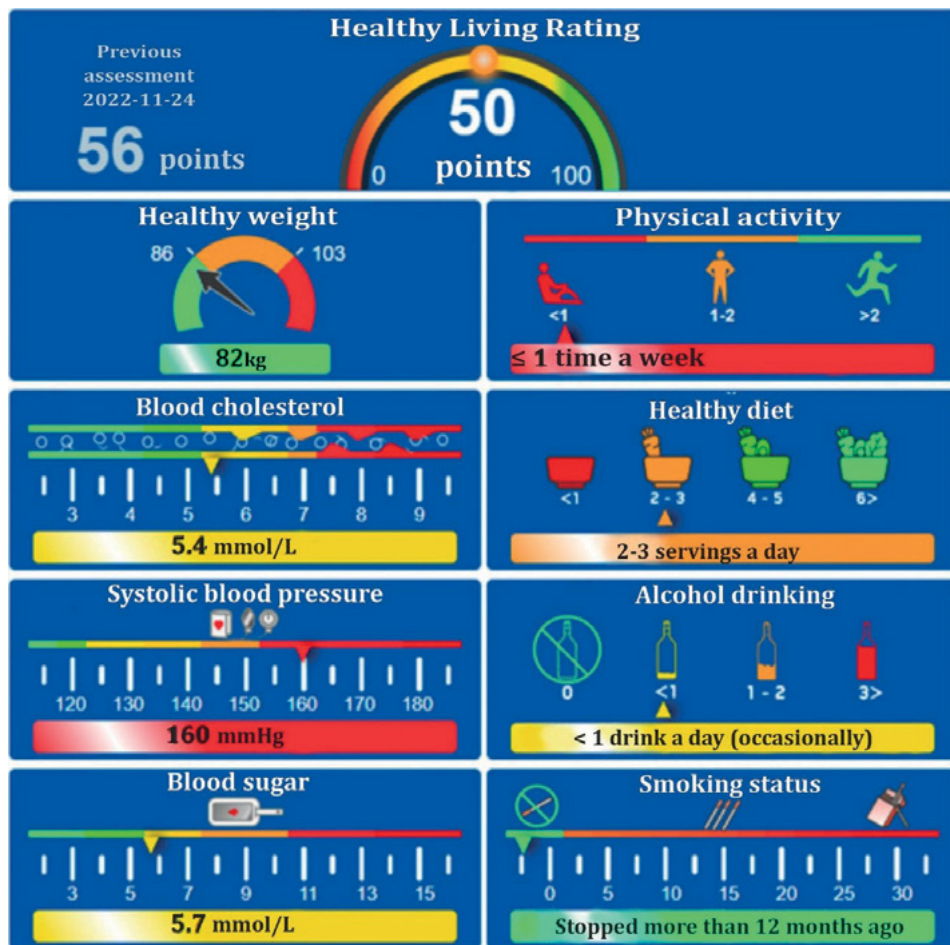
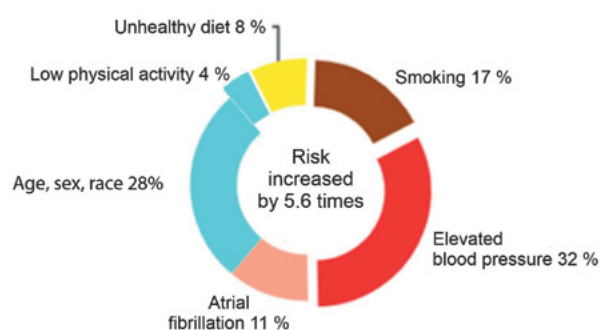


Fig. 3. Healthy Living Rating for patients.

important for them and to select those to correct for the greatest risk reduction, i.e. additional conditions for customization of preventive intervention.

PreventS-MD® also provides an opportunity to estimate relative risk of other significant NCDs including chronic obstructive pulmonary disease, pulmonary embolism, pneumonia, chronic kidney disease, deep vein thrombosis, cancer, hip fracture, and dementia. This calculation is based on the literature related to correspondence between LS7 scores and relative risk of the above conditions [17]. As these data are indicative, a color-coded chart with graphically represented NCD risks is to provide this information to patients (Fig. 5).

Relative contribution of different risk factors to your stroke risk



Please, see which risk factors are the most significant for you. The stick out parts of the chart are modifiable risk factors. You can reduce your stroke risk by controlling them.

Fig. 4. Individual relative RF contribution to the total stroke risk.

Your risk of other major non-communicable diseases based on your modifiable risk factors

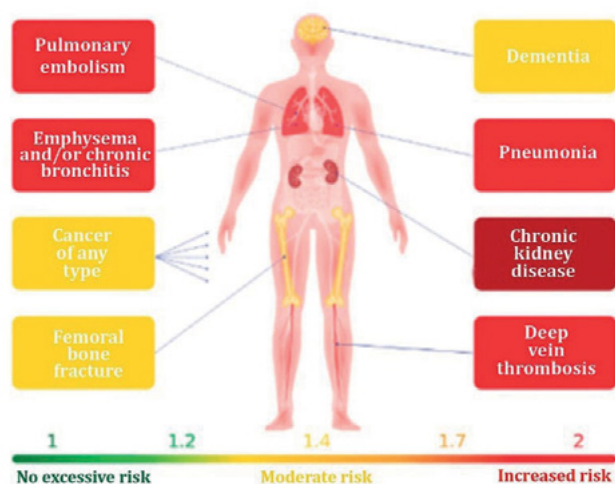


Fig. 5. Relative risks of other significant NCDs.

Summary module for patients

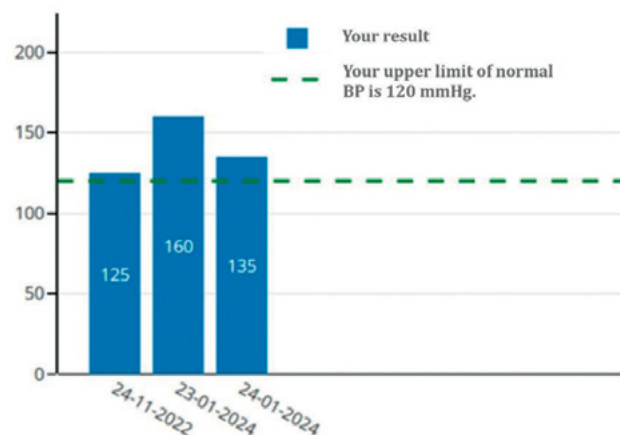
In order to save clinician's time, the final report for a patient is semi-automatically generated. The summary form includes textual description of the results, with an explanation of the identified increase in relative risks and a list of identified RFs (Fig. 4). For each of the identified RFs, recommendations are provided as adapted for non-professionals. The recommendations are based on international and national guidelines for cardiovascular prevention. The summary and recommendations can be edited to correspond with individual requirements. The clinician can select the recommendations to add to the printable summary form because excess of information can evidently have the same negative impact as lack of information.

In addition to textual information, the PreventS-MD® provides the results of current and previous examinations graphically, as charts and graphs. Therefore, the clinician gets an opportunity to discuss changes in patient's risks of stroke and MI and particular RFs with them. In addition to the changes in the considered indicators, the graphs contain information on the optimal (target) levels and repeated information related to the possible positive effect of the target levels achieved on the risk level (Fig. 6).

Maintenance of secondary stroke prevention

PreventS-MD® has been designed not only to maintain primary CVD prevention. Although there are currently no algorithms approved for wide use to calculate individual risks of recurrent stroke and MI, the incidence of recurrent vascular events is generally known. The main RFs targeted by preventive interventions in secondary prevention are the same. However, more attention should be paid to phar-

Systolic blood pressure (mmHg)



If your BP is higher than the target BP recommended by your clinician, BP decrease by each 10 mmHg implies that stroke risk has been decreased by 30%. If your BP has been normalized, it means that stroke risk has been decreased by 55%.

Fig. 6. Changes in the individual SBP levels.

maceutical therapy in such patients. Rationale for good treatment adherence can be added to the report as a separate recommendation (Fig. 7). A number of special phrases are provided to describe the effect of antihypertensive, hypolipidemic, antiaggregant, and anticoagulant therapies on risk levels. These phrases should always be added by clinicians at their discretion by selecting the appropriate options (check boxes). The relevant options are automatically highlighted in red in patients with elevated SBP (> 140 mmHg), elevated total cholesterol (> 6.2 mmol/L), atrial fibrillation, and history of coronary events.

If the patient has a history of stroke and/or manifestations of ischemic heart disease, the system generates a special summary and modified phrases on the effects of pharmaceutical prophylaxis. In addition to textual information on need for good treatment adherence, the system provides graphical representation of risk reduction as compared to that in treatment refusal. These graphs can also be customized depending on whether a particular category of pharmaceuticals is indicated.

Healthy Living Rating

This tool was designed to allow a clinician to focus patient's attention on modifiable RFs in an accessible and attractive manner (Fig. 3). This component is especially important in prevention of recurrent vascular events. As it is impossible to calculate the risks of recurrent events, it also becomes difficult to demonstrate a positive

effect (risk reduction) when behavioral and metabolic RFs are corrected. Healthy Living Rating considers the presence and the severity of the main modifiable RFs. The maximum score is 100 units. The previous test result is also displayed in the report. We should note that the score can be used even if the data are partially absent. In this case, a warning is displayed and the number of points is also calculated with maximum possible value of 100 units but for the specified RFs only.

Behavior change support module

Cardiovascular disease prevention is a challenge mostly related to knowledge about the psychological features of health behavior management. Behavioral psychologists have been trying to find an effective solution for many years. Many models have been created and tested, primarily "motivational behavior models" [2]. Although no universal solution has been found to date, there is consensus that key elements of behavior regulation are aspects of motivation, self-regulation, and setting personalized, specific, and acceptable goals [1]. PreventS-MD® include two tools, a questionnaire for subjective assessment of motivation to initiate correction of identified RFs and a behavior change targeting tool with the Confidence in Achieving Goals questionnaire.

The motivation assessment questionnaire is generated automatically and based on the identified RFs. It is an 0 to 10 visual analog scale to grade desire of starting

Importance of regular taking medications

Anti hypertension medication Cholesterol lowering medication (statins) Anti-aggregant (CHD) Anti-aggregant (stroke) Anti-coagulant

Successful prevention of recurrent stroke and primary myocardial infarction is based on regular taking all the prescribed medications.

Particularly:

- regular taking antihypertensives also decreases risks of recurrent stroke and primary myocardial infarction by ca. 25–35 %.
(Decrease in systolic blood pressure by each 5 mmHg additionally decreases risk of recurrent stroke by 10 %).
- in irregular heart rhythm (e.g. atrial fibrillation), regular taking special medications to prevent blood clots in the circulatory system (e.g. warfarin, dabigatran, rivaroxaban, or apixaban) decreases risk of recurrent stroke by ca. 60–70 %.

Taking all the prescribed medications reduces your risk the best.

Fig. 7. Recommendation that emphasizes the importance of good treatment adherence.

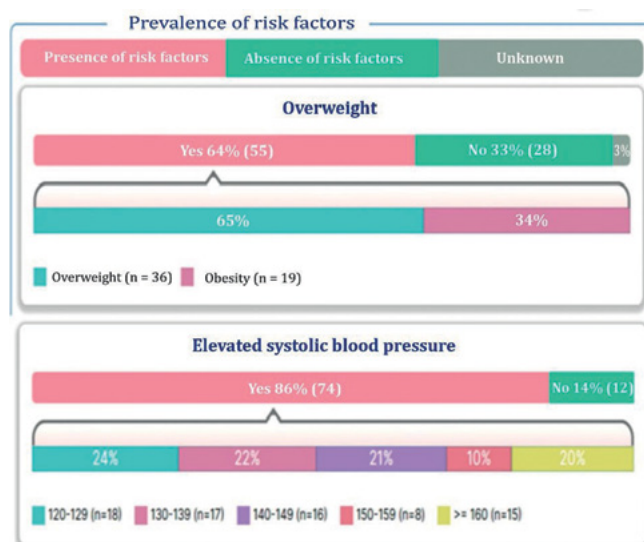


Fig. 8. Prevalence of risk factors represented in an analytical module.

to control certain RFs. Data can be entered immediately into the system via the online interface when interviewing a patient, or the questionnaire can be printed out for the patient to complete with following transfer the responses. According to the literature, further counseling on direct interventions for a specific RF is appropriate if the subjective motivation score is ≥ 5 points. Otherwise, further discussion is necessary on the need to control this RF as a whole. In addition to current survey results, the clinician also has access to the history of motivation assessments at previous visits.

RFs with an entered motivation value of ≥ 5 points are displayed in the interface to set individual goals. The system has several options for each RF, which can be additionally modified. It is possible to set one's own option of the goal entirely. The list of goal templates is planned to be expanded regularly in the future. Behavioral psychologists do not recommend setting over 3 goals per visit although the system allows you to do so.

The clinician can print out an individually generated questionnaire to give the patient a handout with the selected goals and to fulfil an additional, supporting technique, the assessment of confidence in achieving the goals. The questionnaire is an 0 to 10 visual analog scale. The output allows the clinician to determine when it is appropriate to schedule another visit for supportive preventive counseling and which RFs require additional support and are an additional way to support behavior change as they form of a "written agreement between a clinician and a patient."

Analytical module

PreventS-MD® is a software to support preventive intervention and a powerful tool for management decision-

making, and a basis for scientific research. All the data entered into the system and the calculated indicators are available for analysis. The analytical module includes several sections (analytical models), with preset calculation indicators and diagrams grouped to solve the relevant task: assessment of system utilization activity, determination of RF burden in the population served (Fig. 8), assessment of risk changes, health behavior tool usage statistics, and risk estimate of other NCDs. For each analytical model, there is a number of filters to get data selected for a certain period, in a separate unit, for patients of selected age, sex, etc. For additional analysis, anonymized data can be uploaded to a file in a format that is compatible with statistical software.

Technology implementation options

PreventS-MD® can be accessed as a separate software product from authorized devices via the Internet or as part of an actual EHR software. The developed application programming interface (API), in fact, allows one to connect to any EHR system following all the requirements for personal data protection. The ability to semi-automatically prefill the questionnaire with EHR data depends on the system to be integrated with. Presently, there is experience of successful pilot integration with the Medialog medical information system.

Expected results of large-scale implementation into practice

Based on the literature data related to the proven positive impact of addressing major NCD RFs on morbidity and mortality rates, we can state that large-scale PreventS-MD® implementation in the routine practice of healthcare institutions can contribute to reducing the burden of CVDs and other major NCDs by up to 50%, namely:

- preserving the work capacity of experienced workers;
- reducing economic losses to employers and the state;
- reducing treatment and rehabilitation costs;
- increasing effectiveness of other prevention activities;
- improving the quality of life and longevity in the population.

These results can be achieved by the fact that:

1. Clinicians get an opportunity to perform standardized, evidence-based preventive counseling as part of their core activity.
2. The population gets motivated to control the RFs based on customized information and specific instructions.
3. Healthcare managers are able to make timely and targeted decisions based on objective information as the effectiveness of the strategy for RF correction all the international and national prevention guidelines is increased.

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