The Original

ACUTE CORONARY SYNDROME WITHOUT ST-SEGMENT ELEVATION ON ELECTROCARDIOGRAM: SELECTION OF MANAGEMENT STRATEGY USING NEURAL NETWORK TECHNOLOGIES

Kostylev A.N.[1]*, Linchenko S.N.[2], Kostyleva E.A.[3], Onbysh T.E.[4], Kostylev K.A.[5], Sergeev N.S[6]

[1,2,3,4,5,6] Kuban State Medical University, Krasnodar, Russian Federation

ABSTRACT

Objective. The implementation of neural network modeling will enable the integration of a recommendation system (algorithm) based on Bayesian network analysis into the clinical practice and pedagogical training of medical school students in developing a clinical decision-making strategy in cases of suspected coronary artery pathology.

Methods. The development of an artificial intelligence model with integrated Bayesian networks is based on probability estimation across a combination of symptoms and laboratory-instrumental findings, with time-series analysis (frequency distribution across various forms of coronary artery disease and evidence-based medicine data).

Discussion. The proposed diagnostic methodology in cardiology, utilizing neural network technologies built on a probabilistic Bayesian architecture, is driven primarily by the complexity of the diagnostic workup and the determination of treatment strategy in acute coronary syndrome without ST-segment elevation on electrocardiogram. The application of a clinical decision support system has made it possible — drawing on the most robust evidence from randomized controlled trials grounded in the principles of evidence-based medicine — to differentiate latent coronary artery disease in atypical anginal presentations within a large clinical information field.

Conclusions. The use of artificial intelligence allows for the continuous updating of diagnostic and treatment protocols for cardiovascular diseases, taking into account the high comorbidity of cardiac and general internal medicine pathology. The evidence-based paradigm of scientific and clinical inquiry in cardiology, augmented by neural network analytical tools, will enable the development of structured clinical thinking in future specialists from the undergraduate stage of medical education, and facilitate the extrapolation of fundamental knowledge to the interpretation of tactical approaches in suspected coronary artery disease in each individual case.

KEYWORDS: acute coronary syndrome, multi-stage diagnostics, evidence-based medicine, treatment strategy algorithm, neural network technologies, Bayesian networks, medical school students.

INTRODUCTION

Modern cardiology in clinical practice is a dynamically evolving discipline representing a multi-stage process in which successful diagnosis, treatment, and prevention of cardiovascular diseases (CVD) makes a substantial contribution to the quality of life of both the working-age population and older age groups [1].

At the IV National Congress "National Healthcare 2025" held in Moscow, experts emphasized that cardiovascular pathology retains its status as the leading cause of mortality both in the Russian Federation and worldwide. Timely diagnosis, therapy, and systematic prevention in clinical cardiology have been elevated to the level of a national priority.

Minister of Health Mikhail Murashko, speaking at the Annual All-Russian Scientific and Practical Conference "Cardiology on the March 2025," held at the National Medical Research Center for Cardiology named after Academician E.I. Chazov, informed the professional community of a 30% reduction in mortality from cardiovascular pathology among patients enrolled in dispensary monitoring. "The use of innovative technologies (IT-based diagnostic tools) makes it possible to reorganize the interaction between physicians and patients in a fundamentally new way," Mikhail Murashko noted [2].

At the current stage of cardiology development, the determination of clinical management strategy in everyday practice is grounded both in knowledge of research findings and in the application of the fundamental principles of evidence-based medicine (EBM). A scientific strategy based on the synthesis and interpretation of a substantial body of research data from the perspective of EBM principles will help address the information gap among physicians in both outpatient and inpatient settings [3,4,5].

Cardiovascular pathology firmly maintains its leading position in the rankings of morbidity and mortality across Russia, despite the broad arsenal of available pharmacological agents and preventive interventions. According to

Rosstat data for 2025, mortality from circulatory system diseases among the working-age population by sex (2023) accounted for 31.5% of all deaths among men and 25.0% among women [6].
Studies conducted at the National Medical Research Center for Cardiology named after Academician E.I. Chazov identified the following contributing factors: target blood pressure levels were not achieved in 36% of monitored patients; in 70%, plasma levels of atherogenic low-density lipoproteins exceeded the threshold of 1.8 mmol/L; overweight was recorded in 46% of patients, with the abdominal variant present in 59%; inadequate glycemic control (glycated hemoglobin above 7%) was registered in 54% of cases; and 18% of patients continued to smoke [7].
The paradox of the situation lies in the fact that, despite having fairly well-established screening tools for the detection of myocardial ischemia, clinicians face considerable difficulties at the stage of nosological identification — a challenge driven by the latent course of the disease and the burden of comorbid conditions in the geriatric population. This reality necessitates operating within an enormous body of professional knowledge, drawing on the results of randomized controlled trials, while simultaneously possessing competencies in the interpretation of diagnostically informative markers in each individual clinical episode — for instance, in atypical anginal presentations, rare variants of coronary artery disease (CAD) associated with visceral and surgical pathology, mixed infectious burden, and other conditions. Given the contemporary approach to digitalization in healthcare with the use of standard software, technologies employing artificial intelligence (AI) represent a pivotal trend in improving the quality of medical care [8,9].
Neural network platforms are being utilized in numerous countries for population protection in emergency situations: the American NEWMC system, the pan-European RODOS system, the Russian ESPLA-10 complex, and other monitoring systems [10,11,12].
In Japan, clinical decision support systems (CDSS) built on the probabilistic foundation of Bayesian network structures are most actively employed within civil defense services. The operation of these systems with their computational algorithms during the accident at the Fukushima Daiichi nuclear complex revealed deficiencies in the preparedness of emergency response units, while simultaneously ensuring the rapid deployment of medical rescue forces and civil defense formations [13].
The relevance of the present work is directed toward the integration of CDSS into clinical practice, which — drawing on the information base of Bayesian networks — offers the opportunity to ensure nosological identification of coronary artery disease (CAD) through software-based correlation of clinical symptomatology, biochemical abnormalities, and paraclinical examination findings, thereby enabling the projection of a personalized vector for complication prevention.

Objective: The implementation of neural network modeling will enable the integration of a recommendation system (algorithm) based on Bayesian network analysis into the clinical practice and pedagogical training of medical school students in developing a clinical decision-making strategy in cases of suspected coronary artery pathology.

METHODS

The algorithmic framework for the application of artificial intelligence (AI) technologies, grounded in Bayesian network modeling combined with the development of a CDSS software suite, is oriented toward the evaluation of a tactical model in cases of suspected CAD — specifically, the frequency distribution of clinical features across various clinical forms of CAD — based on symptomatology, laboratory panels, and instrumental data according to evidence-based medicine and verified findings from controlled studies.
The review of international and domestic literature was based on information encompassing the epidemiology and diagnosis of acute coronary syndrome, contemporary treatment approaches, and primary and secondary prevention of CAD. A total of 57 literary sources were examined, of which 30 were subsequently included in the reference list of the present study.

DISCUSSION

The RESONANCE and ESSE-RF2 research projects were dedicated to the quality of diagnosis and the efficacy of treatment of CAD. Analysis of morbidity and mortality data revealed diagnostic errors in the establishment of acute coronary insufficiency, which resulted in a more than twofold increase in mortality rates for the acute form of CAD regardless of sex (Fig. 1) [14].

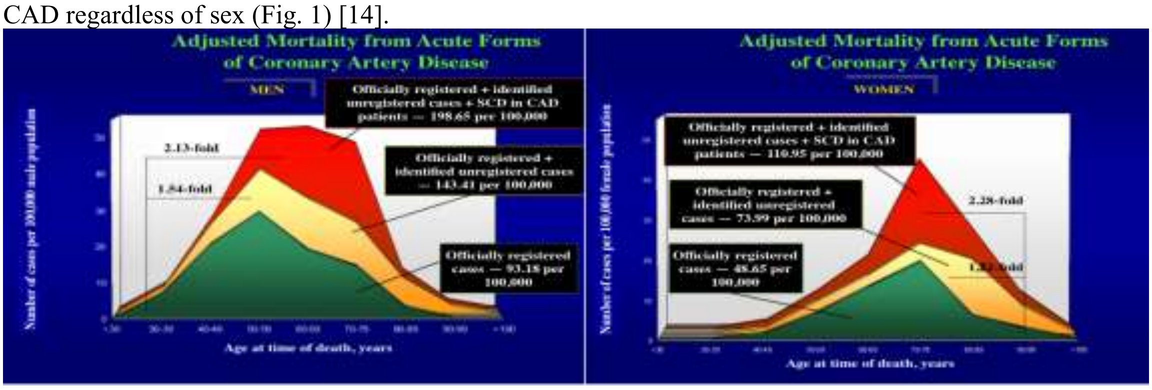


Fig. 1. Adjusted mortality from acute forms of coronary artery disease

NSA — newly onset angina. SCD — sudden cardiac death (fatality within 6 hours).
In such cases, the "masking" diagnoses substituted for acute forms of CAD were chronic forms of CAD (stable angina in 81% of cases), stroke in 8% of cases, and a number of other conditions [14].
In clinical cardiology, the term acute coronary syndrome (ACS) is applied when unstable angina (UA) or myocardial infarction (MI) is suspected but diagnostic criteria are insufficient for confident verification of either UA or MI. Acute coronary syndrome may serve both as an indicator of destabilization of a chronically progressing coronary insufficiency and as the inaugural symptom complex of atherothrombotic injury to the coronary arteries in patients who had not previously reported complaints of cardiac origin. ACS without ST-segment elevation on electrocardiogram (NSTE-ACS) is defined as an acutely presenting semiotics of ischemic myocardial injury in the absence of persistent (exceeding 20 minutes) ST-segment elevation in at least two contiguous leads, with the exclusion of newly onset left bundle branch block. Chronic coronary syndromes (CCS) represent stable phases of the clinical manifestations of CAD, which may either precede an acute episode or manifest following one [3,14,15].
The 2019 guidelines of the European Society of Cardiology delineate six clinical and diagnostic scenarios of CCS regularly encountered in the outpatient setting: stable angina symptoms and/or dyspnea, newly onset heart failure, stabilization of symptoms less than one year after ACS, more than one year after revascularization, angina with suspected vasospastic etiology, asymptomatic patients (in whom CAD was identified during screening), and stable CAD [16].
Prospective and retrospective observational study designs represent the principal determinants that predetermine the grading of the evidentiary strength of scientific findings, with the randomized controlled trial (RCT) recognized as the apex of this hierarchy and regarded as the "gold standard" [4].
A recent trend has been observed toward a decline in the registration of ST-segment elevation myocardial infarction (STEMI) with a simultaneous increase in NSTE-ACS. Based on data from the authoritative GRACE registry, five-year mortality among patients who have experienced ACS remains at a high level, approaching 20%. Notably, no statistically significant differences in mortality rates were recorded between STEMI, NSTE-ACS, and UA (19%, 22%, and 18%, respectively), and the overwhelming majority of fatal episodes in NSTE-ACS occur beyond the hospital threshold (87% in the NSTE-ACS group and 97% in the UA group) [17,18].
The patient's age is of paramount importance: the risk of ACS increases substantially, particularly beyond the threshold of 40–50 years of age. Sex-related characteristics must also be taken into account: males are subject to a greater probability of developing ACS compared to females [14,19]. Additionally, a concurrent pathological background may potentiate the risk of ACS. For instance, diabetic status multiplies the threat of cardiovascular catastrophes, including ACS. Arterial hypertension, atherogenic dyslipidemia, and overweight are likewise recognized as established risk factors [20,21].
Regarding the clinical presentation of ACS, it is important to emphasize that thoracalgia represents a symptom recorded in more than 80% of patients regardless of sex. In women, ACS more characteristically manifests without the classic chest pain syndrome, presenting instead with symptoms not directly associated with the cardiac domain — such as unexplained fatigue, shortness of breath, dyspeptic phenomena in the form of nausea and vomiting, heartburn, or uncontrolled anxiety [22,23,24]. Young age and the absence of the characteristic abdominal-thoracic pain pattern are among the most significant predictors of delayed ACS diagnosis [25].
The clinical manifestation of coronary syndrome in the cohort of elderly patients warrants particular attention. Despite the fact that chest pain remains the dominant and age-invariant indicator of ACS, the primary complaint in patients of advanced age may be expiratory dyspnea (49%), nausea and vomiting (24%), or episodes of loss of consciousness (19%). Thus, an atypical clinical presentation may serve as a catalyst for delayed diagnosis, an inadequate final clinical judgment, and, consequently, a delay in the initiation of therapy [26].
The evolution of medical technologies and the integration of high-sensitivity troponin testing into everyday practice have radically reformed the diagnostic evaluation algorithm for patients with suspected UA and NSTE-ACS. This biochemical marker has established itself as the central component in the detection of necrotic injury to cardiomyocytes [27,28]. Under such circumstances, the diagnosis of NSTE-ACS appears justified even in the absence of classic electrocardiographic criteria [29].
According to the guidelines of the European Society of Cardiology (ESC) with an evidence level of IB (recommendation grade A, evidence level 1), serial measurement of cardiac troponin T or I in the blood is recommended in cases of suspected NSTE-ACS [14].
Thoracalgia is considered one of the principal indicators of ACS without ST-segment elevation. Characteristic radiation of pain to the cervical zone, mandibular region, and left upper extremity is recognized (ESC class IC, recommendation grade C, evidence level 5). It should be noted that the symptomatic presentation of ACS is considerably diverse. Both gross hemodynamic disturbances (arrhythmia, cardiogenic shock, up to circulatory arrest) and minor subjective symptoms (retrosternal discomfort, dyspnea, general weakness) are possible, and the complete absence of any significant cardiac pain cannot be excluded. In approximately 50% of individuals hospitalized with a referral diagnosis of ACS without ST-segment elevation, the final diagnosis was formulated differently, including conditions unrelated to cardiovascular pathology. The thoracic pain phenomenon may be associated with pathological processes in both intrathoracic anatomical structures (pulmonary parenchyma, pleural layers, mediastinal tissue, diaphragm) and the gastrointestinal tract, as well as in the osteoarticular and muscular formations of the thorax and vertebral column against a background of neurological disorders accompanied by a psychogenically determined status.

According to the Russian multicenter epidemiological study ESSE-RF2 (15,300 participants aged 25–64 years), the prevalence of arterial hypertension in Russia is 44%. It is the most prevalent non-communicable disease worldwide (30–45%) and represents the primary cause of critical cardiovascular system damage. Its prevalence increases with age, reaching more than 60% among individuals over 60 years of age [14].
In clinical studies, for all patients with CAD or suspected CAD, when clinical grounds exist for screening for diabetes mellitus (DM), it is recommended (ESC evidence level IB, recommendation grade C, evidence level 5) to begin with measurement of glycated hemoglobin and fasting blood glucose. When results are inconclusive, an oral glucose tolerance test is additionally recommended. Type 2 diabetes mellitus is frequently combined with hyperlipidemia. The risk of developing CVD increases 2–4-fold in men and 3–7-fold in women. In laboratory investigations for CAD, the lipid spectrum of the blood is identified as an independent parameter of high prognostic value (ESC evidence level IC, recommendation grade C, evidence level 5). It has been demonstrated that plasma concentrations of total cholesterol or its fractions (LDL-C, HDL-C, Lp(a), apoB) correlate closely with CAD morbidity and mortality.
The ESC guidelines and Russian grading scales defined the evidence levels for the general biochemical blood panel and general clinical urinalysis as ESC IC (recommendation grade C, evidence level 5), and for the determination of blood electrolyte concentrations as ESC IIbC (recommendation grade C, evidence level 4).
Software utilizing an intelligent platform based on Bayesian networks [30] has enabled the construction of an information environment employing a CDSS for the selection of a management strategy in patients with suspected CAD (Fig. 2).

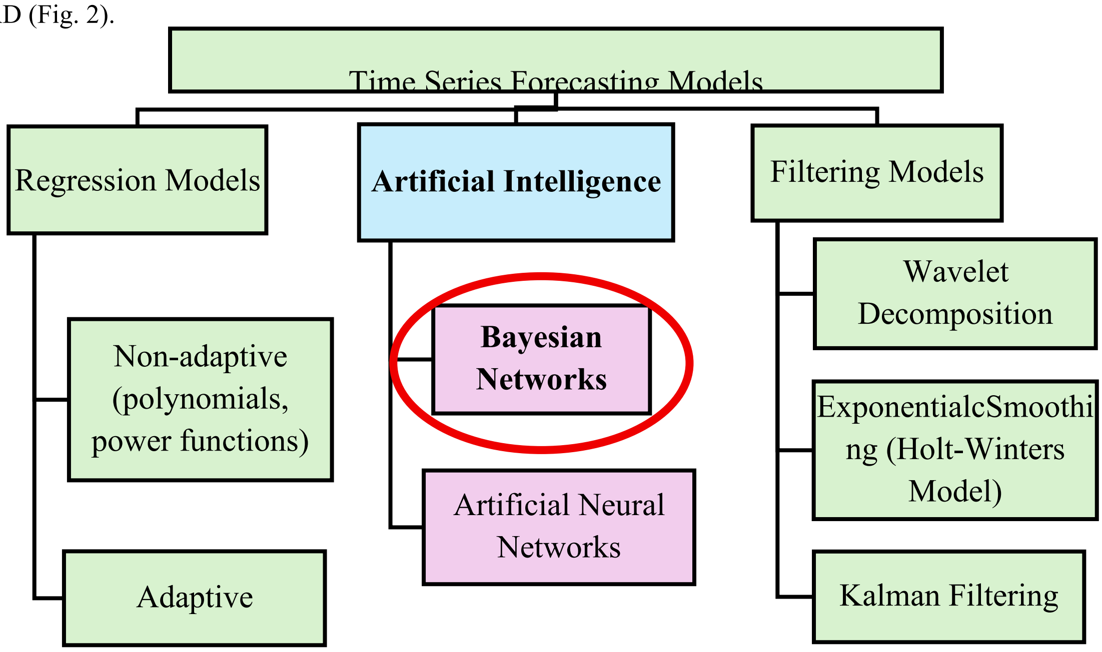
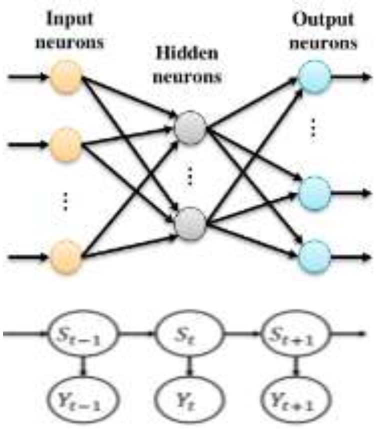


Fig. 2. Neural network technologies incorporating Bayesian networks.

The development of software utilizing Bayesian network structures is implemented through probability estimation across a combination of laboratory-instrumental findings and clinical symptomatology, with time-series analysis (percentage frequency of symptom recurrence across various clinical manifestations of CAD, verified through the lens of evidence-based medicine). The ultimate objective is the computation of the conditional probability (P) of a specific event (A) given the presence of a statistically associated event (B), employing Bayes' formula (Fig. 3).



$$P(A|B) = \frac{P(B|A) * P(A)}{P(B)}$$

Fig. 3. Graphical probabilistic model of neural network technologies with integration of Bayes' formula.

The graphical probabilistic model on the Bayesian network platform is illustrated by the mapping of each recorded value S(t-1) and Y(t-1) (representing, for instance, the aggregate of clinical and laboratory correlates) to latent (unobserved) parameters S(t) and Y(t) (representing, for example, the spectrum of symptomatology across the diversity of CAD forms in light of evidence-based data), and enables the establishment of a conditional probability distribution for S(t+1) and Y(t+1) (output neurons). This determines the capacity to calculate the most probable diagnostic conclusions with subsequent prognostic modeling of the clinical management strategy in cases of suspected coronary artery pathology (Fig. 4).

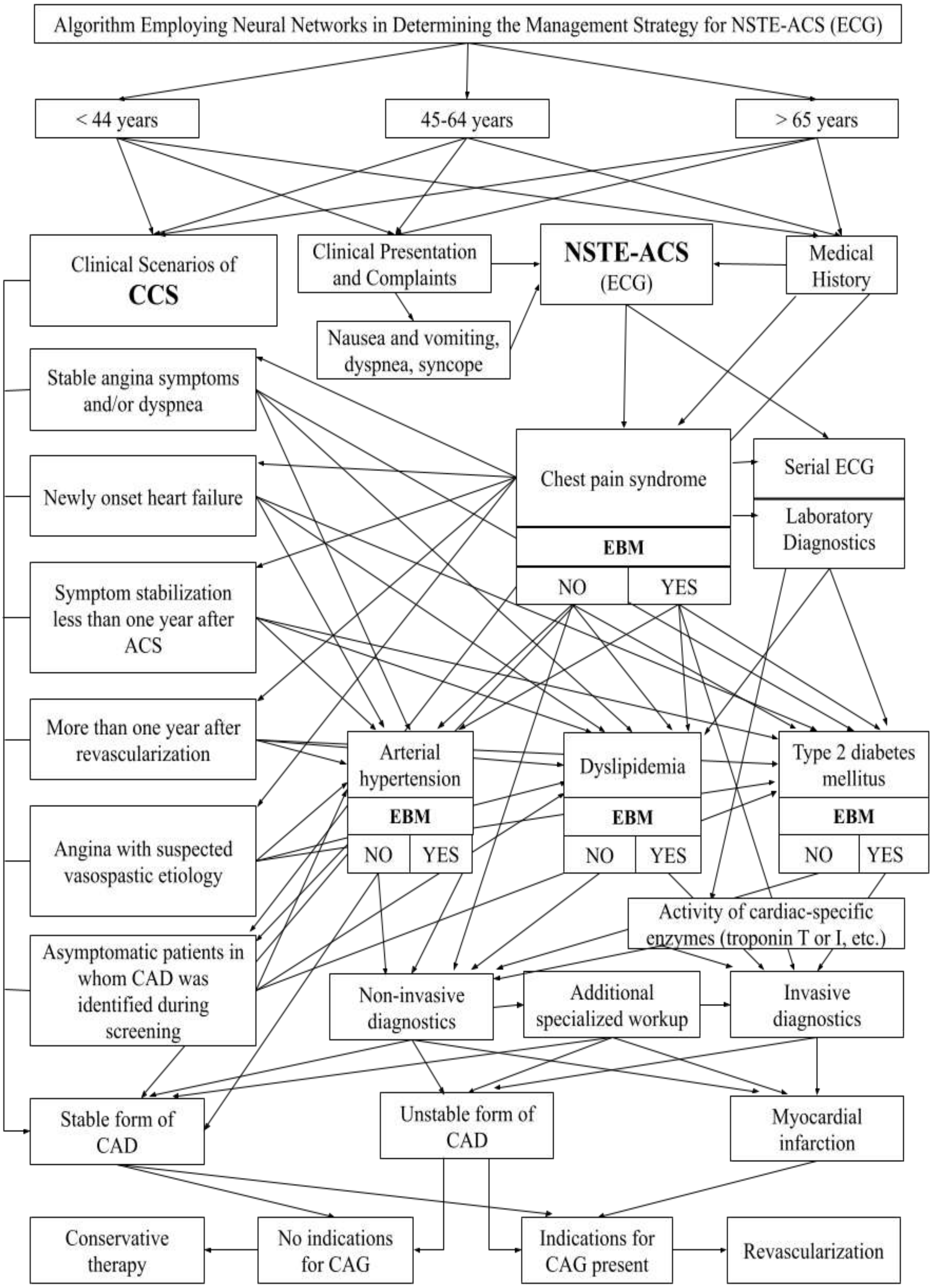


Fig. 4. Algorithm employing neural networks in determining the management strategy for NSTE-ACS on electrocardiogram.

For a substantiated referral to invasive coronary angiography (CAG), the entire body of information accumulated during patient history-taking, physical examination, and paraclinical workup must be taken into account — ESC IB (recommendation grade B, evidence level 1). The frequency of follow-up visits with reassessment of cardiovascular risk determinants is regulated by the baseline risk level and documented cardiotoxicity. The degree of risk of cardiovascular complications (CVC) may demonstrate positive dynamics against the background of effective secondary preventive interventions and adequate myocardial revascularization. For this reason, CVC risk must be systematically reassessed (no less than once per year) [14].
The novelty of the approach is driven by the evolution of cardiological care in the selection of the clinical response vector, which is grounded not only in awareness of scientific research findings but also in the creative application of the fundamental postulates of EBM. A research strategy presupposing the systematization and meaningful interpretation of a large body of empirical data through the lens of EBM principles is capable of compensating for gaps in the professional awareness of medical personnel in both outpatient and inpatient settings. This thesis is dictated, above all, by the complexity of the diagnostic workup in determining the treatment strategy for CVD. The diagnostic methodology in cardiology is periodically subject to revision as updated clinical data accumulate, including risk factors for nosological entities not previously reflected in clinical guidelines.

Practical Significance. The practical significance is determined by the use of AI-based technological solutions grounded in the postulates of EBM, presupposing a synergistic integration of the empirical expertise of the practicing specialist and the judicious selection of the most reliable evidence of the effectiveness of a medical strategy for each individual patient. Furthermore, the ability to evaluate the most robust arguments within an immense information field with the aid of neural network technologies — which the cardiologist encounters on a daily basis — serves as a hallmark of professional medical culture.

CONCLUSIONS

1. Recourse to the capabilities of artificial intelligence built on a probabilistic Bayesian architecture provides the key to the identification of CAD from the perspective of detecting consistent interrelationships between risk factors, clinical symptomatology, biochemical analyses, and instrumental investigations — grounded in the fundamental principles of EBM — and the therapeutic strategy in the prevention of cardiovascular complications.
2. The application of neural network technologies employing a clinical decision support system enables, with a high level of evidence and high probability, the continuous updating of diagnostic and treatment protocols for CVD, taking into account the high comorbidity of cardiac and general internal medicine pathology.
3. The evidence-based paradigm of scientific and clinical inquiry in cardiology, augmented by neural network analytical tools, will enable the development of structured clinical thinking in future specialists from the undergraduate stage of medical education, along with the capacity to apply fundamental knowledge to the selection of a management strategy in cases of suspected CAD in each individual clinical case.

REFERENCES

1. Boytsov S.A., Pogosova N.V. Cardiovascular prevention 2022. Russian national guidelines. Russian Journal of Cardiology. 2023. doi: 10.15829/1560-4071-2023-5452. EDN EUDWYG
2. Murashko: cancer mortality in Russia has decreased by almost 10%. TASS. Available at: https://tass.ru/obschestvo/25564259 (accessed: 23.04.2025).
3. Roitberg G.E., Strutynsky A.V. Internal Medicine. Cardiovascular System: A Textbook. Moscow: MEDpress-inform; 2021. 904 p. (accessed: 23.04.2025).
4. Pavlova T.V. The role of real-world clinical practice studies in evidence-based cardiology. Russian Journal of Cardiology. 2021;26(S3):4636. doi: 10.15829/1560-4071-2021-4636
5. Yakushin S.S., Nikulina N.N., Pereverzeva K.G. Evidence-Based Medicine in Cardiology: A Textbook for Students in the Specialty of General Medicine. Ryazan: OTSiOP; 2023. 260 p. (accessed: 23.04.2025).
6. Healthcare in Russia. 2025: Statistical Compendium. Rosstat. Moscow; 2025. 149 p.
7. Pogosova N.V., Boytsov S.A. Preventive cardiology 2024: current state and development prospects. Cardiology. 2024;64(1):4–13. doi: 10.18087/cardio.2024.1.n2636
8. Zhdanova E.V., Rubtsova E.V. Experience of implementing the pilot project "Artificial Intelligence" in the work of a district general practitioner in the Yamalo-Nenets Autonomous District: a pilot single-center cross-sectional screening observational study. Kuban Scientific Medical Bulletin. 2022;29(4):14–31. doi: 10.25207/1608-6228-2022-29-4-14-31 (accessed: 10.04.2026).
9. Kochkarova E.V. Artificial intelligence in medicine and medical education. In: Proceedings of the XV International Scientific and Methodological Conference "Innovations in Education" (Krasnodar, April 11, 2024). 2025. P. 163–166.
10. Sanderson M.A., Stanton N.A., Plant K.L. Individual dynamic risk analysis (iDRA): A systematic review and network model development. Safety Science. 2020;128:104769. doi: 10.1016/j.ssci.2020.104769 (accessed: 12.04.2026).
11. Realtime Online Decision Support System for nuclear emergency management. RODOS. 2022. Available at: http://www.rodos.fzk.de/ (accessed: 07.01.2025).
12. The official website of the US Federal Emergency Management Agency (FEMA). 2024. Available at: http://www.fema.gov/plan/prevent/fhm/frm_soft.shtm (accessed: 11.02.2025).

13. Cai Y., Golay M.W. Multiunit nuclear power plant accident scenarios and improvements including those based upon interviews with TEPCO engineers concerning the 2011 Fukushima accidents. Nuclear Engineering and Design. 2020;365:110707. doi: 10.1016/j.nucengdes.2020.110707 (accessed: 04.02.2025).
14. Averkov O.V., Arutyunyan G.K., Duplyakov D.V., Konstantinova E.V., Nikulina N.N., Shakhnovich R.M., Yavelov I.S., Yakovlev A.N., Abugov S.A., Alekyan B.G., Aronov D.M., Arkhipov M.V., Barbarash O.L., Boytsov S.A., Bubnova M.G., Vavilova T.V., Vasilieva U.Yu., Galyavich A.S., Ganyukov V.I., Gilyarevsky S.R., et al. Acute coronary syndrome without ST-segment elevation on electrocardiogram. Clinical guidelines 2024. Russian Journal of Cardiology. 2025;30(5):6319. doi: 10.15829/1560-4071-2025-6319. EDN: CXJUIB
15. Tarasova I.V., Vertkin A.L. Review of imaging methods used in the diagnosis of stable coronary artery disease. Attending Physician. 2023;4(26):48–55. doi: 10.51793/OS.2023.26.4.007 (accessed: 23.04.2025).
16. Barbarash O.L., Karpov Yu.A. Stable coronary artery disease. Clinical guidelines 2024. Russian Journal of Cardiology. 2024. doi: 10.15829/1560-4071-2024-6110. EDN HHJJUT
17. Morici N., Savonitto S., Ferri L.A., Grosseto D., Bossi I., Sganzerla P., Tortorella G., Cacucci M., Ferrario M., Crimi G., Murena E., Tondi S., Toso A., Gandolfo N., Ravera A., Corrada E., Mariani M., Di Ascenzo L., Petronio A.S., Cavallini C., et al. Outcomes of elderly patients with ST-elevation or non-ST-elevation acute coronary syndrome undergoing percutaneous coronary intervention. The American Journal of Medicine. 2019;132(2):209–216. doi: 10.1016/j.amjmed.2018.10.027
18. Barbarash O.L., Duplyakov D.V., Zateyshchikov D.A., Panchenko E.P., Shakhnovich R.M., Yavelov I.S., Yakovlev A.N., Abugov S.A., Alekyan B.G., Arkhipov M.V., Vasilieva E.Yu., Galyavich A.S., Ganyukov V.I., Gilyarevsky S.R., Golubev E.P., Golukhova E.Z., Gratsiansky N.A., Karpov Yu.A., Kosmacheva E.D., Lopatin Yu.M., et al. Acute coronary syndrome without ST-segment elevation on electrocardiogram. Clinical guidelines 2020. Russian Journal of Cardiology. 2021;26(4):4449.
19. Pencina M.J., Navar A.M., Wojdyla D., Sanchez R.J., Khan I., Elassal J., D'Agostino R.B. Sr., Peterson E.D., Sniderman A.D. Quantifying importance of major risk factors for coronary heart disease. Circulation. 2019;139(26):1603–1611. doi: 10.1161/CIRCULATIONAHA.117.031855
20. Malakar A.K., Choudhury D., Halder B., Paul P., Uddin A., Chakraborty S. A review on coronary artery disease, its risk factors, and therapeutics. Journal of Cellular Physiology. 2019;234(10):16812–16823. doi: 10.1002/jcp.28350
21. Moscucci F., Lavalle F., Politi C., Campanale A., Baggio G., Sciomer S. Acute coronary syndrome in women: a new and specific approach is needed. European Journal of Preventive Cardiology. 2022;29(11):305–308. doi: 10.1093/eurjpc/zwac143
22. Lichtman J.H., Leifheit E.C., Safdar B., Bao H., Krumholz H.M., Lorenze N.P., Daneshvar M., Spertus J.A., D'Onofrio G. Sex differences in the presentation and perception of symptoms among young patients with myocardial infarction: evidence from the VIRGO Study. Circulation. 2018;137(8):781–790. doi: 10.1161/CIRCULATIONAHA.117.031650
23. Gebhard C.E., Gebhard C., Maafi F., Bertrand M.J., Stähli B.E., Maredziak M., Bengs S., Haider A., Zhang Z.W., Smith D.C., Ly H.Q. Impact of summer season on pre-hospital time delays in women and men undergoing primary percutaneous coronary intervention. Science of the Total Environment. 2019;656:322–330. doi: 10.1016/j.scitotenv.2018.11.363
24. Meyer M.R., Bernheim A.M., Kurz D.J., O'Sullivan C.J., Tüller D., Zbinden R., Rosemann T., Eberli F.R. Gender differences in patient and system delay for primary percutaneous coronary intervention: current trends in a Swiss ST-segment elevation myocardial infarction population. European Heart Journal: Acute Cardiovascular Care. 2019;8(3):283–290. doi: 10.1177/2048872618810410
25. Mehilli J., Presbitero P. Coronary artery disease and acute coronary syndrome in women. Heart. 2020;106(7):487–492. doi: 10.1136/heartjnl-2019-315555
26. Pushkin A.S., Khavinson V.Kh. Personification of monitoring of acute coronary syndrome and its outcomes in elderly and senile patients. Advances in Gerontology. 2019;(5):771–780.
27. Bergmark B.A., Mathenge N., Merlini P.A., Lawrence-Wright M.B., Giugliano R.P. Acute coronary syndromes. Lancet. 2022;399(10332):1347–1358. doi: 10.1016/S0140-6736(21)02391-6
28. Boytsov S.A., Provatorov S.I. Possibilities for improving in-hospital and long-term prognosis in unstable angina. Therapeutic Archive. 2024;(1):5–10. doi: 10.26442/00403660.2024.01.202555
29. Chapman A.R., Adamson P.D., Shah A.S.V., Anand A., Strachan F.E., Ferry A.V., Lee K.K., Berry C., Findlay I., Cruikshank A., Reid A., Gray A., Collinson P.O., Apple F., McAllister D.A., Maguire D., Fox K.A.A., Vallejos C.A., Keerie C., Weir C.J., et al. High-sensitivity cardiac troponin and the universal definition of myocardial infarction. Circulation. 2020;141(3):161–171. doi: 10.1161/CIRCULATIONAHA.119.042960
30. Khairullin R.Z. Application of the Bayesian network method for establishing causal relationships. Bulletin of Tula State University. Technical Sciences. 2022;(3). Available at: https://cyberleninka.ru/article/n/primenenie-metoda-bayesovskih-setey-dlya-ustanovleniya-prichinno-sledstvennyh-svyazey (accessed: 23.04.2025).