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COR-VIDENS: ИНТЕГРИРОВАННАЯ ПЛАТФОРМА ДЛЯ ПРОГНОЗИРОВАНИЯ ПРОФИЛАКТИКИ СЕРДЕЧНО-СОСУДИСТЫХ ЗАБОЛЕВАНИЙ И ЗАТРАТ НА ЧРЕЗМЕРНОЕ ИСПОЛЬЗОВАНИЕ РЕСУРСОВ

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COR-VIDENS: AN INTEGRATED PLATFORM FOR PREDICTING CARDIOVASCULAR DISEASE PREVENTION AND OVERUSE COSTS

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Резюме. Сердечно-сосудистые заболевания остаются ведущей причиной смертности во всем мире. Несмотря на десятилетия исследований, в результате которых были разработаны валидированные инструменты прогнозирования риска, их рутинное клиническое использование остается низким: только 41% подходящих пациентов получают терапию в соответствии с клиническими рекомендациями. Целью данного исследования была разработка и клиническая валидация Cor-Videns – интегрированной цифровой платформы, объединяющей 38 существующих шкал сердечно-сосудистого риска в автоматизированный инструмент для сокращения времени оценки риска, улучшения последовательности и повышения приверженности клиническим рекомендациям. Платформа повысила диагностическую точность с 72% до 90% ($p<0,001$), сократила время принятия решения на 37% (с 6,7 до 4,2 минуты, $p=0,002$) и улучшила adherence к рекомендациям с 68% до 94%. Наибольшие преимущества наблюдались в уязвимых популяциях: диагностическая точность улучшилась на 20% для пожилых пациентов, на 18% для женщин и на 19% для пациентов этнических меньшинств.

Ключевые слова: сердечно-сосудистые заболевания, прогнозирование риска, поддержка клинических решений, приверженность рекомендациям, справедливость здравоохранения

Resume. Cardiovascular diseases remain the leading cause of mortality worldwide. Despite decades of research yielding validated risk prediction tools, routine clinical use remains low, with only 41% of eligible patients receiving guideline-recommended therapies. This study aimed to develop and clinically validate Cor-Videns, an integrated digital platform that consolidates 38 existing cardiovascular risk scores into an automated tool to reduce risk assessment time, improve consistency, and enhance guideline adherence. The platform increased diagnostic accuracy from 72% to 90% ($p<0.001$), reduced decision time by 37% (from 6.7 to 4.2 minutes, $p=0.002$), and improved guideline adherence from 68% to 94%. Critically, the largest benefits were observed in vulnerable populations: diagnostic accuracy improved by 20% for elderly patients, 18% for women, and 19% for ethnic minorities.

Keywords: cardiovascular diseases, risk prediction, clinical decision support, guideline adherence, healthcare equity

Relevance. Cardiovascular diseases remain the leading cause of mortality worldwide, accounting for approximately 17.9 million deaths annually according to the World Health Organization. Despite decades of research yielding validated risk prediction tools such as SCORE, QRISK, and Framingham Risk Score, proven to improve outcomes through early identification and preventive intervention, routine clinical use remains alarmingly low. Current evidence indicates that only 41% of eligible patients receive

guideline-recommended therapies, representing a significant gap between evidence-based medicine and clinical practice. The primary barriers to widespread adoption are multifaceted: time constraints requiring 5–10 minutes per manual calculation, difficulty recalling complex scoring criteria across dozens of tools (each with unique variables and weighting schemes), and fragmentation across disparate platforms that do not communicate with one another. This fragmentation disproportionately affects vulnerable populations–elderly patients, women, and ethnic minorities–who often present with atypical symptoms and are inconsistently managed compared to the standard reference populations used to develop original risk scores. Studies have shown that women are 1.5 times more likely to have their cardiovascular risk underestimated, while elderly patients frequently have risk scores miscalculated due to age-related physiological changes not captured in standard models. This study investigates how consolidating existing cardiovascular risk scores into a single automated platform with seamless electronic health record integration can address these implementation gaps while simultaneously reducing unnecessary healthcare overuse costs associated with inappropriate testing and treatment.

Aim: to develop and clinically validate an integrated digital platform that consolidates existing cardiovascular risk prediction scores into an automated tool to reduce risk assessment time, improve diagnostic consistency, enhance guideline adherence, and reduce unnecessary healthcare costs associated with overuse of cardiovascular testing and interventions.

Objectives:

1. To design and implement a microservices-based digital platform (Cor-Videns) integrating 38 peer-reviewed cardiovascular risk scores into a unified, user-friendly interface with automated calculation capabilities.
2. To evaluate the platform's impact on diagnostic accuracy, guideline adherence, and clinical decision time compared to standard manual risk assessment practices.
3. To assess the platform's effectiveness in reducing medication dosing errors and unnecessary healthcare utilization across diverse clinical settings.
4. To perform subgroup analyses to determine whether the platform delivers equitable benefits across vulnerable populations including elderly patients, women, and ethnic minorities.
5. To validate the heart failure prediction suite prospectively on patients with atherosclerosis and the cardiovascular disease suite on larger cohorts with chronic kidney disease, rheumatoid arthritis, and diabetes mellitus.

Materials and methods. The Cor-Videns platform was built on a microservices architecture that follows international standards (ISO/IEC 25010 for software quality and HL7 FHIR for healthcare interoperability), bringing together 38 existing, peer-reviewed cardiovascular risk scores into one easy-to-use interface. Rather than inventing new algorithms, the platform automates risk calculation with a modular engine that applies each published score exactly as written, preserving the original validation and calibration of each tool. A Data Integration Layer pulls patient data directly from hospital electronic health records using FHIR (Fast Healthcare Interoperability Resources) APIs, eliminating manual data entry and transcription errors. The platform includes risk scores across multiple cardiovascular domains: coronary artery disease (Framingham, ASCVD, PROCAM, QRISK3), heart failure (MAGGIC, SHFM, Seattle Heart Failure Model),

stroke (CHA_2DS_2-VASc, R_2CHADS_2, ABCD2), venous thromboembolism (Wells, Geneva, Padua), and bleeding risk (HAS-BLED, ATRIA, ORBIT).

For statistical validation, we used McNemar's test to assess diagnostic accuracy before and after platform implementation, paired t-tests to compare decision times, and subgroup analyses stratified by age, sex, and ethnicity to ensure the tool works equitably for vulnerable populations, with statistical significance set at $p<0.05$. To validate the heart failure prediction suite, we prospectively tested 25 patients with atherosclerosis (13 men and 12 women, total 25 patients as noted) at the 4th Minsk Clinical Hospital, with each patient undergoing comprehensive cardiovascular assessment including echocardiography, biomarker analysis (NT-proBNP), and six-minute walk testing. Meanwhile, the cardiovascular disease (CVD) prevention suite was evaluated on a larger cohort of 213 patients with chronic kidney disease (CKD stages 3-4), 115 patients with rheumatoid arthritis (active disease for >5 years), and 105 patients with diabetes mellitus (type 2, HbA1c >7.0%), totaling 433 patients (217 women and 216 men, aged 21 to 80 years, mean age 58.4 ± 12.7 years). Data were collected from multiple centers including the 4th Minsk Clinical Hospital, Bristol Royal Infirmary (UK), and Oxford John Radcliffe Hospital (UK), providing a true multi-center international assessment. Exclusion criteria included acute cardiovascular events within the preceding 30 days, active malignancy, and inability to provide informed consent.

Results and their discussion. The In standard practice prior to platform implementation, clinicians calculated appropriate risk scores in only 43% of indicated cases. The primary reasons for non-calculation were time constraints (reported by 67% of clinicians), difficulty recalling scoring criteria (52%), and simply not thinking to use them (38%). These findings highlight the critical implementation gap between evidence availability and clinical application. Following implementation of the Cor-Videns platform, risk scores were automatically calculated for every patient meeting indication criteria, leading to substantial and statistically significant improvements across multiple outcome measures.

Diagnostic accuracy increased from 72% to 90% ($p<0.001$), representing a 25% relative improvement in correct risk classification. This improvement translated directly into clinical action: guideline adherence improved from 68% to 94% ($p<0.001$), meaning that nearly all eligible patients received appropriate preventive interventions including statin therapy, antiplatelet agents, and lifestyle modification counseling. Clinical decision time decreased significantly by 37%, from 6.7 minutes per patient to 4.2 minutes ($p=0.002$), representing a time savings of 2.5 minutes per assessment. Over a typical clinic day seeing 20 patients, this translates to nearly one hour of reclaimed time that can be redirected to direct patient care and shared decision-making conversations.

Medication dosing errors, particularly miscalculations of anticoagulant doses in atrial fibrillation patients and statin intensity selection based on risk category, were reduced by 83% (from 12.4% of prescriptions to 2.1%, $p<0.001$). The platform's FHIR-compliant architecture provided seamless electronic health record interoperability, automatically populating risk scores with available laboratory and clinical data while flagging missing variables for efficient data collection.

Critically, the platform delivered the largest benefits for vulnerable populations who have historically been underserved by standard cardiovascular risk assessment approaches.

Diagnostic accuracy improved by 20% for elderly patients (aged ≥75 years), 18% for women, and 19% for ethnic minority patients. Importantly, these improvements were achieved not through new algorithms specifically designed for these populations, but by ensuring consistent application of existing scores that have often been overlooked or incorrectly applied in these groups. Subgroup analysis revealed that prior to implementation, clinicians were significantly less likely to calculate risk scores for women (38% of indicated cases) compared to men (52%, p=0.008), and for elderly patients (35%) compared to middle-aged adults (49%, p=0.003). The platform eliminated this unconscious bias by automating the calculation process independent of patient demographics.

Resource utilization analysis demonstrated significant reductions in unnecessary healthcare overuse costs. Rates of inappropriate cardiac imaging (stress tests, echocardiograms, coronary CT angiography) in low-risk patients decreased by 34% (from 18.7% to 12.3%, p=0.004), while appropriate high-intensity statin prescribing in high-risk patients increased from 56% to 89% (p<0.001). Unnecessary anticoagulation in low-risk atrial fibrillation patients (CHA_2DS_2-VASc score 0-1) decreased by 72%, preventing potential bleeding complications and reducing medication costs by an estimated $340 per patient annually. The platform correctly identified 94% of high-risk patients who would benefit from intensive preventive interventions, compared to only 68% under standard care.

Conclusions:

1. The Cor-Videns digital platform, consolidating 38 existing cardiovascular risk scores into a single automated tool, significantly improved clinical care by increasing diagnostic accuracy from 72% to 90% (p<0.001) and guideline adherence from 68% to 94% (p<0.001).
2. The platform reduced clinical decision time by 37% (from 6.7 to 4.2 minutes per patient, p=0.002) and decreased medication dosing errors by 83%, representing substantial improvements in clinical efficiency and patient safety.
3. Critically, the platform delivered equitable benefits across vulnerable populations, improving diagnostic accuracy by 20% for elderly patients, 18% for women, and 19% for ethnic minorities, thereby reducing unconscious bias in clinical risk assessment and advancing healthcare equity.
4. The success of Cor-Videns stems not from novel algorithms or artificial intelligence, but from the consistent application of existing, validated knowledge–addressing the implementation gap by putting proven tools at clinicians' fingertips. The platform reduced unnecessary healthcare overuse costs by 34% for inappropriate cardiac imaging and 72% for unnecessary anticoagulation.
5. Future directions include integration of real-time biomarker data (high-sensitivity troponin, coronary calcium scoring), expansion to primary care and community health settings, and prospective validation of long-term clinical outcomes including major adverse cardiovascular event reduction.

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