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OPINION REVIEW

Vascular medicine in the 21st century: Embracing comprehensive vasculature evaluation and multidisciplinary treatment

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Abstract

The field of vascular medicine has undergone a profound transformation in the 21st century, transforming our approach to assessment and treatment. Atherosclerosis, a complex inflammatory disease that affects medium and large arteries, presents a major challenge for researchers and healthcare professionals. This condition, characterized by arterial plaque formation and narrowing, poses substantial challenges to vascular health at individual, national, and global scales. Its repercussions are far-reaching, with clinical outcomes including ischemic heart disease, ischemic stroke, and peripheral arterial disease—conditions with escalating global prevalence. Early detection of vascular changes caused by atherosclerosis is crucial in preventing these conditions, reducing morbidity, and averting mortality. This article underscored the imperative of adopting a holistic approach to grappling with the intricacies, trajectories, and ramifications of atherosclerosis. It stresses the need for a thorough evaluation of the vasculature and the implementation of a multidisciplinary treatment approach. By considering the entire vascular system, healthcare providers can explore avenues for prevention, early detection, and effective management of this condition, ultimately leading to improved patient outcomes. We discussed current practices and proposed new directions made possible by emerging diagnostic modalities and treatment strategies. Additionally, we considered healthcare expenditure, resource allocation, and the transformative potential of new innovative treatments and technologies.

Key Words: Vascular medicine; Vasculature assessment; Holistic approach; Prevention

avenues; Healthcare transformation

Core Tip: Early detection of atherosclerotic vascular changes holds the key to prevention, reducing morbidity and averting mortality. This manuscript emphasized the need to adopt a holistic approach to deal with the complex intricacies, trajectories, and ramifications of atherosclerosis. It discussed the need for a comprehensive vasculature evaluation with subsequent implementation of a multidisciplinary treatment paradigm.

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INTRODUCTION

Atherosclerosis is a complex immuno-inflammatory disease affecting medium-sized and large arteries, characterized by the formation of arterial plaques and narrowing, ultimately impacting the entire vascular system. It constitutes a global health challenge, serving as the primary driver of vascular diseases, including ischemic heart disease, ischemic stroke, and peripheral arterial disease[1-3]. In the United States, approximately 30% of individuals suffer from ischemic heart disease and/or stroke, underscoring the magnitude of its prevalence[4]. Cardiovascular events, including vascular events, account for 38% of mortality in high-income countries[4]. The burden of cardiovascular disease (CVD) extends to disability-adjusted life years, affecting 18% in high-income countries and 10% in low-income to medium-income countries [4]. The American Heart Association reported that the annual direct and indirect costs of CVD in the United States reached an estimated $407.3 billion in 2018-2019[5].

Risk factors for significant atherosclerotic changes and stenosis in arteries include: (1) Advanced age and family history; (2) Modifiable risk factors such as obesity and lifestyle behaviors including smoking, alcohol consumption, dietary patterns and substances, reduced physical activity, and increased sedentary lifestyle; and (3) Highly prevalent physiologic and metabolic alterations, which can be associated with concurrent medical conditions, including dyslipidemias (hyperlipidemia), high glucose levels and insulin resistance (diabetes mellitus), high blood pressure (hypertension), and changes in immune-related or coagulation-related factors (thrombophilia)[3,6,7].

Previous studies have demonstrated that atherosclerosis not only targets coronary arteries but also extends to other vital sites within the body. Peripheral vascular disease is present in approximately one-third of coronary artery disease (CAD) patients[8], while carotid artery stenosis affects 25.4% of CAD patients[9]. Among patients with severe carotid artery stenosis, up to 77.5% have concomitant CAD[10]. Furthermore, abdominal aorta aneurysms are identified in 9.5% of CAD patients[11]. The involvement of crucial cerebral arteries[12], as well as renal arteries[13] and mesenteric arteries [14], is not uncommon. The prevalence of asymptomatic superior mesenteric artery stenosis has been reported as 3% in patients under 65 years and 18% in patients older than 65 years[15]; superior mesenteric artery stenosis and the resultant occlusion can lead to significant morbidity, including abdominal angina and malabsorption, or mortality when thrombosed[14].

Involvement of cerebral arteries may lead to cerebrovascular accidents, resulting in severe functional impairment or death. Renal artery stenosis can cause hypertension and lead to serious renal impairment. Abdominal aorta involvement can lead to aneurysms, dissections, and death. Despite atherosclerosis manifesting as a systemic disease affecting multiple vascular sites, the current medical approach often fails to consider the simultaneous evaluation of the entire vasculature. For instance, middle-to-old age patients with chest pain primarily prompt investigations into coronary arteries[16]. Investigation is typically limited to catheterization resulting in local treatments including balloon angioplasty and stent insertion[17] or coronary bypass graft surgery[18]. When carotid artery stenosis is identified, the focus tends to be on assessing the degree of stenosis, resulting in carotid endarterectomy alone[8].

PRESENTATION OF THE PROBLEM

The current approach has several issues that can be divided into distinct but related categories: (1) There are no comprehensive guidelines for prevention and early detection of the potentially perilous vascular conditions; (2) Evaluations are typically conducted at a late stage in response to specific symptoms or incidental findings among ill patients, rather than being performed routinely on a wider scale as a monitoring tool to identify at-risk subpopulations and plan individual evaluations that consider the entire vasculature; and (3) The medical envelope involves multiple diverse specialists, each focusing on their own area of expertise. We suggest creating specialized multidisciplinary teams to address all aspects of atherosclerosis comprehensively. The medical process involving this team should be orchestrated, integrated, and led by

a vascular specialist with comprehensive expertise on the entire process and its diverse aspects, to ensure optimal information flow and informed decision-making.

THE PROPOSED MODEL

Our proposal envisions a revolutionary paradigm shift in our approach to atherosclerosis, clotting abnormalities, and their associated consequences by embracing a holistic approach to vascular health. Therefore, we call for the development of guidelines that view the entire vasculature as one interlinked system and focus on prevention, continuous monitoring of populations at risk, early detection, and targeted intervention. Both the patients and the medical system may benefit from harnessing the capabilities of multidisciplinary teams led by a specialized integrative professional. Overall, the proposed model strives to offer cost-effective equitable vascular care for all. In doing so, it seeks to usher in a new era of comprehensive, proactive management of vascular conditions.

We will now outline the key components of our model (Figure 1) and highlight the current situation along with our proposed changes. At the end of each component, we will present the key aspects to concisely summarize the pivotal features. Finally, we will discuss the economic implications and technological opportunities, as well as future directions.

MISSING GUIDELINES

Research to create comprehensive guidelines for the early detection of potentially dangerous vascular conditions is currently lacking. Guidelines aimed at evaluating the entire vasculature could greatly aid in diagnosing cardiovascular conditions at an earlier stage, thus preventing serious outcomes, reducing morbidity, and preventing mortality. We believe that prevention should be given greater emphasis, from both a medical and economic standpoint, with continuous monitoring of at-risk populations for early detection and targeted treatment alongside comprehensive evaluation and integrated treatment of those who present symptoms.

In 2023, the American Heart Association/American College of Cardiology Joint Committee on Clinical Practice Guidelines released a comprehensive guideline for managing patients with chronic coronary disease. This guideline advocates for an evidence-based, patient-centered approach that considers social determinants of health. It emphasizes the importance of shared decision-making and a team-based care approach[19]. However, the report neither explicitly addressed the prevention of concurrent vascular diseases nor explored the potential benefits of a multidisciplinary team of medical specialists assessing an individual's entire vascular system.

Key aspects

Vasculature as a whole system, expanding circles from prevention to early detection, and comprehensive assessment and treatment.

COMPREHENSIVE RISK ASSESSMENT AT THE POPULATION AND INDIVIDUAL LEVELS

The cornerstone of effective risk assessment for diverse vascular events should involve two complementary aspects: Identifying at-risk subpopulations through a structured questionnaire and comprehensive review of medical records; and a meticulous assessment of the risk score of each individual at risk to determine the appropriate prevention, monitoring, and potential treatment plan.

Given the potential link between diverse vascular events and variability in the risk of all vascular events based on individual risk factors, we propose a combined risk assessment scheme that employs a scale that accounts for the risk of all potential vascular events for each patient. This risk assessment would guide a multi-specialist evaluation led by a vascular specialist. We maintain that even as we strive to minimize the need for interventions to address vascular consequences of atherosclerosis, a multidisciplinary patient evaluation remains essential.

These at-risk individuals would then undergo a comprehensive medical assessment, including: (1) A detailed socio-demographic profile including age, sex, place of origin, residence, and occupational history; (2) A detailed medical history encompassing current complaints, past medical conditions, lifestyle habits (such as smoking, alcohol consumption, and drug use), medications, and a thorough family medical history, with an emphasis on vascular events; (3) A comprehensive physical examination with a primary focus on evaluating the cardiovascular system, including the heart and major neck vessels. The abdominal examination should include searching for pulsating masses and identifying murmurs. A comprehensive assessment of pulses should include the neck, arms, groin, popliteal area, dorsalis pedis, and tibialis posterior. Additionally, a thorough neurological examination should be performed to identify deficits; (4) Evaluation of body mass index and blood pressure measurements; (5) Hematological evaluation for thrombophilia and serologic assessment for rheumatic disease; and (6) Metabolic state assessment, including glucose levels, glycosylated hemoglobin, lipid profile, liver function, and renal function.

Armed with this comprehensive information, a risk score can be calculated using established tools such as PROspective Cardiovascular Munster, Framingham[20], HeartSCORE, or others. The diverse current CVD risk-estimation scores not only differ from each other in the inclusion of different risk factors/variables but also in their receiver operating characteristic curves and function performance (mainly calibration and to a lesser extent discrimination), their outcome,

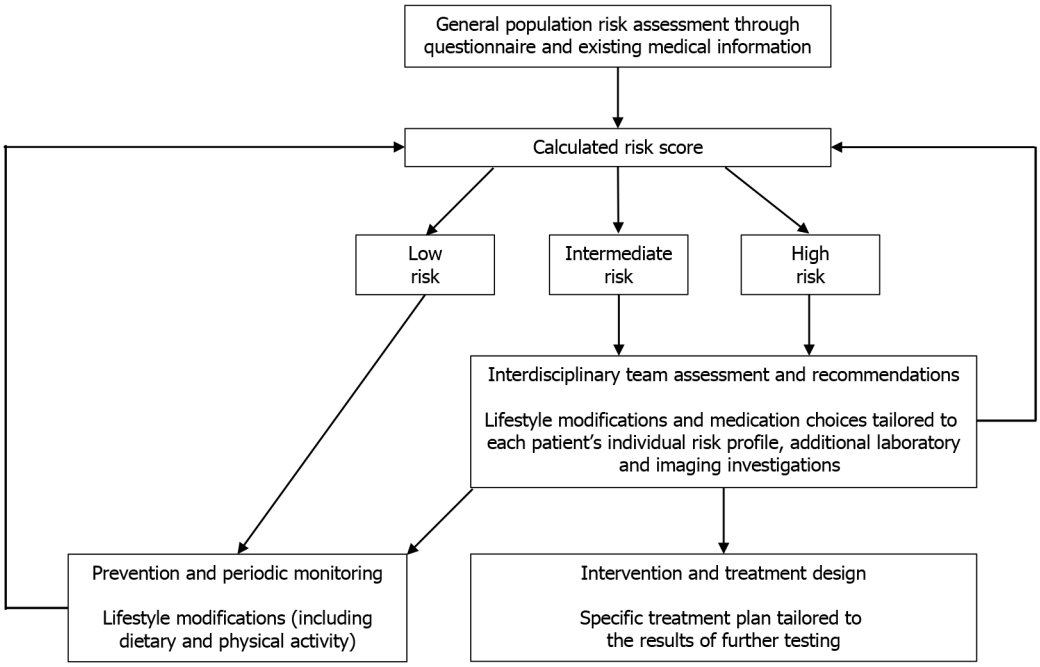

Figure 1 Schematic representation of the proposed model.

population derived/validated, risk classification, and limitations[21,22]. Of note, comparisons between them seems to be affected by operator optimism and outcome selection biases, raising the need for standardized reporting and formal, consistent statistical comparisons[23]. While model comparisons revealed significant heterogeneity in risk categorizations, which might be population/ethnicity-dependent, the choice of risk prediction model can clearly influence clinical decision-making and patient management[24,25].

We propose a new study to modify these existing risk scores to account not only for CAD but also for conditions such as abdominal aortic aneurysm, peripheral vascular disease, and cerebral artery diseases. A patient may have, for example, a high score for CAD but a low score for an abdominal aortic aneurysm, namely differential score categorizations for specific vasculature sites. According to these scores, the team specialist (or a board of specialists) would determine which vasculature imaging is required (if necessary), creating a personalized plan to comprehensively assess the specific risks of each patient and potentially lead to a tailored recommended prophylactic treatment strategy[26]. This holds significance for prevention, monitoring, early detection, and treatment strategies. Of note, while whole-body magnetic resonance angiography (MRA) may be recommended in light of the risk assessment score, its findings should be investigated as a possible valuable additional dimension to risk assessment[27].

Key aspects

Identifying subpopulations at risk and tailoring individual assessments while considering the whole vasculature.

STRATEGIES OF ASSESSMENT, DIAGNOSIS AND TREATMENT: WHEN SHOULD THEY APPLY?

Assessments are generally initiated in response to symptoms or incidental findings, sometimes at a late stage when serious health implications, such as myocardial infarction, cerebrovascular accident, aortic dissection, pulmonary embolism, or peripheral artery closure, which can lead to lower extremity gangrene or ischemic bowel, have already manifested. Current treatments for chronic coronary disease encompass a range of strategies, including dietary and lifestyle modifications, smoking cessation, moderation of alcohol consumption, medication management, and endovascular procedures such as catheterization, balloon angioplasty, arterial stenting, and surgical artery bypass procedures. The substantial costs in disability-adjusted life years, hospitalizations, disability-related expenses, and loss of life due to delayed diagnoses and treatments make a compelling case for a comprehensive evaluation of the entire vasculature and multidisciplinary assessments that prioritize prevention, early detection, and holistic treatment.

While imaging techniques such as computerized tomography angiography (CTA), MRA, and ultrasound (US) have the potential to offer a broader perspective when performed, they are infrequently utilized as tools for early detection leading to the possibility of preemptive investigation and treatment. In addition, CTA is often used for a given component of the vasculature (*e.g.*, coronary, cerebral, abdominal, or peripheral limb arteries), while whole-body CTA is limited due to its associated high radiation exposure. Studies have demonstrated the correlation between intima-media thickness, as measured by US of carotid arteries, and CAD[28]. Similarly, abdominal US can detect abdominal aortic aneurysms, particularly among individuals above 60-years-old who are smokers and have significant CAD[29,30]. More recently, advances in magnetic resonance imaging (MRI) technology have made it feasible to consider whole-body vascular

assessments using MRI or MRA, allowing for the evaluation of various vascular sites. Studies have shown that these investigations can identify narrowing and atherosclerotic plaques not only in known CAD patients but also in apparently healthy individuals[31-35].

These examinations are typically conducted only in response to specific symptoms as part of a medical process that predominantly focuses on treating the symptomatic conditions of a given suspected vasculature component. We suggest routinely performing such assessments as a monitoring tool to allow early detection among populations at risk, and expand their utilization, when required, to whole-vasculature evaluation.

Key aspects

Earlier application to combined components of the vasculature on a wider scale and in targeted populations.

FROM A GROUP OF SPECIALISTS TO A SPECIALIZED MULTIDISCIPLINARY TEAM

Diverse medical disciplines are usually involved in addressing atherosclerotic changes and stenosis in arteries and their implications, with each specialist concentrating on his/her respective fields. Cardiologists, vascular specialists, vascular and cardiac surgeons, neurovascular surgeons, imaging specialists, invasive radiologists, internal medicine specialists, hematologists, rheumatologists, or family physicians typically treat specific aspects of vascular health.

We advocate for creating specialized multidisciplinary teams or centers[36-38] dedicated to comprehensively addressing all facets of atherosclerosis, from preventive acts, through risk assessment and monitoring, to diagnosis and treatment. This multidisciplinary team of physicians, including dietitians and lifestyle coaches in addition to the abovementioned specialists, would conduct simultaneous assessments and determine a comprehensive treatment plan for the patient. The team would not only assess risk but also devise preventive strategies aimed at reducing cardiovascular events and stabilizing the atherosclerotic process. This strategy would encompass lifestyle modifications, medication choices tailored to the individual risk profile of each patient, and additional laboratory and imaging investigations.

Once the evaluation is complete, a specifically tailored treatment plan is created based on the compromised vasculature and monitoring requirements of the patient, determining the sequence and optimal timing for each treatment modality. The central focus of this approach is simultaneous treatment to prevent further damage, while carefully weighing the risks associated with treatment in consideration of the patient's overall health. Research to facilitate ongoing dynamic risk assessment following changes in the test results and lifestyle of a particular patient could provide a strong ongoing impetus for continued personal improvement.

Key aspects

A specialized multidisciplinary team that provides a holistic approach to all facets, from prevention to monitoring and assessment to diagnosis and treatment.

WHOLE VASCULAR SPECIALIST ORCHESTRATING THE WORK OF THE MULTIDISCIPLINARY TEAM

Considering the escalating burden of vascular diseases worldwide, there is a pressing need for vascular specialist physicians to adopt a holistic, comprehensive approach to patients with vascular conditions. This approach should involve the vascular specialist overseeing the management of a diverse group of patients, often dealing with multiple comorbidities and complex multi-vessel diseases. That necessitates close collaboration among various specialists in a multidisciplinary effort to provide efficient care to these multimorbid poly-vascular patients, including necessary interventional procedures[39].

We believe that the evolvement of a specialty dedicated to the entire vascular system requires "vascular medicine" to supplant the traditional "cardiology" as a more encompassing specialty.

To support this approach, physicians may obtain certification through vascular medicine fellowship programs such as the American Board of Vascular Medicine (ABVM) general examination and the Registered Physician in Vascular Interpretation examination, administered by the American Registry for Diagnostic Medical Sonographers. Some vascular medicine fellowship programs also offer the necessary instruction and experience for fellows to qualify for the American Board of Venous and Lymphatic Medicine specialty examination[8]. The ABVM, established in 1989, has been certifying both vascular and endovascular medicine since 2005[40]. As of 2020, the ABVM is part of the Alliance for Physician Certification and Advancement[41]. However, while sub-specialty certification is available, a clear definition of the scope of vascular medicine is lacking, and there are no guidelines for the simultaneous evaluation of the entire vasculature to formulate a comprehensive treatment plan[8,40]. Table 1 summarizes the differences between the existing approach and the proposed model.

Key aspects

Vascular specialist overseeing and coordinating the entire process (Table 1).

Table 1 A comparison of key elements in the existing approach and the proposed model

Aspect	Existing approach	Proposed model
Guidelines	Focus on treatment	Focus should be on prevention and early detection
Risk assessment	Relies on established risk assessment tools, mainly for coronary artery disease. Only at the individual level	Expands risk assessment to include all vascular events, using a modified risk score that considers various vascular diseases. Should be expanded to identify subpopulations at risk
Treatment approach	Standard treatments for vascular diseases. Response guided approach to diagnosed conditions	Tailored treatment to individual patients and timing based on findings, prioritizing preventive measures
Multidisciplinary assessment	Diverse medical specialists are involved, but each concentrate on his/her respective field. Collaboration should be involved, but currently it is not systematic	Promotes a multidisciplinary approach involving vascular specialists, imaging specialists, hematologists, rheumatologists, and vascular and cardiac surgeons, led by a vasculature specialist who coordinates the process
Medical specialty	Cardiology focuses primarily on the heart	Vascular medicine becomes a broader specialty

THE FUTURE OF VASCULAR MEDICINE

The integration of genetic factors, artificial intelligence (AI)-based tools, advanced imaging modalities, novel technologies, and future innovations such as those related to the microbiome (Table 2) may pave the way for the application of the proposed model as these avenues can enhance preventive interventions, identification of subpopulations at risk, and better monitoring, diagnosis, and treatment of vascular conditions.

Genetic factors

Recent advancements in whole-genome association studies have revealed a multitude of genetic polymorphisms that influence atherosclerosis and its vascular consequences. So far, hundreds of genes have been implicated in atherosclerosis pathogenesis and subsequent CVDs. These genes are involved in various pathways, including those related to insulin receptors, RAS and MAPK activation, TNF-α and NF-κB pathways, the impact of reactive oxygen species on signaling, endothelial adaptations to flow, lipoproteins, purinergic signaling, leukocyte activation control, foam cell formation, and macrophage and vascular smooth muscle cell signaling involving proliferation, efferocytosis, and apoptosis[42-46]. Additionally, associations of epigenetic changes with atherosclerosis are being realized, presenting new opportunities and horizons from both therapeutic and diagnostic perspectives[47-50].

Hopefully, with the help of big data and AI algorithms (discussed separately below), our understanding of the genetic and epigenetic factors contributing to atherosclerosis and CVDs will expand. We can anticipate that this knowledge will be integrated into prevention and treatment strategies. Furthermore, harnessing genetic information about patients will enable personalized medication regimens, optimizing effectiveness and minimizing medication side effects. For instance, insights into genetic polymorphisms in *CYP3A4*, *SLCO1B1*, *ABCG2*, and *HMGCR* have shed light on the pharmacokinetics and potential toxicity of statins[51].

Artificial intelligence (AI) tools

The clinical application of AI tools to predict cardiovascular events, though still in its infancy, is already proving beneficial. For example, integrating AI tools in information extraction of retinal vascular images has the advantage of increasing diagnosis accuracy and improving the identification of CVD risk[52]. AI methods are also useful for predicting angina pectoris in females and identifying related risk factors[53]. Applying machine learning techniques, such as the support vector machine, to clinical laboratory and imaging data, augments the diagnosis of acute coronary disease[54]. Evolutionary computational methods and machine learning techniques were utilized to identify predictors of hospital mortality due to acute ST-segment elevation myocardial infarction[55]. AI tools have been used in stroke risk prediction [56-58] and detection[57]. They were also utilized and proven important in predicting functional outcomes in stroke survivors[59], following lower extremity endovascular revascularization/interventions among patients suffering from peripheral artery disease[60,61], and after infra-inguinal bypass for peripheral artery disease[62].

These selected examples illustrate the potential of AI tools in risk assessment, prediction, detection, diagnosis, and improving treatment and outcome of vasculature diseases, as well as their key role in optimizing clinical decision-making and helping clinicians to provide personalized evidence-based care for these patients. Integration of diverse AI tools in a holistic vasculature approach based on overall data (clinical, laboratory, imaging, demographic, genetic, familial history, *etc*) may very well pave the way towards early prevention or tailored and improved intervention and patient care.

Imaging

As technology advances, and MRI devices become more accessible, we are confident that evaluating the entire vasculature without the risk of excessive ionizing radiation will become feasible. Several studies have explored the combined use of CT and MRI or positron emission tomography/MRI hybrid scanners to improve vascular imaging results[63-66]. This opens up the possibility for simultaneously expanding imaging to additional populations (not just those presenting symptoms but those at risk) and additional vasculature components (not just the suspected component but also multiple components or the whole body).

Table 2 A comparison of future aspects in the existing approach and the proposed model

Aspect	Existing approach	Proposed model
Genetic factors	Limited incorporation of genetic data	Explores genetic factors influencing atherosclerosis and medication response
Artificial intelligence tools	Sporadic use in a given step of the process	Systematic use in risk assessment, prediction, detection, diagnosis, possible outcomes and treatment of vasculature diseases, and in optimizing clinical decision-making
Imaging modalities	Commonly uses computerized tomography angiography and ultrasound	Considers the use of whole-body MRI/ magnetic resonance angiography for comprehensive vascular evaluation including routine liver fat content (in all abdominal MRI results)
Advances technologies	Not extensively discussed	Emphasizes nanotechnology for vascular lesion investigation and treatment
The microbiome	Acknowledgment of microorganism diversity role in atherosclerotic process	Using knowledge about microbiome for risk assessment, prevention, and treatment of cardiovascular disease
Economic aspects	Limited discussion of economic factors and their implications	Discusses economic aspects, including cost-effectiveness, resource allocation, preventive measures, technological advances, research funding, patient-centered care, and healthcare disparities

MRI: Magnetic resonance imaging.

Advanced technologies

Nanotechnology holds great promise for the investigation and treatment of vascular lesions as well as for the stabilization or removal of atherosclerotic plaques. This emerging technology operates on the scale of individual cells, utilizing nanoparticles. Developments in this field are already underway, with studies discussing applications such as using nanoparticles for vascular visualization, targeted drug delivery to damaged vascular sites, and repairing compromised blood vessels. Such innovations could potentially revolutionize vascular disease treatment[67-70].

The microbiome

The leaky gut hypothesis centers on intestinal epithelial barrier dysfunction causing increased permeability of the gut and subsequent alterations to gut composition by endotoxins and microbial metabolites[71]. Recent studies have demonstrated that variations in the diversity and activity of intestinal microbes, comprising viruses, bacteria, fungi, and protozoa, play a significant role in atherosclerosis and CVD formation and etiology[72-74]. This is a new avenue for preventive interventions, risk assessment, and treatments. Table 2 summarizes the differences between the existing approach and the proposed model regarding future vascular medicine and economic aspects.

ECONOMIC ASPECTS, COST-EFFECTIVENESS, ALLOCATION OF RESOURCES, AND EQUITABILITY OF THE PROPOSED SCHEME

Economic considerations and the availability of health care services play a pivotal role in the evolving landscape of vascular evaluation and disease treatment in the 21st century. These considerations encompass various dimensions.

Cost of traditional vs innovative treatments

Traditional approaches to vascular disease treatment often involve invasive surgeries, extended hospital stays, and prolonged recovery periods. These procedures can be financially burdensome due to direct medical expenses, lost productivity, and rehabilitation costs. The paradigm shift toward less invasive, more innovative treatments, such as endovascular interventions and minimally invasive procedures, has the potential to significantly reduce healthcare costs [75-79].

Cost-effectiveness of multidisciplinary care

The transition to multidisciplinary vascular teams, while requiring initial resource investment, can lead to improved patient outcomes, decreased hospital readmissions, and enhanced long-term management of vascular diseases. From an economic standpoint, this can translate into long-term cost savings[80,81].

Preventive measures and lifestyle interventions

In the 21st century, preventive healthcare is gaining prominence. Encouraging patients to adopt healthier lifestyles, manage risk factors (*e.g.*, hypertension, hyperlipidemia, diabetes), and engage in regular exercise can help prevent the development and progression of vascular diseases. These preventive measures, while not devoid of costs, are often more cost-effective than treating advanced vascular conditions[82-84].

Technological advances and cost savings

Advanced imaging technologies, automated readings, and telemedicine can reduce diagnostic and monitoring costs associated with vascular disease. Telemedicine, for instance, can lower patient transportation expenses, reduce the need for in-person visits, and enable remote monitoring, resulting in early intervention when necessary[85-89]. While investments are required in the short term to acquire advanced technologies, benefits such as reduced expenditure on treatment, rehabilitation, *etc* are expected in the long term. In addition, as the use of such technologies expands, their cost may decrease.

Resource allocation and research funding

Economic considerations extend to resource allocation and research funding. As the paradigm shifts toward more comprehensive evaluation and treatment approaches, allocating resources to support research and development in vascular medicine becomes imperative. This includes funding for clinical trials, the development of new medical devices, and training healthcare professionals in cutting-edge techniques[90-93].

Patient-centered care and shared decision-making

The economic dimension of patient-centered care involves patients in shared decision-making. Informed patients who actively participate in decision-making are more likely to adhere to treatment plans and achieve better outcomes. This, in turn, can lead to cost savings by reducing the likelihood of treatment non-compliance and complications[94-96].

Healthcare access and disparities

Economic factors are closely intertwined with healthcare access and disparities; thus, addressing issues related to equitable access to vascular care is vital. Patients with lower socioeconomic status may encounter barriers to accessing innovative treatments and preventive measures. Tackling these disparities not only enhances public health but can also yield economic benefits by reducing the overall burden of vascular diseases on the healthcare system[97-101].

POTENTIAL LIMITATIONS

The suggested model, while promising, comes with certain limitations that must be considered. Addressing the identified issues necessitates the allocation of additional personnel and resources. Medical teams must undergo training to adapt to the new approach, and clear timetables for implementation must be established. The creation of infrastructure and the allocation of financial resources are imperative for the successful implementation of the proposed model.

Consequently, the implementation process should follow a structured approach. This involves gradually introducing the model to populations at risk and formulating plans for effective investigation to identify individuals requiring in-depth examination and treatment based on a revised risk factor score. Essential infrastructure, comprising specialized teams, training programs, and resources for the required imaging modalities and technologies, must be developed.

A plausible starting point is to raise awareness within the medical establishment about the existing challenges in treating CVD using current treatment methods compared to the proposed model. Al-Makhamreh *et al*[102] claimed that "By improving the caregivers' knowledge, identifying their role in patient care, and raising awareness in susceptible populations, healthcare professionals can improve the patients' quality of life." These components can facilitate the implementation of the proposed model as well.

To initiate the process, a pilot project should be set up to study the implications of the proposed model. This approach allows for a comprehensive examination of the feasibility and effectiveness of the model before widespread implementation.

CONCLUSION

The evaluation of vasculature and treatment of vascular diseases in the 21st century presents a complex and multifaceted landscape. The paradigm shift towards comprehensive care and innovative assessments and treatments not only opens up new opportunities for medical advancements but also has the potential for cost-effective healthcare delivery, optimal resource utilization, and improved patient outcomes.

It is crucial to strike a delicate balance between economic considerations and the quality of care. However, we have responsibility to proactively identify at-risk subpopulations and initiate preventive interventions and monitoring programs to enable early detection and tailored treatments. We need to be farsighted not only regarding the individual medical process but also regarding the economic impact of healthcare. This balance ensures that progress in vascular medicine translates into tangible benefits for both patients and healthcare systems. By embracing the evolving landscape of vascular healthcare, we can enhance preventive measures, early detection, and treatment strategies, ultimately contributing to a healthier and more resilient society. The ongoing pursuit of innovative models, such as the one proposed here, underscores the commitment to advancing healthcare practices for the betterment of individuals and the broader community.

FOOTNOTES

Author contributions: Chaiter Y and Machluf Y conceived the idea for the manuscript; Chaiter Y, Machluf Y, and Fink DL reviewed the literature and drafted and revised the manuscript.

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