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Treatment methods and cost coverage evaluation for patients with cardiovascular disease worldwide

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Abstract

Cardiovascular diseases (CVDs) are among the leading causes of mortality and disability worldwide and account for a substantial proportion of the global disease burden and healthcare expenditures. Scientific advances in pharmacological therapy, cardiovascular interventions, and cardiac surgery significantly improved patient survival and quality of life. However, the direct and indirect costs associated with these diseases, particularly in countries with limited resources, have become a major challenge for health policymakers. This study provides a comprehensive review of existing treatment approaches for cardiovascular diseases and presents a comparative analysis of health insurance coverage systems across different countries. Treatment methods include pharmacological interventions (antiplatelet agents, statins, and beta-blockers), interventional procedures (angioplasty, coronary artery bypass grafting, and heart valve replacement), as well as lifestyle modification strategies. Analysis of insurance systems shows that countries with universal healthcare systems such as the United Kingdom, Canada, and Germany provide more comprehensive coverage (approximately 90–100%), whereas countries with predominantly private insurance systems, such as the United States, exhibit more variable coverage (60–90%) and higher out-of-pocket costs for patients. Our findings suggest that countries using universal health coverage frameworks, health technology assessment (HTA), and cost-effectiveness analysis in healthcare decision-making show better performance in controlling costs and improving patient access to cardiovascular services. Furthermore, emphasizing primary and secondary prevention strategies and promoting lifestyle modification are crucial in reducing both the economic and clinical burden of CVDs. Inequality in access to treatment, the high cost of emerging medical technologies, and insufficient coverage for new medications remain major challenges for healthcare systems worldwide.

Keywords: Cardiovascular diseases, pharmacological treatment, health economics, cost coverage, healthcare systems, health technology assessment, healthcare policy

Introduction

Cardiovascular diseases (CVDs) are a group of disorders of the heart and blood vessels including coronary artery disease, stroke, heart failure, valvular heart diseases, and arrhythmias. According to the World Health Organization (WHO) in 2022 these diseases are responsible for approximately 31% of all global deaths. The main risk factors include high blood pressure, diabetes, obesity, smoking, unhealthy diet, and physical inactivity As a result, health systems are faced with two simultaneous challenges: growing demand for specialized cardiovascular services and limited financial resources (1). The CVDs are the leading cause of mortality globally, responsible for a significant number of deaths and disabilities. In 2021 alone, CVDs accounted for 20.5 million deaths, comprising approximately one-third of all global deaths (13). In Europe, this figure reached approximately 210 billion euros in 2023. These expenses include direct medical costs, loss of productivity, and long-term care (2). Often accompanied by increased stress and environmental factors, can also be important in exacerbating the CVD burden in these regions (14).

This study aimed to identify effective strategies for reducing the adverse impacts of these diseases and lowering healthcare costs across different countries, with a particular focus on patients with CVDs in Iran (15). In this study, the underlying causes of CVDs, the associated medical and pharmaceutical costs, and the key challenges faced in managing these conditions are examined (4). When the major non-communicable diseases are compared, the prevalence of CVDs is observed to be higher than that of diabetes, cancers, and respiratory diseases. CVDs account for 43% of cases, followed by diabetes at 25%, respiratory diseases at 17%, and cancers at 15%. This high proportion of patients with cardiovascular disease highlights the importance of this disease group for countries and for the WHO (5).

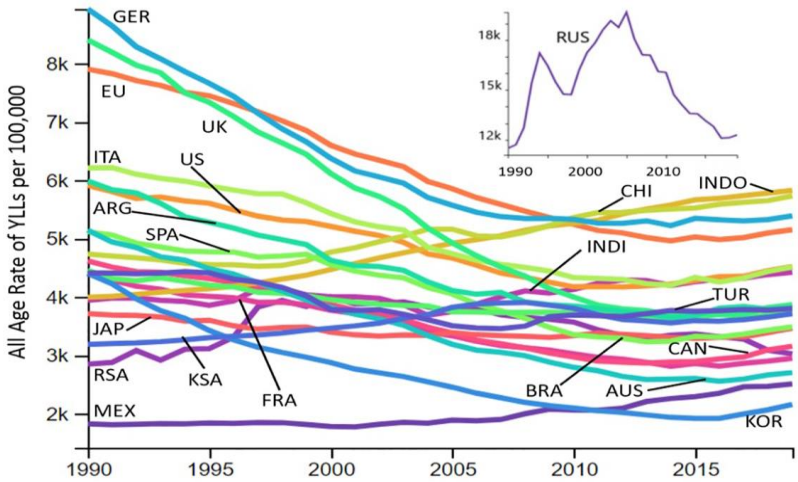

Figure 1. Trend of the rate of Years of Life Lost (YLLs) due to cardiovascular diseases per 100,000 population in different countries of the world from 1990 to 2018 (3).

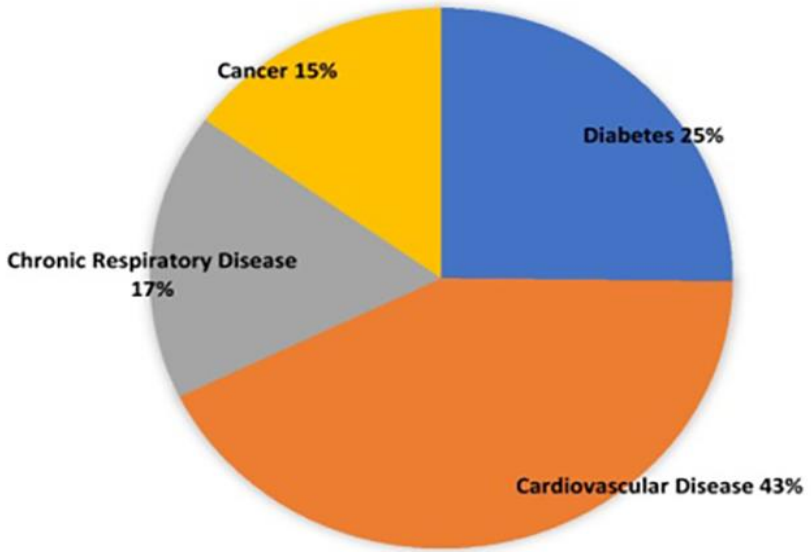

Figure 2. Comparative percentage of cardiovascular disease patients compare to other non-communicable diseases (5).

Method

In this study, with CVDs were examined using specific data sources The methods of healthcare cost coverage for these patients in various countries, particularly advanced and developed nations also were analyzed. This study is a cross-sectional study conducted aiming to collect and analyze existing information on the prevalence, treatment methods, and financial coverage provided for patients with CVDs. By comparing these variables across countries, we aimed to derive a logical and evidence-based conclusion regarding the situation of these patients (6).

Results

Pharmacological Treatments

For a rigorous and systematic presentation, it is essential to first delineate the pharmacological treatment modalities, followed by a comprehensive evaluation of their underlying mechanisms of action. This should be accompanied by a detailed assessment of their therapeutic indications and associated adverse effects. Additionally, an in-depth discussion of key clinical considerations, along with potential drug–drug interactions, is necessary to ensure a complete and evidence-based analysis (16).

Aspirin

Administered at 75–325 mg daily, it is considered the gold standard for secondary prevention of cardiovascular events. Its mechanism of action involves irreversible inhibition of the cyclooxygenase-1 (COX-1) enzyme. Aspirin is commonly used for the prevention of myocardial infarction, management of acute coronary syndrome, during angioplasty procedures, and after coronary artery bypass graft (CABG) surgery. The adverse effects of aspirin include gastric irritation, vomiting, gingival bleeding, allergic reactions, and in severe cases, anaphylaxis. Also, aspirin has important drug interactions with anticoagulants, non-steroidal anti-inflammatory drugs (NSAIDs), corticosteroids, antidepressant medications, and alcohol (7).

Due to the large number of cardiovascular medications, they were reviewed briefly and summarized in a single table1:

Table 1. Comparative overview of major cardiovascular medications: Mechanisms, clinical indications, adverse effects, and drug–drug interactions (17).

Drug Class	Mechanism of Action	Primary Clinical Indications	Common Adverse Effects	Major Drug–Drug Interactions
Aspirin	Irreversible COX-1 inhibition; antiplatelet effect	Prevention of MI, ACS management, PCI, post-CABG	GI irritation, bleeding, hypersensitivity	Anticoagulants, NSAIDs, SSRIs
Statins	HMG-CoA reductase inhibition decreaseLDL	Dyslipidemia, CAD, secondary prevention	Myalgia, elevated liver enzymes	Macrolides, azole antifungals
Beta-Blockers	β-adrenergic receptor blockade decrease HR and BP	Hypertension, HF, arrhythmias, post-MI	Bradycardia, fatigue	Verapamil, insulin
Losartan	AT1 receptor blockade	Hyperkalemia, dizziness	Hyperkalemia, dizziness	Potassium supplements, NSAIDs
Dapagliflozin	Inhibition of renal glucose reabsorption	HF, type 2 diabetes	Volume depletion, UTI	Diuretics, insulin
Calcium Channel Blockers	L-type calcium channel blockade	HTN, angina, arrhythmias	Edema, constipation	Beta-blockers, digoxin
Spironolactone	Mineralocorticoid receptor blockade	HF, resistant HTN	Hyperkalemia, gynecomastia	ACEi, ARBs, K supplements
Thiazide	NCC inhibition in distal tubule	Hypertension	Hypokalemia, hyperglycemia	Lithium, digoxin
Amiodarone	Potassium/sodium/calcium channel blockade	Atrial/ventricular arrhythmias	Thyroid dysfunction, pulmonary toxicity	Warfarin, digoxin
Furosemide	Inhibition of NKCC2 in loop of Henle	edema	Hypokalemia, dehydration	Digoxin, NSAIDs

Coverage of treatment costs in global healthcare systems

Countries with universal healthcare systems

Universal healthcare systems are designed to ensure that all residents receive essential medical services regardless of income, employment status, or socioeconomic position. These systems are typically financed through taxation, mandatory insurance contributions, or a hybrid of both. The extent of coverage varies by country, but most universal systems include preventive care, outpatient care, inpatient hospitalization, emergency treatment, prescription drugs, and chronic disease management.

The National Health Service (NHS) is one of the most comprehensive universal healthcare systems in the world. Hospital services, surgeries, and cardiovascular interventions are almost entirely funded by the government nearly complete coverage of cardiovascular services، Very limited out-of-pocket payments.
In Canada, the system type is a publicly funded, provincially administered single-payer system. Cost coverage includes essential medical services, hospital care, diagnostics, and surgeries fully covered, while prescription medications are covered partially and vary by province. Patient out-of-pocket costs are moderate, mainly for outpatient drugs, dental, and vision.

In Germany, the system type is mandatory universal insurance funded by employer and employee contributions. Cost coverage is comprehensive, including hospital care, outpatient services, mental health, rehabilitation, and prescription drugs. Patient out-of-pocket costs are low, with small

copayments for medications and hospital stays.

In Sweden, the system type is a tax-funded universal system that is decentralized. Cost coverage includes preventive care, chronic disease management, emergency care, and hospital treatment. Patient out-of-pocket costs are low due to annual caps on costs for medical visits and drugs.

In the United Kingdom, the NHS is a tax-funded universal system. Hospital care, emergency services, surgeries, and specialist consultations are fully covered, and patient out-of-pocket costs are minimal, primarily for dental and vision services (7).

Countries without universal healthcare systems

Countries without universal healthcare systems are examined and analyzed in Table 2 (8).

Table 2 .Characteristics of countries without universal healthcare systems (8).

Country	Healthcare System Type	Coverage of Treatment Costs	Out-of-Pocket Costs	Key Issues
United States	Private insurance–based, multi-payer	Coverage depends on insurance; public programs limited to specific groups	High: deductibles, copayments, coinsurance	Access disparities, high spending, uninsured population
India	Mixed system, partial insurance (PhilHealth)	Partial coverage; many services require co-payment	Moderate to high	Implementation gaps, limited coverage
Indonesia	Transitioning system (JKN)	Broad but incomplete coverage; many services partially paid	Moderate	Sustainability issues, regional disparities
Pakistan	Fragmented mixed system	Limited provincial insurance; private sector dominant	High	Financial hardship, insufficient public resources
Egypt	Mixed system, moving toward universalization	Basic public coverage; private care often required	Moderate to high	Quality variation, incomplete reforms
Nigeria	Mixed system without universal coverage	National Health Insurance Scheme covers small fraction	Very high: majority pay out-of-pocket	Underfunded public sector, poor access

Table 3. Comparative table of cardiovascular treatment coverage across countries (7, 8).

Country	Type of Health System	Coverage of Cardiovascular Services	Drug Coverage / Co-payment	Access & Waiting Times	Key Challenges
United Kingdom (NHS)	Tax-funded universal health system (NHS)	Hospital care, surgeries, and cardiac interventions are almost fully funded by the government	Fixed prescription charge ≈ €9.90 per item	Long waiting lists for some elective cardiac surgeries	Waiting times, resource constraints

Germany	Statutory Health Insurance (SHI), mandatory	About 90–100% coverage of cardiovascular services	Approx. 10% patient co-payment for medications	Generally faster access compared with many European countries	Cost containment, sustainability of SHI
France	Social health insurance with strong public regulation	Basic coverage ≈ 70%; up to 100% for chronic diseases (ALD)	Drug reimbursement between 15% and 100%	Good access; relatively high level of financial protection	High public expenditure, system complexity
Brazil	Tax-funded universal system	Free access to many hospital and cardiac services in the public system	Essential medications may be covered; availability can be uneven	Long waiting times and resource limitations in public sector	Underfunding, regional disparities
Iran	Multiple health insurance schemes, strong public sector role	Approximately 70–90% coverage of hospitalization for cardiac conditions	Around 90% coverage for medications; significantly lower costs in public hospitals	Better financial protection in public hospitals; higher costs in private sector	Fragmentation of insurers, budget constraints

Global models of cardiovascular treatment cost coverage

Tax-based systems (National Health Service Model)

The NHS model, also known in health economics as the "Beveridge Model," is a healthcare system in which care is financed and provided by the government through tax revenues. In this system, healthcare is treated as a public good, similar to public education or fire services. In countries such as the United Kingdom and several Scandinavian countries, healthcare services are primarily financed through general taxation include Minimal or no out-of-pocket payment at the point of service، Extensive use of Health Technology Assessment (HTA) to control healthcare costs (2).

Social Health Insurance Systems

The Social Health Insurance (SHI) system, widely known in health economics as the "Bismarck Model," is a healthcare framework where care is financed through mandatory, payroll-based contributions from both employers and employees. In countries such as Germany, France, and Japan, the healthcare system is based on social health insurance, funded through contributions from both employers and employees include Mandatory basic health insurance، Availability of supplementary insurance plans .While the provision and insurance are largely private, the government heavily regulates the system. It dictates standard prices for medical services and medications, ensuring that sickness funds make no profit and that all essential treatments are covered (9).

Market-Based Systems (Private Insurance-Dominated Systems)

The Market-Based Healthcare System, often associated with a private insurance-dominated model, treats healthcare primarily as a commodity or consumer good rather than a guaranteed public right. In this system, healthcare services are financed and delivered predominantly by private entities, and prices are largely driven by market forces such as supply and demand. In countries such as the United States, a large portion of healthcare financing is provided through private insurance plans. These plans include a wide variety of options، but they also lead to a

higher likelihood of out-of-pocket payments and inequality in access to healthcare services. Prices for medical services, procedures, and pharmaceuticals are largely negotiated between private insurers and private healthcare providers, rather than being strictly set or capped by the government. On the other hand, individuals with good coverage generally have a wide range of choices in selecting doctors, specialists, and healthcare facilities (10).

Findings

Based on the comparative analysis of the primary healthcare financing models—tax-based, social health insurance, and market-based—the overall findings and key takeaways can be synthesized as follows.

Every healthcare financing system involves inherent trade-offs between three primary objectives: equity (access), quality (innovation and speed), and cost containment. No single model optimizes all three simultaneously.

The social health insurance model balances universal coverage with rapid access and high patient choice. However, it maintains high-quality care while facing challenges such as rising administrative complexities, difficulty in cost containment due to fee-for-service payment structures, and reliance on employment status.

Standard pharmacological treatments—particularly for hypertension, dyslipidemia, and heart failure—have been reported as cost-effective in most studies. Health systems with universal coverage and structured HTA mechanisms have demonstrated better performance in controlling cost growth and promoting equity in access compared to market-based healthcare models (11).

Discussion

Earlier literature primarily focused on highly invasive procedures, such as traditional Coronary Artery Bypass Grafting (CABG) and open-heart surgeries, as the gold standard for severe CVDs. Previous healthcare models largely treated cardiovascular events reactively (post-myocardial infarction), with less emphasis on predictive algorithms. Modern research frequently includes the clinical outcomes and cost-savings associated with remote patient monitoring, wearable ECG devices, and AI-driven predictive diagnostics, which were largely absent in previous studies. In many countries—particularly low-income nations and those with weak insurance systems—access to advanced cardiovascular services remains limited. This inequality exists both between countries and within countries, such as disparities between urban and rural areas and between wealthier and poorer populations. Therefore, cost-coverage policies should be designed with an equity-oriented approach to ensure that patients in need are not deprived of essential treatments (12).

Although substantial progress has been made in pharmacological treatments, minimally invasive interventions, and medical technologies, equitable access to these services continues to be a major concern. Countries with universal healthcare systems typically provide better financial protection for patients, whereas systems that rely on private insurance often result in higher out-of-pocket expenses. In developing countries, limited resources and inadequate healthcare infrastructure create additional challenges. To improve global outcomes, it is essential to focus on prevention, expand insurance coverage, adopt innovative technologies, and enhance the efficiency of healthcare systems.

Among the strengths of CVDs management are advances in medical treatment methods such as stent placement and cardiac pacemaker devices. Another strength is the use of effective medications that reduce the impact of CVDs, including statins, ACE inhibitors, and aspirin. The implementation of structured prevention programs is also considered an important advantage. On the other hand, the weaknesses include high treatment costs, limited access to advanced therapeutic methods, drug side effects, shortages of specialized medical personnel, and patients' poor adherence to treatment plans. Irregular medication use and reduced motivation for treatment are additional challenges that complicate the management of these diseases.

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Conflict of Interest

This research has no conflict of interest with the health system or individuals.

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The Ethical code adhered to in this article is as follow:

TUMS.SPH.REC.1404.16

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