

A review on recent advances in cardiovascular pharmacotherapy: Emerging therapies, novel anticoagulants, and cardiometabolic innovations

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Abstract

Cardiovascular diseases continue to be the top cause of death and illness across the globe. Therefore, the development of new treatment options must continue. The last few years have seen positive development in the treatment of the heart and blood vessels with the use of glucagon-like peptide-1 receptor agonists (GLP-1 RAs), new oral anticoagulants (NOACs), and sodium-glucoside cotransporter-2 inhibitors (SGLT2), as well as new molecules. The purpose of this article is to look at the most recent occurrences in cardiovascular medicine and their possible effects in practice. Large-scale randomized controlled trials and modern medicine show, for example, that besides controlling blood sugar, GLP-1 RAs have a protective effect on the heart and blood vessels. Also, NOACs provide an effective, safer anticoagulation compared to traditional vitamin K antagonists. Newer treatments such as mavacamten, tirzepatide, evolocumab, and vutrisiran fulfill unaddressed clinical needs and represent advances in tailored therapies for patients with heart problems. There have also been various treatment combinations and polypills that have been shown to have a positive effect on patient compliance to treatment and positive outcomes. Broadly speaking, these advances have shown positive outcomes for patients and improved care in cardiovascular medicine. There also needs to be additional study on the integration of these therapies into cardiovascular care.

Keywords: Cardiovascular Diseases; GLP-1 Receptor Agonists; Novel Oral Anticoagulants; SGLT2 Inhibitors; Cardiovascular Pharmacotherapy; Heart Failure; Precision Medicine.

1. Introduction

Glucagon-like peptide-1 receptor agonists (GLP-1 RAs) were originally introduced as antidiabetic agents for the management of type 2 diabetes mellitus (T2DM). These drugs mimic the actions of the endogenous incretin hormone GLP-1, stimulating glucose-dependent insulin release, reducing glucagon secretion, and delaying gastric emptying. Through these mechanisms, GLP-1 RAs improve glycemic regulation while also contributing to significant weight reduction (Zheng et al., 2024).

Large-scale clinical trials have demonstrated that GLP-1 RAs provide substantial cardiovascular protection, including a reduction in major adverse cardiovascular events (MACE) among individuals with T2DM and established

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atherosclerotic cardiovascular disease (ASCVD). More recent evidence suggests that the cardiovascular benefits of this drug class may extend beyond glucose control and may be observed even in patients without T2DM. Emerging data indicate potential therapeutic roles in the management of coronary artery disease (CAD), heart failure (HF), atrial fibrillation (AF), and hypertension. In addition, studies have reported favorable outcomes in patients with peripheral artery disease (PAD), particularly when accompanied by T2DM. This review summarizes the expanding cardiovascular applications of GLP-1 RAs and discusses practical considerations for their integration into modern cardiovascular treatment strategies (Gupta et al., 2025).

A substantial body of evidence from randomized controlled trials (RCTs) has established Novel Oral Anticoagulants (NOACs), also known as direct oral anticoagulants (DOACs), as the preferred therapeutic option over vitamin K antagonists (VKAs) for most patients with atrial fibrillation (AF) and venous thromboembolism (VTE). Compared with traditional VKAs, NOACs demonstrate superior or comparable efficacy alongside an improved safety profile (Roberti et al., 2021).

The anticoagulant activity of NOACs results from their targeted inhibition of key serine proteases involved in the coagulation cascade. Among the currently available agents, apixaban, edoxaban, and rivaroxaban selectively inhibit factor Xa, whereas dabigatran acts through direct inhibition of thrombin (factor IIa). These agents possess several pharmacokinetic advantages, including rapid therapeutic onset, relatively short elimination half-lives, and fewer interactions with dietary factors and concomitant medications. Furthermore, NOACs are administered using standardized dosing schedules and generally do not require routine laboratory monitoring, owing to their predictable anticoagulant effects (Jannati et al., 2024).

Most bleeding events associated with NOAC therapy are mild to moderate in severity and can be effectively managed through temporary treatment discontinuation, local hemostatic measures, minor surgical intervention, or blood product administration when necessary. Nevertheless, serious hemorrhagic complications, including intracranial bleeding, may occasionally occur and have prompted the development of specific reversal agents. Idarucizumab has been shown to rapidly neutralize the anticoagulant effect of dabigatran, while andexanet alfa effectively reverses the activity of factor Xa inhibitors. These antidotes provide prompt hemostatic control in patients experiencing life-threatening bleeding or requiring urgent invasive procedures. Currently, idarucizumab is approved for emergency reversal of dabigatran anticoagulation, whereas andexanet alfa is primarily indicated for severe bleeding associated with factor Xa inhibitor therapy (Bracey et al., 2018). This paper assesses the changing uses of NOACs for various cardiovascular conditions and in different patient groups. With new clinical data and guidelines being released regularly, we present both the traditional and newly broadened scopes of NOACs, focusing on the more recent NOACs in the field of cardiology.

There is a global burden of morbidity and mortality related to cardiovascular diseases (CVDs) that constitutes an increasing amount. There has been progress with therapies; however, the treatment of many cardiovascular diseases has remained suboptimal, with concerns for side effects and limited treatment benefits. There is an ongoing need for new treatment options and strategies to provide better outcomes for patients with improved safety. The field of cardiovascular medicine underwent rapid development in 2022. Many novel therapies, within the first of their kind, were approved, and a number of clinical trials investigated the safety and efficacy of other medications that were previously used for other indications in combination with other therapies. This addressed barriers in the existing literature and created new opportunities in the treatment and prevention of CVDs (Roth et al., 2020).

We provide a summary of the products of this recent innovation in the field of cardiovascular medicine. We also include the important clinical trials in 2022 that changed and guided current practices in cardiology.

To identify the most impactful developments in cardiovascular pharmacology, we examined medications and drug combinations that obtained approval from major regulatory agencies, including the European Medicines Agency (EMA) and the United States Food and Drug Administration (FDA), during 2022. Furthermore, a comprehensive search of the PubMed and EMBASE databases was performed to identify relevant clinical trials published within the same period. Selection of the therapies and studies included in this review was based primarily on their pharmacological significance and was determined through expert consensus among the authors (Chung & Pacifici, 2026)

Table 1 First-in-Class Therapeutic Advances

Mavacamten	Mavacamten represents a novel cardiac myosin ATPase inhibitor that provides targeted therapy for patients with obstructive hypertrophic cardiomyopathy (oHCM).
Tirzepatide	Tirzepatide is the first dual glucose-dependent insulinotropic polypeptide (GIP) and GLP-1 receptor agonist approved for the management of type 2 diabetes mellitus.
SGLT2 Inhibitors	SGLT2 inhibitors were the first glucose-lowering agents shown to improve outcomes in heart failure across the entire spectrum of left ventricular ejection fraction.

Table 2 Addressing Unmet Clinical Needs

Dapagliflozin	Dapagliflozin significantly lowers the risk of heart failure progression and cardiovascular mortality in both HFrEF and HFpEF populations.
Vitamin K Antagonists	Vitamin K antagonists remain the recommended anticoagulant therapy for patients with rheumatic heart disease-associated atrial fibrillation.
Infective Endocarditis Prevention	Recent evidence supports antibiotic prophylaxis before invasive dental procedures in individuals at elevated risk of infective endocarditis.
Evolocumab	Long-term administration of evolocumab has demonstrated sustained safety and substantial reductions in cardiovascular event rates.
Vutrisiran	Vutrisiran is an siRNA-based therapy that suppresses transthyretin production and is effective in hereditary transthyretin-mediated amyloidosis.

Table 3 Fixed-Dose Combination Strategies

The combination of ACETAZOLAMIDE and LOOP DIURETICS enhances decongestion in patients with acute decompensated heart failure who exhibit inadequate responses to conventional diuretic therapy.
Combined treatment with EZETIMIBE and moderate-intensity statins provides effective LDL-cholesterol reduction in patients with atherosclerotic cardiovascular disease.
The use of angiotensin receptor blockers together with β -blockers offers additional therapeutic benefit in individuals with Marfan syndrome.
Polypill-based approaches have emerged as a practical strategy for improving adherence and reducing recurrent cardiovascular events in secondary prevention

2. Methodology

The aim of this narrative review was to identify developments in cardiovascular pharmacotherapy and assess their implications for present-day practice. We reviewed publications from 2022-2025 in PubMed, EMBASE and Google Scholar. We included peer-reviewed articles, RCTs, SRs, MAs, and clinical guidelines and regulatory documents.

The strategy involved searching keywords such as “cardiovascular pharmacotherapy”, “SGLT2 inhibitors”, “GLP-1 receptor agonists”, “mavacamten”, “atrial fibrillation”, “tirzepatide”, “evolocumab”, “vutrisiran”, “novel oral anticoagulants”, “heart failure”, “combination therapy”, and “cardiovascular pharmacotherapy” among others. Additional information was obtained from publications and approvals of significant regulatory agencies, including the European Medicines Agency (EMA) and the United States Food and Drug Administration (FDA).

Included studies were assessed for their clinical and pharmacological relevance, design, and cardiovascular outcome impacts. We prioritized landmark studies and first-in-class drugs. We aimed to include studies describing drugs that target novel pathways or those that expand existing drugs for cardiovascular use. We aimed to collect and analyze qualitative data for novel cardiovascular pharmacotherapies and their future potential for improving clinical outcomes and patient care.

3. Discussion

Cardiovascular diseases (CVDs) remain the leading cause of death worldwide and continue to be a substantial burden on healthcare systems despite major advancements in prevention, diagnosis, and the treatment. Traditional cardiovascular therapies have significantly improved patient outcomes; that said, residual cardiovascular risk persists in many patients, underscoring the importance of developing innovative treatment approaches. This review examined recent developments in cardiovascular pharmacotherapy, focusing on the expanding cardiovascular applications of glucagon-like peptide-1 receptor agonists (GLP-1 RAs), the growing role of novel oral anticoagulants (NOACs), and several newly introduced pharmacological agents and treatment strategies that have transformed contemporary cardiovascular care (Dores et al., 2025).

One of the most important developments in recent years has been the recognition of GLP-1 receptor agonists as cardio-metabolic agents rather than solely glucose-lowering drugs. Initially developed for the management of type 2 diabetes mellitus, GLP-1 RAs have demonstrated significant cardiovascular benefits in multiple large-scale clinical trials. Beyond improving glycaemic control through stimulation of glucose-dependent insulin secretion and suppression of glucagon release, these agents have shown the ability to reduce body weight, lower blood pressure, improve lipid profiles, and decrease systemic inflammation. These effects collectively contribute to a reduction in major adverse cardiovascular events, including myocardial infarction, stroke, and cardiovascular death (Moiz et al., 2025).

The cardiovascular benefits of GLP-1 RAs appear to extend beyond their metabolic actions. Several mechanisms have been proposed, including improvement of endothelial function, reduction of oxidative stress, attenuation of inflammatory pathways, stabilization of atherosclerotic plaques, and enhancement of myocardial energy utilization. Such mechanisms may explain why cardiovascular protection has been observed even in certain patient populations without diabetes. The growing evidence supporting the use of GLP-1 RAs in coronary artery disease, heart failure, hypertension, and peripheral artery disease suggests that these agents may occupy an increasingly important position in future cardiovascular treatment guidelines. Their ability to simultaneously address multiple cardiovascular risk factors further strengthens their therapeutic value (Ma et al., 2021).

Another major advancement discussed in this review is the widespread adoption of novel oral anticoagulants. For decades, vitamin K antagonists such as warfarin represented the cornerstone of anticoagulation therapy. Although effective, these agents are associated with numerous limitations, including a narrow therapeutic index, frequent monitoring requirements, variable dose responses, and significant interactions with foods and medications. The introduction of NOACs has largely overcome many of these challenges (Kholmukhamedov et al., 2025).

Direct factor Xa inhibitors, including apixaban, rivaroxaban, and edoxaban, together with the direct thrombin inhibitor dabigatran, have demonstrated efficacy equal or superior to warfarin in preventing thromboembolic events in patients with atrial fibrillation and venous thromboembolism. Importantly, these agents are associated with lower rates of intracranial hemorrhage and provide more predictable anticoagulant effects. Their rapid onset of action and fixed dosing regimens have simplified anticoagulation management and improved patient adherence (Graff & Harder, 2013).

The development of specific reversal agents represents another milestone in anticoagulant therapy. Historically, the management of life-threatening bleeding associated with anticoagulation posed a major clinical challenge. The availability of idarucizumab for dabigatran reversal and andexanet alfa for factor Xa inhibitor reversal has significantly improved the safety profile of NOACs. These advancements have increased the physician's confidence in prescribing these medications and have expanded their use of clinical settings (Thibault et al., 2016).

This review also emphasizes the emergence of several first-in-class cardiovascular therapies that target previously unaddressed pathophysiological mechanisms. Mavacamten represents a turning point in the treatment of obstructive hypertrophic cardiomyopathy by directly inhibiting cardiac myosin ATPase activity and reducing excessive myocardial contractility. Unlike conventional therapies that primarily alleviate symptoms, mavacamten targets the underlying disease mechanism and offers a more personalized therapeutic approach. Such mechanism-based therapies are likely to play an increasingly important role in future cardiovascular medicine (Mansour et al., 2025).

Similarly, tirzepatide has generated considerable interest because of its dual agonistic activity on glucose-dependent insulinotropic polypeptide (GIP) and GLP-1 receptors. Clinical studies have demonstrated superior effects on glycemic control and weight reduction compared with traditional therapies. Given the strong relationship between obesity, diabetes, and cardiovascular disease, tirzepatide may provide substantial long-term cardiovascular benefits, although additional outcome studies are required to fully establish its role in cardiovascular prevention (Willard et al., 2020).

The success of sodium-glucose cotransporter-2 (SGLT2) inhibitors represents another landmark achievement in cardiovascular pharmacology. Originally developed as antidiabetic agents, SGLT2 inhibitors have consistently demonstrated reductions in heart failure hospitalizations, cardiovascular mortality, and renal disease progression. The benefits observed in patients with and without diabetes suggest that these agents possess unique cardioprotective and renoprotective properties independent of glucose lowering. Dapagliflozin, in particular, has shown remarkable efficacy across the spectrum of heart failure phenotypes, including both reduced and preserved ejection fraction. These findings have fundamentally altered treatment guidelines and established SGLT2 inhibitors as essential components of heart failure management (Armilotta et al., 2025).

Combined approaches to treatment are particularly relevant in the case of cardiovascular disease, where multiple interrelated pathophysiological mechanisms create complex clinical issues. Because of this, combination strategies such as acetazolamide and diuretics in acute heart failure, ezetimibe and statins in atherothrombotic cardiovascular disease, and ARB plus beta-blocker therapy in Marfan syndrome are designed to be additive to the treatment mechanisms. Multiple mechanistic pathways of an illness may be addressed with a combined approach to treatment. These strategies aim to provide a tailored treatment plan to a patient (Bahiru et al., 2017).

The design of polypill approaches and their implementation in the context of secondary prevention of cardiovascular disease are noteworthy. Addressing patient non-adherence to medication in long-term cardiovascular disease management is of utmost importance. Polypill therapy has the potential to address this and other issues such as simplification of treatment, reduction in the cost of healthcare, and a decrease in the frequency of cardiovascular disease in patients. This may be especially relevant in low-resource settings, where the complexity of treatments is often associated with poor patient outcomes (Espinosa et al., 2024).

It is important, however, to consider the challenges that these systems may create. For many newly innovated treatments, the long-term safety systems of pharmacovigilance are just beginning. Furthermore, cost to benefit analyses of these systems and the treatment options that may be incorporated into them must be considered, particularly in newly developing countries. Systems to maximize the benefit of these treatments must also be developed. Future studies should focus primarily on the long-term safety of new therapies, and potentially complementary effects of these therapies if used in treatment combinations (Garashi et al., 2022).

Another important consideration is the growing attention on precision medicine in cardiovascular care. Advances in molecular biology, genetics, and pharmacogenomics may allow clinicians to customise therapy according to individual patient characteristics. Many of the novel agents covered in this review show the move toward more personalized cardiovascular treatment. As scientific understanding of cardiovascular disease mechanisms continues to evolve, future therapeutic approaches will likely become increasingly targeted and individualized (Kayani et al., 2025).

In summary, the evidence reviewed demonstrates that cardiovascular pharmacotherapy is undergoing a period of rapid and transformative advancement. The expanding cardiovascular applications of GLP-1 receptor agonists, the widespread adoption of NOACs, the introduction of innovative agents such as mavacamten and tirzepatide, and the growing utilization of SGLT2 inhibitors and combination treatment strategies have significantly broadened therapeutic possibilities. Collectively, these developments have the potential to improve survival, reduce cardiovascular complications, enhance quality of life, and address previously unmet clinical needs. Continued research, real-world clinical experience, and guideline updates will be essential for maximizing the benefits of these therapies and further advancing cardiovascular patient care (Mousavi et al., 2025).

4. Conclusion

Cardiovascular Pharmacotherapy is evolving through the introduction of new medications and novel frameworks for clinician-led therapeutic strategies. Improvements in the cardiovascular usage of GLP-1 receptor agonists, the new class of drugs dubbed novel oral anticoagulants, and innovative therapies such as mavacamten, tirzepatide, and SGLT2 inhibitors, have vastly improved the treatment of cardiovascular disease. The improvements in pharmacotherapy have greater positive morbidity and mortality outcomes; furthermore, the advancements in pharmacotherapy address clinical gaps, and unmet needs, through novel, targeted, and personalized approaches.

Introduced combination therapies and polypill approaches have shown treatment improvement. Even with these positive outcomes, several challenges remain for pharmacotherapy. These include long-term safety, accessibility, and cost-effectiveness. Future research should focus on real-world outcomes of precision medicine and the integration of the new medications into existing treatment frameworks. The outcome of the current advancements in cardiovascular

pharmacoepidemiology gives a more extensive framework of therapeutic methods at the clinician's disposal and optimistically improves global cardiovascular health.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

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