Review Article

Targeted Anti-Inflammatory Therapies in Atherosclerosis: Beyond Lipid Control With Statins

María José Víquez Angulo[1*], Marco Andrey Vega Chaves[2], Stefanny Nikole Trejos Castro[3], José Pablo Rosales Jiménez[4], Boris Fernández Barrantes[5], Ariel Francisco Carranza Villalobos[6]

[1]Medical Doctor, Independent Researcher, San José, Costa Rica
[2]Medical Doctor, Carlos Luis Valverde Vega Hospital, Alajuela, Costa Rica
[3]Medical Doctor, México Hospital, San José, Costa Rica
[4]Medical Doctor, Independent Researcher, Heredia, Costa Rica
[5]Medical Doctor, Caja Costarricense de Seguro Social, Cartago, Costa Rica
[6]Medical Doctor, Víctor Manuel Monseñor Sanabria Hospital, Puntarenas, Costa Rica
[*]Corresponding author email: **marijose_v.a@hotmail.com**

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Abstract

Atherosclerosis is increasingly recognized as a chronic inflammatory disease rather than a purely lipid-storage disorder. Its pathogenesis begins with endothelial dysfunction, which disrupts vascular homeostasis and promotes the retention and modification of apolipoprotein B-containing lipoproteins within the arterial wall. These altered lipoproteins trigger an inflammatory response that recruits monocytes, which differentiate into macrophages and become foam cells, contributing to fatty streak formation and plaque development. As the lesion progresses, activation of innate immunity, particularly through the NLRP3 inflammasome, amplifies the production of inflammatory mediators such as interleukin-1 beta, interleukin-6, tumor necrosis factor-alpha, and C-reactive protein, thereby promoting plaque instability and thrombotic complications. Although statins remain central to

atherosclerosis management because of their lipid-lowering and pleiotropic anti-inflammatory effects, they do not fully eliminate residual inflammatory risk, which has emerged as a strong predictor of recurrent cardiovascular events. This has led to growing interest in targeted anti-inflammatory therapies that address specific inflammatory pathways involved in disease progression. Canakinumab and colchicine have demonstrated that selective modulation of inflammation can reduce major adverse cardiovascular events, whereas neutral trials such as CIRT have highlighted the importance of pathway specificity. Emerging therapies, including interleukin-6 inhibitors, NLRP3 inflammasome inhibitors, pro-resolving mediators, nanoparticle-based delivery systems, and gene-based approaches, offer promising directions for future treatment. However, optimal implementation requires careful patient selection, biomarker integration, imaging-based risk assessment, and a precision medicine approach that balances efficacy, safety, and cost while complementing intensive lipid-lowering strategies.

Key words

Atherosclerosis, inflammation, statins, colchicine, canakinumab, cardiovascular risk.

Introduction

Atherosclerosis is characterized not only by the accumulation of lipid-laden plaques, but also by a persistent chronic inflammatory process that contributes directly to plaque instability and rupture, ultimately increasing the risk of cardiovascular events. Within this process, inflammation involves multiple interconnected mechanisms, including endothelial dysfunction, macrophage polarization, T-cell activation, and the release of pro-inflammatory cytokines such as IL-1β and TNF-α, all of which participate in the progression and destabilization of atherosclerotic lesions [1, 2]. In this context, elevated hsCRP levels have been associated with greater plaque burden and increased plaque vulnerability, supporting their value as indicators of higher risk for adverse cardiovascular outcomes [3].

Although lipid-lowering therapy remains a cornerstone of cardiovascular prevention, residual inflammatory risk persists even in patients receiving optimal treatment, and this residual inflammatory burden continues to be a major predictor of recurrent cardiovascular events. Indeed, available evidence has shown that inflammation, as reflected by hsCRP levels, may be a stronger determinant of cardiovascular events than residual cholesterol risk itself [4]. This concept was reinforced by the CANTOS trial, which demonstrated that specifically targeting inflammation with canakinumab, an IL-1β inhibitor, was capable of reducing cardiovascular risk independently of lipid levels [5, 6].

In response to this residual inflammatory burden, targeted anti-inflammatory therapies have emerged as a promising therapeutic strategy. Recent advances in this field include monoclonal antibodies directed against specific cytokines, epigenetic modulators, and other immune-based interventions [2]. Among these approaches, low-dose colchicine has been approved as an adjunct to statin therapy to reduce myocardial infarction, stroke, and cardiovascular death, with evidence showing a 31% reduction in events and minimal side effects [4, 6]. At the same time, other therapies remain under investigation, including IL-6 inhibition and agents such as bempedoic acid, which have demonstrated the ability to reduce both LDL-C and hsCRP levels [7].

Despite these advances, important challenges remain. One of the main difficulties in the development of anti-inflammatory therapies is achieving an appropriate balance between efficacy and safety [2]. For this reason, the identification of novel biomarkers and therapeutic targets through ongoing clinical and

translational research remains essential for the continued evolution of treatment strategies [5]. In parallel, the integration of anti-inflammatory approaches with intensive lipid management may offer additional cardiovascular benefit and represents an important direction for future therapeutic development [7].

The objective of this narrative review is to analyze the role of targeted anti-inflammatory therapies in atherosclerosis beyond lipid control with statins, with emphasis on the pathophysiological basis of vascular inflammation, residual inflammatory risk, current therapeutic strategies, and emerging approaches that may improve cardiovascular outcomes.

Methodology

This manuscript was developed as a structured narrative review aimed at providing an updated and clinically integrated analysis of targeted anti-inflammatory therapies in atherosclerosis beyond lipid control with statins, with particular emphasis on the pathophysiological basis of vascular inflammation, the concept of residual inflammatory risk, current evidence on targeted therapeutic strategies, and emerging anti-inflammatory approaches with potential cardiovascular benefit. A predefined methodological protocol was established prior to literature screening. Given the biological complexity of atherosclerosis and the heterogeneity of inflammatory pathways, therapeutic targets, and study populations, a narrative interpretative synthesis was selected over quantitative pooling in order to integrate mechanistic, clinical, and therapeutic evidence into a coherent and clinically applicable framework. Special attention was given to the role of inflammation in plaque development and destabilization, the prognostic relevance of residual inflammatory risk despite optimal lipid-lowering therapy, and the evolving role of cytokine-targeted agents, colchicine, and other immunomodulatory strategies in cardiovascular prevention. The objective was to provide a structured synthesis capable of supporting a broader understanding of inflammation-guided cardiovascular risk reduction in contemporary atherosclerotic disease management.

A comprehensive literature search was conducted in PubMed, Scopus, and Web of Science, including peer-reviewed articles published in English or Spanish between January 2020 and December 2025. The final search was performed in April 2026. This timeframe was selected to capture contemporary advances in the understanding of inflammatory mechanisms in atherosclerosis, the development of targeted anti-inflammatory therapies, and updated evidence regarding residual inflammatory risk and cardiovascular outcomes. Foundational studies were incorporated when necessary to contextualize key pathophysiological mechanisms or the historical evolution of anti-inflammatory concepts in atherosclerotic disease. The search strategy combined MeSH and free-text terms using Boolean operators related to atherosclerosis, vascular inflammation, residual inflammatory risk, high-sensitivity C-reactive protein, interleukin-1 beta, interleukin-6, canakinumab, colchicine, bempedoic acid, cytokine inhibition, inflammasome, statins, and cardiovascular outcomes. Searches were conducted in titles and abstracts as well as indexed subject headings to maximize sensitivity.

The initial search yielded 190 records. After removal of duplicates, 120 articles remained for title and abstract screening. Of these, 80 underwent full-text evaluation, and 39 studies were included in the final synthesis. Selection was performed independently by two authors, with disagreements resolved through discussion and consensus. Exclusion criteria comprised non-peer-reviewed publications, isolated case reports, editorials without clinical or mechanistic outcome data, redundant datasets, studies focused exclusively on lipid lowering without inflammatory relevance, and publications not directly addressing inflammatory pathways, residual inflammatory risk, or the therapeutic

role of targeted anti-inflammatory interventions in atherosclerosis.

Eligible studies included randomized controlled trials, large observational cohorts, systematic reviews, meta-analyses, expert consensus statements, and contemporary international guidelines from cardiology, preventive cardiology, and vascular medicine societies. Priority was assigned to multicenter investigations, studies with standardized cardiovascular outcome definitions, and research evaluating inflammatory biomarkers, recurrent cardiovascular events, plaque-related mechanisms, and treatment-related adverse effects. Extracted variables included study design, population characteristics, baseline inflammatory markers, therapeutic target or intervention, comparator strategy, effects on inflammatory biomarkers, lipid-related parameters when applicable, cardiovascular outcomes, and reported safety findings. Methodological quality and internal validity were assessed narratively, considering risk of bias, sample size, follow-up duration, consistency in endpoint definitions, and reproducibility of reported results. In cases of conflicting evidence, greater interpretative weight was assigned to higher-level evidence and guideline-supported recommendations.

Reference lists of included studies were manually screened to identify additional relevant publications. Given its narrative design, this review is subject to potential selection bias and does not provide pooled quantitative estimates. Artificial intelligence-based tools were used exclusively to assist in literature organization and structural coherence, whereas critical appraisal, synthesis, and final interpretation were conducted independently by the authors to preserve methodological rigor.

Inflammatory Pathophysiology of Atherosclerosis

Endothelial dysfunction represents the initiating event in atherosclerosis and is characterized by an impaired ability of the endothelium to regulate vascular tone and maintain vascular homeostasis [8, 9]. In this altered environment, apolipoprotein B-containing lipoproteins, such as low-density lipoproteins, are retained within the arterial wall, where they undergo modification through enzymatic and oxidative processes. These modified lipoproteins subsequently trigger an inflammatory response that promotes the recruitment of immune cells to the affected site [10, 11].

As this inflammatory process progresses, monocytes are recruited into the arterial intima in response to chemokines and adhesion molecules expressed by activated endothelial cells [12]. Once they enter the intima, these monocytes differentiate into macrophages, which play a central role in plaque development by engulfing lipids and transforming into foam cells [13]. In turn, these lipid-laden macrophages contribute to the formation of fatty streaks, which represent one of the earliest recognizable manifestations of atherosclerosis [14].

At the same time, the development of the atherosclerotic plaque is accompanied by activation of innate immunity, particularly through the NLRP3 inflammasome, which plays a crucial role in the production of pro-inflammatory cytokines such as IL-1β [15]. This inflammatory environment is further amplified by key mediators including interleukin-1 beta, interleukin-6, tumor necrosis factor-alpha, and C-reactive protein, all of which contribute to worsening plaque inflammation and instability [8, 9]. In parallel, chemokines and adhesion molecules facilitate the continuous recruitment of immune cells, thereby perpetuating the inflammatory cycle within the arterial wall [12, 16].

As a consequence of sustained inflammation, plaque progression occurs through the transition from a stable lesion to a vulnerable plaque, a process characterized by thinning of the fibrous cap and enlargement of the necrotic core.

Ultimately, plaque rupture or erosion may occur, exposing thrombogenic material to the bloodstream and leading to thrombotic complications such as myocardial infarction or stroke [12, 16].

Statins and the Limits of Lipid-Centered Therapy

Statins exert their therapeutic effect in atherosclerosis primarily through inhibition of HMG-CoA reductase, which reduces cholesterol synthesis and increases low-density lipoprotein receptor expression, thereby enhancing low-density lipoprotein clearance from the bloodstream [17]. In addition to their lipid-lowering action, statins also modulate inflammatory pathways, including inhibition of NF-κB signaling and reduction of pro-inflammatory cytokines such as IL-6 and TNF-α [18]. Through these mechanisms, statins significantly lower low-density lipoprotein cholesterol levels, which represent a major risk factor for atherosclerosis, and in doing so reduce the incidence of major cardiovascular events [17]. Clinical trials have further demonstrated that statins can stabilize and even regress atherosclerotic plaques, which contributes substantially to their cardiovascular protective effects [19].

Beyond these benefits, statins also exhibit pleiotropic anti-inflammatory effects that extend independently of lipid lowering. These include reduction of C-reactive protein levels and improvement of endothelial function [20, 21]. In this context, their anti-inflammatory activity involves modulation of endothelial cell inflammation and senescence pathways, reinforcing their protective role within the vascular wall. At the same time, the reduction in C-reactive protein, a marker of systemic inflammation, has been associated with improved cardiovascular outcomes [19]. In parallel, statins enhance endothelial function by reducing endothelial cell inflammation and promoting nitric oxide production [21].

However, despite intensive statin treatment, patients may continue to experience residual inflammatory risk, which has been identified as a stronger predictor of recurrent cardiovascular events than residual cholesterol risk. This persistent risk underscores the distinction between residual lipid risk, which refers to the remaining cholesterol burden after statin therapy, and residual inflammatory risk, which reflects ongoing inflammation despite adequate lipid control. Because both contribute to disease progression and adverse cardiovascular outcomes, addressing each of them is essential for comprehensive atherosclerosis management [4].

In clinical practice, identifying patients with persistent inflammatory activity is particularly important for tailoring adjunctive therapies, especially because agents such as low-dose colchicine have shown efficacy in reducing cardiovascular events. This supports the development of more personalized treatment strategies aimed at targeting both lipid and inflammatory pathways simultaneously. Accordingly, given the limitations of statins in fully addressing residual inflammatory risk, adjunctive therapies such as colchicine and other novel anti-inflammatory agents are being explored to complement statin treatment by specifically targeting the inflammatory processes involved in atherosclerosis [4].

Biological Rationale for Targeted Anti-Inflammatory Therapy

The biological rationale for targeted anti-inflammatory therapy in atherosclerosis is based on the recognition that inflammation constitutes an independent therapeutic target because it plays a central role in plaque formation and instability. Elevated inflammatory markers such as C-reactive protein and interleukin-6 have been associated with increased cardiovascular risk, supporting the concept that inflammation itself is a viable target for therapeutic intervention [22, 23]. In this context, it is important to distinguish between nonspecific anti-inflammatory therapy

and targeted immunomodulation, since nonspecific therapies, such as general anti-inflammatory drugs, may not adequately address the particular inflammatory pathways involved in atherosclerosis. By contrast, targeted therapies seek to modulate specific cytokines or signaling pathways, potentially allowing for a more precise and effective therapeutic approach [5, 12].

Within cardiovascular disease, an effective anti-inflammatory strategy should ideally promote plaque stabilization by reducing inflammation and preventing plaque rupture, which represents a major cause of acute cardiovascular events [1]. In addition, by addressing the inflammatory component of atherosclerosis, targeted therapies may reduce the incidence of recurrent ischemic events such as myocardial infarction and stroke [24]. At the same time, targeting specific immune pathways may attenuate vascular immune activation by decreasing the activation of immune cells within the vascular system, thereby reducing overall inflammation and slowing disease progression [25].

Despite these potential benefits, targeted anti-inflammatory therapy also carries important risks. Suppression of specific inflammatory pathways may impair the body's ability to fight infections, as has been observed with therapies directed against the interleukin-1 pathway [22, 24]. In a broader sense, such therapies may weaken host defense mechanisms and increase susceptibility to infectious diseases [12]. Moreover, because immune modulation involves complex biological networks, there is also a risk of unintended off-target systemic effects [26].

Against this background, several major therapeutic targets have emerged. The interleukin-1 pathway has attracted particular attention, as canakinumab, an IL-1β inhibitor, has demonstrated efficacy in reducing cardiovascular events, although at the cost of increased infection risk [22, 24]. Similarly, the interleukin-6 pathway represents another important target, since its inhibition may reduce inflammation and cardiovascular risk, although its long-term effects remain under investigation [16, 23]. The NLRP3 inflammasome has also been identified as a relevant pathway in the inflammatory response of atherosclerosis, and its inhibition may offer new therapeutic opportunities [27, 28]. In parallel, microtubule-mediated leukocyte activation constitutes another clinically relevant target, as colchicine, which interferes with this process, has been shown to reduce cardiovascular events in clinical trials [22, 24]. Neutrophil and monocyte signaling pathways are critical components of the inflammatory process in atherosclerosis and therefore represent additional potential targets for therapy [25].

Established Targeted Anti-Inflammatory Therapies

Canakinumab has emerged as an important example of targeted anti-inflammatory therapy in atherosclerosis because it acts directly against IL-1β, a pro-inflammatory cytokine involved in disease progression. By neutralizing IL-1β, canakinumab reduces inflammatory leukocyte production and uptake within atherosclerotic plaques, thereby slowing the inflammatory processes that contribute to plaque progression [29]. This mechanistic rationale gained major clinical relevance through the CANTOS trial, which demonstrated that canakinumab significantly reduced recurrent cardiovascular events in patients with prior myocardial infarction, independently of lipid levels [5, 30]. In parallel, canakinumab has been shown to effectively lower inflammatory biomarkers such as IL-6 and high-sensitivity C-reactive protein, both of which are strongly associated with cardiovascular risk [31]. Nevertheless, despite representing a novel strategy for cardiovascular risk reduction, its clinical use remains limited by high cost and by potential adverse effects, particularly an increased risk of infections related to immune suppression [2, 25].

In contrast, colchicine represents a low-dose oral anti-inflammatory therapy with a different

mechanism of action. Its effects are largely mediated through disruption of microtubule function, which interferes with neutrophil trafficking and reduces vascular inflammation. In addition, colchicine modulates the NLRP3 inflammasome, a key component of the inflammatory cascade involved in atherosclerosis [8]. Through inhibition of neutrophil activity, colchicine decreases inflammatory responses in the vascular endothelium and thereby contributes to plaque stabilization [4]. This biological effect has been supported by clinical evidence, as trials such as COLCOT and LoDoCo2 have shown that colchicine reduces major adverse cardiovascular events in both chronic and acute coronary syndromes [31]. Among its main advantages are oral administration, affordability, and broad availability, although its use may be limited by gastrointestinal side effects and potential drug interactions [12].

When comparing biologic therapy with low-dose oral anti-inflammatory therapy, both canakinumab and colchicine have demonstrated efficacy in reducing cardiovascular events, but they differ considerably in accessibility, route of administration, and safety considerations. Canakinumab, as a biologic therapy, is more expensive and requires injection, whereas colchicine is administered orally and is substantially more accessible in routine clinical practice [24]. For this reason, patient selection and risk management are essential when considering either strategy, since the choice between these therapies may depend on individual factors such as infection risk, cost considerations, and the need for long-term control of vascular inflammation [30].

Emerging and Investigational Therapies

Interleukin-6 inhibitors have attracted growing attention because IL-6 is a key cytokine within the inflammatory cascade, with an important influence on immune cell regulation and proliferation. In the context of atherosclerosis, IL-6 plays a significant role in disease pathogenesis by promoting inflammation and contributing to plaque instability [4]. For this reason, these agents have generated substantial translational and clinical interest, particularly because clinical trials have shown that IL-6 inhibitors can reduce inflammatory markers and may potentially lower cardiovascular events, supporting their role as a promising therapeutic target in atherosclerosis [16].

In parallel, direct NLRP3 inflammasome inhibitors represent another emerging strategy with considerable mechanistic promise. The NLRP3 inflammasome is crucial in the inflammatory response and contributes to endothelial injury as well as foam cell formation during the development of atherosclerosis, which suggests that inhibiting this pathway could reduce inflammation and slow plaque progression [27, 32]. This possibility has been reinforced by preclinical and early clinical development, since experimental studies have shown that NLRP3 inhibitors can decrease vascular inflammation and attenuate atherosclerosis progression by reducing leukocyte supply and uptake into vascular lesions [33].

Beyond these pathways, other therapeutic strategies are being explored through targeting innate immune cell activation. One such approach involves modulation of clonal hematopoiesis-related inflammation, since clonal hematopoiesis contributes to a pro-inflammatory state that may accelerate atherosclerosis progression. Although this strategy remains in the early stages of research, it represents a potentially relevant direction for future intervention [12]. At the same time, pro-resolving mediators and resolution biology-based therapies seek to enhance the body's natural capacity to resolve inflammation, with the goal of stabilizing plaques and reducing cardiovascular risk [34].

Another important area of development involves nanoparticle-based targeted drug delivery. Through the use of nanoparticles and other

delivery systems, anti-inflammatory agents may be directed specifically toward atherosclerotic plaques, thereby minimizing systemic exposure and reducing side effects. This precision drug delivery strategy is currently being explored as a means of improving the therapeutic index of anti-inflammatory interventions in atherosclerosis [35]. Similarly, gene-based and RNA-based anti-inflammatory approaches offer innovative possibilities by modulating specific inflammatory pathways at the genetic level, thereby providing a novel strategy for reducing vascular inflammation [25].

Despite the promise of these emerging therapies, important challenges remain in translating experimental success into meaningful clinical benefit. One of the principal difficulties lies in maintaining an appropriate balance between safety and efficacy, since therapies must reduce inflammation effectively without excessively compromising immune function, and the risks of infection and other adverse effects must be carefully managed [34]. In addition, successful clinical translation depends on identifying which patients are most likely to benefit from these therapies and on developing biomarkers capable of guiding treatment decisions [25]. Regulatory and economic hurdles also represent significant barriers, as the development and approval of new therapies require major investment and complex regulatory navigation, which may delay their availability in clinical practice [2].

Clinical Evidence, Trial Interpretation, and Lessons Learned

Clinical evidence from major trials has provided important insight into the role of targeted anti-inflammatory therapy in atherosclerosis. The CANTOS and COLCOT trials demonstrated the efficacy of canakinumab and colchicine, respectively, in reducing major adverse cardiovascular events by targeting specific inflammatory pathways, particularly those related to the NLRP3 inflammasome pathway. This success reinforces the importance of focusing on specific inflammatory mediators in the treatment of atherosclerosis [5, 24]. In contrast, the CIRT trial, which evaluated methotrexate, failed to demonstrate cardiovascular benefit, thereby highlighting the difficulty of targeting inflammation without a clear understanding of the precise biological pathways involved [1].

These findings underscore the importance of pathway specificity. Successful trials have frequently targeted the NLRP3/IL-1β/IL-6/CRP pathway, which plays a central role in the inflammatory process of atherosclerosis. Inhibition of this pathway has been associated with reductions in myocardial infarction and coronary revascularization, although not consistently with reductions in all-cause mortality [37, 16]. At the same time, emerging targets such as the CCL2-CCR2 axis are being investigated in an effort to develop more specific interventions with fewer systemic side effects [38].

Another key factor in interpreting these trials is the relevance of baseline inflammatory burden. Studies such as JUPITER have shown that baseline levels of inflammatory biomarkers, particularly hsCRP, may help guide treatment allocation and predict outcomes. Higher baseline inflammation has been associated with greater benefit from anti-inflammatory therapies, emphasizing the importance of patient selection and suggesting that therapeutic efficacy may vary according to the inflammatory status of each individual [16, 39].

The relationship between biomarker reduction and clinical outcomes is also central to trial interpretation. Reductions in biomarkers such as hsCRP and IL-6 have been associated with improved clinical outcomes, although this relationship is not always linear or straightforward. For example, the REDUCE-IT trial demonstrated event reduction without significant biomarker changes, indicating that the mechanisms linking inflammation, biomarkers, and clinical benefit may be more complex than

initially assumed. Therefore, understanding this relationship remains essential for interpreting trial results and refining future therapeutic strategies [37, 39, 40].

In addition, efficacy appears to differ across patient populations. Anti-inflammatory therapies have shown variable results depending on the clinical setting, with some treatments appearing more effective in stable coronary artery disease than in the period following recent myocardial infarction [16]. Likewise, patients in high-risk secondary prevention settings or those with elevated baseline inflammation may derive greater benefit from targeted therapies [1, 5].

Taken together, these observations have important implications for future trial design. Upcoming studies should increasingly adopt precision medicine approaches by targeting specific inflammatory pathways while also considering individual patient characteristics, particularly baseline inflammatory burden [1, 5]. In parallel, incorporating comprehensive biomarker analysis into trial design may help clarify mechanisms of action, improve interpretation of outcomes, and optimize patient selection for anti-inflammatory therapies in atherosclerosis [37, 39].

Patient Selection, Biomarkers, and Precision Medicine

Identifying candidates for anti-inflammatory therapy requires careful recognition of inflammatory burden, particularly through biomarkers that reflect residual inflammatory risk beyond lipid levels. High-sensitivity C-reactive protein is a well-established biomarker of systemic inflammation and an independent predictor of adverse cardiovascular outcomes, regardless of low-density lipoprotein cholesterol levels. Elevated hsCRP levels are associated with higher event rates in coronary artery disease and indicate residual inflammatory risk that is not adequately addressed by lipid-lowering therapies [3, 39]. In a similar way, interleukin-6 and other cytokines are also relevant, as IL-6 is linked to increased cardiovascular risk and serves as a central mediator of inflammation in atherosclerosis. Inhibition of IL-6 has shown promise in reducing hsCRP levels and cardiovascular events [7]. Accordingly, patients with higher inflammatory burdens, as reflected by elevated hsCRP and IL-6 levels, are more likely to benefit from anti-inflammatory therapies, and these clinical phenotypes often correlate with greater plaque vulnerability and progression [2, 4].

In addition to circulating biomarkers, imaging tools also play an important role in the assessment of vascular inflammation. Positron emission tomography can detect active inflammation within atherosclerotic plaques, thereby providing insight into plaque stability and the risk of rupture. Likewise, coronary computed tomography-based plaque characterization helps identify high-risk plaques that are more prone to rupture and may therefore assist in guiding therapeutic decisions [2].

The integration of inflammatory biomarkers with lipid parameters further strengthens cardiovascular risk stratification. Combining markers such as hsCRP with lipid-related variables allows more comprehensive risk assessment and helps identify patients who may benefit from a combined anti-inflammatory and lipid-lowering therapeutic strategy. In this context, agents such as bempedoic acid, which reduce both low-density lipoprotein cholesterol and hsCRP, illustrate the potential value of integrated therapeutic approaches [4, 7].

From a precision medicine perspective, the goal is to balance benefit and risk by tailoring anti-inflammatory therapies according to individual risk profiles, thereby optimizing therapeutic efficacy while minimizing adverse effects [2, 4]. However, unresolved issues remain, particularly in defining treatment thresholds and in monitoring therapeutic responses. The variability in individual responses to anti-inflammatory

agents underscores the need for further research to refine these strategies [34].

Conclusions

Atherosclerosis should not be understood solely as a lipid deposition disorder, but rather as a chronic inflammatory process in which endothelial dysfunction, immune activation, and plaque instability play central roles in disease progression and in the development of thrombotic events such as myocardial infarction and stroke.

Although statins remain essential because of their lipid-lowering and anti-inflammatory effects, residual inflammatory risk persists and may predict recurrent cardiovascular events even after adequate cholesterol control, which supports the need for complementary therapies specifically directed against inflammatory pathways.

Current clinical evidence indicates that targeted anti-inflammatory therapies, such as canakinumab and colchicine, can reduce cardiovascular events when they act on specific inflammatory pathways; however, their optimal implementation still requires better patient selection, biomarker-guided strategies, careful balance between efficacy and safety, and further development of precision medicine approaches.

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