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Letters to Editor

Targeting inflammation: Implications for chronic disease and cancer therapy

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Over the past decade, significant advancements in immunology have deepened our understanding of inflammation's central role in both chronic diseases and cancer. This letter aims to summarize recent developments in immunology and explore their translational implications for therapeutic strategies in chronic diseases, including cardiometabolic disorders and autoimmune diseases, as well as in cancer treatment.

Recent discoveries in immune signaling have revolutionized our understanding of inflammation. The identification of key pattern recognition receptors (PRRs), including Toll-like receptors (TLRs) and the cGAS-STING pathway, has underscored the importance of innate immunity in initiating and maintaining inflammation [1,2]. Additionally, the activation of inflammasomes, such as NLR family pyrin domain containing 3 (NLRP3), has been linked to a variety of chronic inflammatory diseases, including atherosclerosis and type 2 diabetes [3]. On the adaptive immune side, research into T-cell subsets, particularly Th17 and Treg cells, has highlighted their dual roles in both promoting and resolving inflammation [4]. Furthermore, cytokine signaling, particularly the roles of IL-1β, TNF-α, and IL-6 has become a critical area of focus, as these mediators are implicated in a wide range of inflammatory conditions [5].

In chronic disease, inflammation plays a pivotal role in the pathogenesis of several conditions. In cardiometabolic diseases, inflammation accelerates the progression of atherosclerosis and insulin resistance. Studies have demonstrated that inhibiting IL-1β reduces the incidence of cardiovascular events, providing a clear example of how targeting inflammation can improve clinical outcomes [6,7]. In autoimmune disorders such as rheumatoid arthritis and inflammatory bowel disease (IBD), advances in immunopathology have led to the development of targeted therapies, such as TNF inhibitors, that directly modulate the inflammatory response [8]. Additionally, fibrotic diseases like chronic kidney disease (CKD) are increasingly recognized as driven by chronic inflammation, where macrophages and fibroblasts interact to exacerbate tissue damage [9]. Understanding these mechanisms is crucial for developing more effective treatments for these chronic, debilitating conditions.

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Inflammation also plays a crucial role in cancer development and progression. Chronic inflammation in the tumor microenvironment promotes tumor initiation, immune evasion, and metastasis. Tumor-associated macrophages (TAMs) and myeloid-derived suppressor cells (MDSCs) are particularly prominent in creating an immunosuppressive niche that supports tumor growth [10]. Moreover, cytokine signaling, such as IL-6 and TNF-α, has been shown to facilitate cancer cell proliferation and metastasis [11].

This understanding has led to the development of cancer immunotherapies targeting immune checkpoints like PD-1/PD-L1 and CTLA-4, which have revolutionized cancer treatment [12,13]. The recent success of chimeric antigen receptor T-cell (CAR-T) therapy and other immune-modulating strategies further underscores the potential of targeting inflammation to enhance antitumor immunity [14]. Additionally, modulating inflammatory pathways, such as IL-6 blockade or STING activation, is emerging as a promising approach to overcome resistance to standard cancer therapies [15,16].

Despite these promising advances, several challenges remain. Resistance to immunotherapies, variable patient responses, and the risk of adverse inflammatory responses pose significant barriers [17]. Personalized medicine, supported by immune profiling and biomarker development, is essential to optimize treatment outcomes and minimize toxicity. Future research should focus on integrating systems immunology, single-cell sequencing, and patient-specific immune landscapes to refine therapeutic strategies and improve patient care in both chronic diseases and cancer.

In conclusion, recent advancements in immunology and inflammation have transformed our understanding of chronic diseases and cancer. The development of targeted therapies to modulate inflammatory pathways offers exciting new treatment avenues. Continued research into the immune system's complex role in disease will be essential to developing more effective and personalized therapies.

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Authors' contributions

The authors equally contributed to the conception of the study, performed the literature search, synthesized the evidence, and wrote and approved the final version of the manuscript.

Conflict of interest

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