

Revolutionizing the Treatment of Chronic Lymphocytic Leukemia: A Comprehensive Review of Targeted Drug Delivery Strategies

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Abstract: *Chronic Lymphocytic Leukaemia (CLL) therapy has evolved from broad-spectrum chemoimmunotherapy to precise molecular targeting with BTK and BCL-2 inhibitors. However, challenges such as drug resistance, off-target toxicity, and protection within the tumour microenvironment persist. Emerging targeted drug delivery systems offer promising solutions. Nanocarriers like liposomes and polymeric nanoparticles improve drug solubility, control release, and enable selective delivery to leukemic cells, reducing systemic side effects. Antibody-drug conjugates (ADCs) further enhance specificity by coupling potent cytotoxins to antibodies targeting CLL cell-surface antigens. Meanwhile, Chimeric Antigen Receptor (CAR) T-cell therapy represents a breakthrough in personalized medicine by reprogramming immune cells to eradicate leukemia. These innovative platforms aim to overcome biological barriers, penetrate lymphoid niches, and counter resistance mechanisms. Collectively, they redefine the therapeutic index by maximizing efficacy while minimizing toxicity. This review highlights the design, clinical potential, and translational challenges of these advanced delivery strategies, emphasizing their pivotal role in shaping a more precise, durable, and potentially curative treatment paradigm for CLL..*

Keywords: Chronic Lymphocytic Leukaemia (CLL), Targeted Drug Delivery, Nanomedicine, Antibody-Drug Conjugates (ADCs), CAR T-cell Therapy, Tumor Microenvironment, Drug Resistance

