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A new pathway towards immunotherapy-supported radiology for targeted Boron Neutron Capture Therapy (BNCT)

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Abstract

Background: We present our novel, patented paradigm of immunotherapy-supported radiology designed to augment conventional FDA-approved Boron Neutron Capture Therapy (BNCT). This innovative approach employs immunocompetent cells as vectors for boron nanoparticles, thereby facilitating targeted radiological treatment. Our methodology addresses the evasive propensity of 'cold' solid tumors, which often remain undetected due to their integration within fibroblast-rich micro environments devoid of distinct markers.
Methods: By loading boron into immunocompetent cells, these entities function as highly selective delivery agents—akin to nanorobots—capable of transporting therapeutically sufficient payloads (80 μg/tumor) of the stable isotope ^{10}B directly into malignant cells or their immediate vicinity, priming them for BNCT. The subsequent treatment method involves exposing the patient to a relatively benign beam of low-energy, 'epithermal' neutrons (E_n ~ 0.025 eV) generated by a compact particle accelerator. The therapeutic efficacy hinges on the nuclear reaction $^{10}B + n \rightarrow {}^4He + {}^7Li$, which occurs with a high cross-section and is impervious to any tumor-supporting microenvironment. The energy released via Linear Energy Transfer (LET) by the resultant lithium and helium ions is confined to a cellular scale (~9 μm), inducing apoptosis with remarkable precision. **Hallmark:** This spatially restricted energy deposition minimizes collateral damage to adjacent healthy tissue, the hallmark aim of our approach. Our patented boron-loading mechanism employing liposome-mediated endocytosis enables the incorporation of approximately 10^9 boron atoms into a single immunocompetent cell without compromising its biological functionality. In vitro experiments conducted at the neutron-providing nuclear reactor at the ICN in Pitesti corroborate the immense potential of this immunotherapy-supported BNCT paradigm.
Conclusion: We conclude that this pioneering strategy can potentially become a transformative advancement in targeted oncological therapies of recalcitrant solid tumors.