

Cold Atmospheric Plasma Therapy Induces Immunogenic Cell Death in Chemoresistant Triple-Negative Breast Cancer

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Abstract

Triple-negative breast cancer (TNBC) lacks targeted therapies and frequently develops chemotherapy resistance. Cold atmospheric plasma (CAP) generates reactive oxygen/nitrogen species (RONS) that selectively kill cancer cells. We demonstrate that CAP treatment of cisplatin-resistant TNBC cell lines and patient-derived xenografts induces immunogenic cell death (ICD), characterized by calreticulin exposure, ATP secretion, and HMGB1 release. CAP-generated RONS activated the cGAS-STING pathway, triggering type I interferon responses and dendritic cell maturation. Combination of CAP with anti-PD-1 therapy eradicated established tumors in immunocompetent mice through CD8+ T-cell-mediated immunity. Physical plasma medicine offers an innovative immunotherapeutic modality for resistant TNBC.

Keywords: cold atmospheric plasma, immunogenic cell death, triple-negative breast cancer, cGAS-STING pathway, chemoresistance, physical oncology



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