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Electric Pulse Modification of Cancer Cell Population Dynamics

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Cancer cell populations contain proliferating, quiescent, and dead cells that drive tumor growth and cancer metastasis based on the surrounding microenvironment [1]. Many existing cancer treatments are highly cytotoxic and predominantly target the proliferating cells, which drive cancer development [2]. This begs the question about whether electric pulses (EPs), which are under investigation for cancer treatment [3], preferentially target proliferating or quiescent cells. To address this, we apply a mathematical model of cancer cell population dynamics based on coupled differential equations representing proliferating and quiescent cell growth [1] to experiments applying EPs of various pulse durations, electric fields, and pulse number to Jurkat cells. EPs above a specific energy threshold severely retarded cell growth such that it did approach the standard "S-curve"exhibited by untreated cells, despite replenishing the cell growth media daily. Fitting experimental data to the mathematical model [1] showed that that the proliferating cell population decreased with a concomitant increase in quiescent cell death rate as we applied additional EPs. This caused the quiescent cells to consume additional nutrients, further reducing the proliferating cell population and driving down the final steady state cell population for potential treatments. The implications of these results for tuning EPs for applications ranging from cancer treatment to cell growth stimulation for wound healing will be discussed.

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[3] R. Nuccitelli, R. Wood, M. Kreis, B. Athos, J. Huynh, K. Lui, P. Nuccitelli, and E. H. Epstein Jr, "First-in-human trial of nanoelectroablation therapy for basal cell carcinoma: Proof of method,"Exp. Dermatol., vol. 23, pp. 135-137, 2014.

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