Probabilistic analysis of apoptosis and necrosis in cancer cells induced by natural killer cells

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Cytotoxic T lymphocytes and natural killer (NK) cells are the main cytotoxic killer cells of the human body to eliminate pathogen-infected or tumorigenic cells. They can kill target cells via the release of cytolytic molecules, which leads to necrosis or apoptosis or induce apoptosis via binding to Fas receptors. Experimentally Backes et al. (unpublished) have observed, that the killing mechanism employed by a single NK cell varies in time and the sequence of the killing mechanisms varies among different cells of a population. Whether these variations indicate the existence of different NK cell phenotypes, or whether it is a purely probabilistic phenomenon is unknown. We rely on experimental data for these time sequences to model the observed sample of killing sequences as realizations of one or more independent stochastic processes. Each process represents different NK cell phenotype with different killing characteristics. We find that a model with one stochastic process suffices to reproduce the experimental data, and compute from maximum likelihood considerations the optimal parameter set for the observed data.