Mathematical Model of MMC Chemotherapy for Non-Invasive Bladder Cancer Treatment

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Mitomycin-C (MMC) chemotherapy is a well-established anti-cancer treatment for non-muscle-invasive bladder cancer (NMIBC). However, despite comprehensive biological research, the complete mechanism of action and an ideal regimen of MMC have not been elucidated. In this study, we present a theoretical investigation of NMIBC growth and its treatment by continuous administration of MMC chemotherapy. Using temporal ordinary differential equations (ODEs) to describe cell populations and drug molecules, we formulated the first mathematical model of tumor-immune interactions in the treatment of MMC for NMIBC, based on biological sources.

Several hypothetical scenarios for NMIBC under the assumption that tumor size correlates with cell count are presented, depicting the evolution of tumors classified as small, medium, and large. These scenarios align qualitatively with clinical observations of lower recurrence rates for tumor size $\leq$30 mm with MMC treatment, demonstrating that cure appears up to a theoretical x mm tumor size threshold, given specific parameters within a feasible biological range.

The unique use of mole units allows us to introduce a new method for theoretical pre-treatment assessments by determining MMC drug doses required for a cure.

In this way, our approach provides initial steps toward personalized MMC chemotherapy for NMIBC patients, offering the possibility of new insights and potentially holding the key to unlocking some of its mysteries.

References

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