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The role of symmetric and asymmetric division of cancer stem cells in developing drug resistance for various types of tumor growth

Often, resistance to drugs is an obstacle to a successful treatment of cancer. Many attempts to study drug resistance have been made in the mathematical modeling literature. Clearly, in order to understand drug resistance, it is imperative to have a good model of the underlying dynamics of cancer cells. One of the main ingredients that has been recently introduced into the rapidly growing pool of mathematical cancer models is stem cells. Surprisingly, this all-so-important subset of cells has not been fully integrated into existing mathematical models of drug resistance. In this work we incorporate the various possible ways in which a stem cell may divide into the study of drug resistance. We derive a new estimate of the probability of developing drug resistance by the time a tumor is detected, and calculate the expected number of resistant cancer stem cells at the time of tumor detection. We are also able to obtain analytical results for cases where the average exponential growth of cancer has been replaced by other, arguably more realistic types of tumor growth. Finally, to demonstrate the significance of this approach, we combine our new mathematical estimates with clinical data to show that leukemic stem cells must tend to renew symmetrically as opposed to their healthy counterparts that predominantly appear to divide asymmetrically. (Part of this work is joint with D. Levy, University of Maryland)

References

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