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Current problems in surgical oncology

I. Theoretical models in oncology and their implications in surgical therapy

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Abstract

Cancer biology has proven to be far more complex than imagined twenty years ago. While current treatment strategies (i.e., surgery, chemotherapy, and radiation) are successful in many cancers, they all have limitations. In some types of solid tumors some survival progress has been recorded, such in the case of breast and colorectal cancer, but these improvements are probably mainly due to screening programmes and earlier detection than to more-effective treatment. In other tumor types the mortality certainly increased: the death rate from lung cancer rose from 43 to 53 per 100,000 people from 1975 to 2005, the death rate from melanoma has risen nearly 30 percent, and death rate from liver and bile-duct cancer almost doubled, from 2.8 to 5.3 per 100,000. Cancer is commonly viewed as minimally controlled by modern medicine, especially when compared with other major diseases (Sharon Begley, 2008). Either directly from the phenomenological observation or through the biological model, mathematicians and biologists can generate mathematical models aimed at describing the biological phenomenon. The analysis of the solution properties by mathematical methods will give a description of the dynamics resulting in a deeper insight into the problem. The models can be implemented numerically to give rise to in silico models. The quality of the modeling process can be tested, validating the results of the simulations with experiments and clinical data. The theoretical predictions generated from the models may optimize the experimental protocol by identifying the most promising candidates for further clinical investigation. The speed with which large numbers of simulations can be performed may reduce the number of animal experiments and identify new experimental programmes and optimal cancer therapy schedules. However, it is clear that surgical decisions in cancer therapy are strongly driven by the theoretical hypotheses of local tumor evolution and malignant cells dissemination. For 60 years cancer was seen as a disease that arose in one location and spread through the lymphatic system first to nearby lymph nodes and subsequently to other organs. This theory of "contiguous" development of metastases has become known as the Virchow-Halsted theory. After 1954 an alternative theory was formulated by B. Fisher stating "that breast cancer is a systemic disease“. Following the therapeutic implications of this "systemic theory," the disease has been attacked in recent years by chemotherapy and hormone therapy to the whole body. In 1994 S. Hellman stated the case for what he calls the "spectrum theory." He observed that there are intermediate tumor states between purely localized lesions and widely metastatic. Such clinical circumstances are not accounted for by either the contiguous (Halsted theory) or the systemic (systemic theory) hypotheses and supports the idea that loco-regional therapies (surgery and radiotherapy) may be useful in some cases. So, it is obvious that the extent and the role of cancer surgery are direct consequences of our theoretical understanding of cancer natural history. The genetical, pathological and clinical heterogeneity of cancers suggest new theoretical approaches based on chaos and fractal theory.

Key words: oncology, theoretical models, in silico, fractal, chaos theory

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