Computer Simulation of Breast Cancer Screening Efficacy

Recent controversy over the age at which a women should begin mammographic screening, and at what screening interval, has underlined the need for better understanding in this area. Screening efficacy is traditionally studied using large scale clinical trials, an expensive and time consuming procedure. Furthermore, at a time of rapid technological development as mammography has experienced recently, the results of long clinical trials (such as the Canadian study) are difficult to interpret because the results are averaged over both new and older technologies. To complement clinical trials, we propose the use of computer simulation techniques to better understand screening efficacy, and to identify salient factors which are important in improving efficacy.

Computer simulation of breast cancer screening requires the development of several different sub-components to the model. The principal sub-components are: (1) the growth rate (and variability in the growth rate) of breast cancer, from a single cell to a macroscopic, detectable tumor, (2) the age-dependent probability of developing breast cancer, (3) the demographics (number of women versus age) of the population being screened, (4) the post-diagnosis prognosis, defining average survival versus time after diagnosis as a function of lesion diameter (etc.) at diagnosis, and (5) the detectability of breast cancer as a function of its size and other variables of the breast (breast density, breast thicknesses, role of calcifications, etc.). Many other factors are involved as well, including death-rate statistics, breast self examination (BSE) efficacy, ethnic variables, radiation risks, etc.

Once all the sub-components of model are mathematically parameterized, they are combined with Monte Carlo techniques to produce the screening model. When run, the model generates the life histories of "women", one by one, and statistics can be developed by running the model over millions of "women". As on overlay onto the model, different breast cancer screening methodologies can be incorporated. Mammography is the focus here, but other breast cancer screening tests such as blood tests, BSE, and MRI could be studied using similar techniques. The screening model can be re-run over and over, studying the effect of screening women starting at ages 50, 45, 40, 35, for example, and studying the effect of the screening interval as well. Because the exact same study population can be run through numerous life-spans with different screening strategies, the years-of-life-saved for each women can be tallied, and this forms the basis for evaluating screening efficacy.

The talk will discuss the overall approach towards computer modeling epidemiological data, and the details of each of the specific sub-components under development will be presented. Validation issues will be discussed. Results derived from the screening model will be presented which demonstrate the utility of the proposed methodology as a tool in breast cancer research. This work is still preliminary and the results need to be carefully verified; therefore, specific recommendations concerning breast cancer screening strategies will not be made.

Learning Objectives: To introduce participants to an analysis technique which may led to a better understanding of breast cancer screening, and how different parameters influence its efficacy.