James Michaelson, PhD

Director of the Laboratory of Quantitative Medicine, Member of the Departments of Pathology and Surgery at the Massachusetts General Hospital, and Associate Professor, Harvard University. His research concerns: the assembly of very large databases on patients; the development of improved mathematical methods for predicting cancer outcome; the analysis of patient outcome and cost; the analysis of cancer screening; the mathematics of growth; the mathematics of metastasis; the use of modern computer speech and telephony to design systems that improve patient compliance; and the development of advanced method for imaging cancer specimens.

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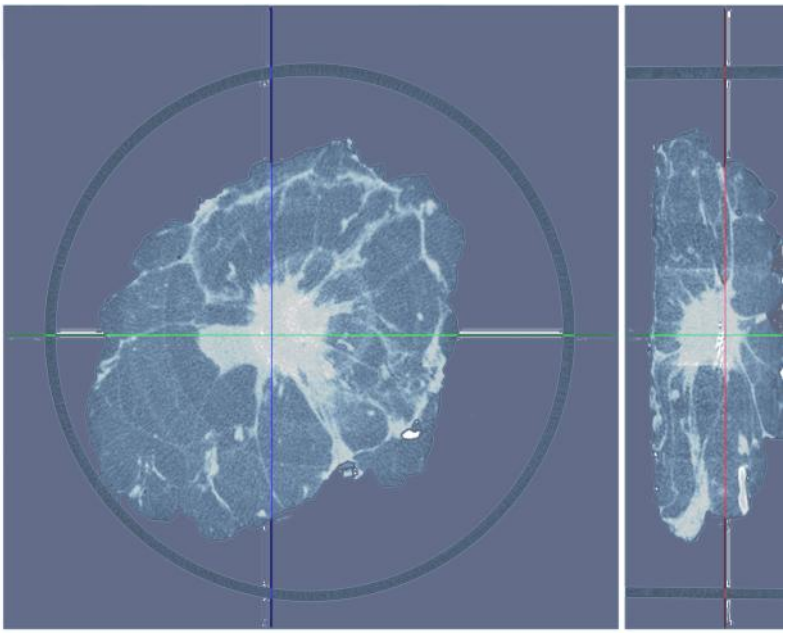

Micro CT in Medicine

The absence of real-time, detailed, 3D, information on the composition surgical specimens presents an enormous challenge in surgical oncology and pathology. The problem is especially pressing for breast cancer, where as many as ~1-in-3 patients undergoing lumpectomy have been found, upon pathological examination of the slides, to be margin positive. These patients need to return to the hospital for re-excision, sometimes multiple times, in order to achieve negative margins. A solution may be found in a relatively new technology, Micro CT, a high resolution X-ray imaging method, that has been widely used in industry and materials science, but little used in medicine. Over the past three years, we have imaged a great variety of surgical specimens with three Micro CT machines (a SkyScan 1173 Micro CT, an Xradia MicroXCT-200, and a Nikon Metrology XTH225). Our findings indicate the Micro CT is able to provide 3D images of surgical specimens, which can identify, within 10 minutes, most of those breast cancer patients later found to be margin positive on pathological analysis, as well as to identify a small number of patients whose cancers appear to be margin positive on Micro CT alone. Micro CT can also identify lymph nodes in cancer specimens, including nodes not detected by pathological dissection. These findings suggest that Micro CT has a considerable potential for providing the surgeon and pathologist with rapid, accurate, actionable information on the status of the surgical specimen while the patient is still in the OR.

James Michaelson PhD Accomplishments

 Multicellular Organization: Dr. Michaelson created a mathematical method, ***binary biology***, for modeling many macroscopic features of biology as the aggregate consequence of the innumerable single interactions of individual molecules and cells. He has used this approach to model normal and cancerous growth.[1]

 Cancer Outcome

- Dr. Michaelson used his ***binary biological*** math to create a mathematical framework for capturing cancer spread.[2]
- Dr. Michaelson derived an expression, the ***SizeOnly*** Equation (***L*=1-e^Q*D***) for characterizing the relationship between tumor diameter (***D***) and chance of cancer death (***L***)[3]
- Dr. Michaelson went on to develop a set of linked equations (***SNP*** method) for combining information on tumor size, cancer in lymph nodes, and other factors, into highly accurate and specific estimates of chance of death (***L***).[4-8]
- To test this mathematics, Dr. Michaelson built very large databases on cancer, including one with ~173,000 MGH patients, containing 44 million records, very possibly the largest source of clinical data on cancer in the world.
- He went on to develop of a series of web-based tools, the **cancermath.net** calculators, driven by the ***SNP*** method, used by more than 90,000 patients last year, and likely to be the most widely used cancer aid on the web.

 Cancer Screening

- Dr. Michaelson created a computer simulation model for cancer screening, which could can calculate the cancer survival rates, and years of life saved, that can be expected from various usage of screening.[9-20]
- Dr. Michaelson went on to carry out a number of very detailed studies on the operational performance of mammographic screening, and its negative consequences, as well as of screening for skin cancer.[10-24]
- These studies have been widely used to inform decision making on how best to use screening.
- Dr. Michaelson was asked, three years ago, to serve on the American Cancer Society (ACS) cancer screening guidelines committee[25], culminating, a few weeks ago, in their mammographic screening guidelines published in JAMA.[26] Dr. Michaelson was the senior member with the most experience in this area. This JAMA paper[26] elicited enormous interest, was the lead story on all three national TV network evening news broadcasts, all of the cable news shows, hundreds of newspaper, and countless local media outlets and television news programs, and Dr. Michaelson played a role in explaining these recommendations to the media.

 Growth

- In order to drive his computer simulation model of cancer screening, Dr. Michelson developed a new mathematical method to measure the growth rate of breast cancer, arguably still the most accurate such measure.[27]

Dr. Michelson developed a new method for measuring growth, ***the growth portion method***, which allowed him to discover the long-sought ***universal growth law*** for capturing the large-scale feature of growth from the fertilized egg to adulthood, where ***the rate of growth*=[ln(2)/C]*N*A^N^B**.

- Dr. Michaelson's new method for charactering growth, and the new growth equation found by this method, have a variety of practical applications, from developing methods for optimization in agriculture and aquaculture, assessing growth of human fetuses and children, understanding caner growth, and creating improved computer simulations models for determining the optimal ways to use cancer screening to lower the cancer death rate.

 Micro CT

- Dr. Michaelson adapted a relatively new technology, Micro CT, a high resolution X-ray based imaging method, which has been widely used in industry and materials science, but very little used in medicine, to the imaging of surgical specimens. As far as I am aware, Dr. Michaelson leads the only group in the world doing this.
- Dr. Michaelson has found that Micro CT can identify, within 10 minutes, those breast cancer patients that the pathologist later finds to be margin positive, as well as a small number of margin-positive patients that are never found by the pathologist to be margin positive. He has also found that Micro CT can provide valuable information on a whole range of other surgical specimens, including heart valves, liver and lung biopsies, failed implanted medical devices, and hearts. He found that Micro CT can identify lymph nodes in cancer specimens, including locating lymph nodes that are not detected by conventional pathological dissection. His studies have revealed that Micro CT has an important role to play in the analysis of surgical specimens[28-33]
- Dr. Michaelson has also used Micro CT to carry out ground-breaking studies on the 3 and 4 dimensional anatomy of Mollusks, Ctenophores, Eyes, and Livers.