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Advances in Optics are Redefining Health and Disease

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Imaging and sensing tools have catalyzed a paradigm shift in animal models of human biology and disease by enabling detection and visualization of the very small changes that precede the onset of symptoms. Traditionally disease has been defined at the time a patient becomes symptomatic, however, the advances in animal models has led to the development of clinical tools and methods with the potential for monitoring health and disease in humans that can detect changes early and even predict risk years or decades prior to symptoms. As these tools for assessing health risk are improving and are applied clinically, the threshold between health and disease will need to be redefined. If we use cancer as an example, current technologies for the detection of cancer lack the sensitivity for early detection at times when therapy would be most effective, and cannot detect minimal residual disease that persists after conventional therapies. To impact this disease, we will need to develop methods to sense and then visualize small numbers of cancer initiating cells and move from detection limits of 1 cm to 1 mm or even 100 μm diameter masses. Optical imaging has the sensitivity for this level of detection and there are a number of recent advances that will enable the use of optics in the clinic for cancer detection. New instruments based on micro-optical designs can be used to reach into the body to reveal microanatomic and molecular details that are indicators of early cancers. We are advancing the technologies that enable miniaturization of 3-D scanning confocal microscopes and Raman endoscopes to examine tissue in situ for early anatomic and molecular indicators of disease, in real time, and at cellular resolution. The advances in genomics is identifying markers of risk that can be used years or even decades prior to the onset of disease, and by identifying at-risk populations, the new tools in imaging can be used to determine onset and time to treat. The emerging combinations of risk assessment tools, methods for early detection and prognostication, and instruments that reveal disease states in finer detail serve to provide greater information to clinicians for more informed, and directed therapies. These advances are redefining the threshold that separates health from disease and are catalyzing a change healthcare.

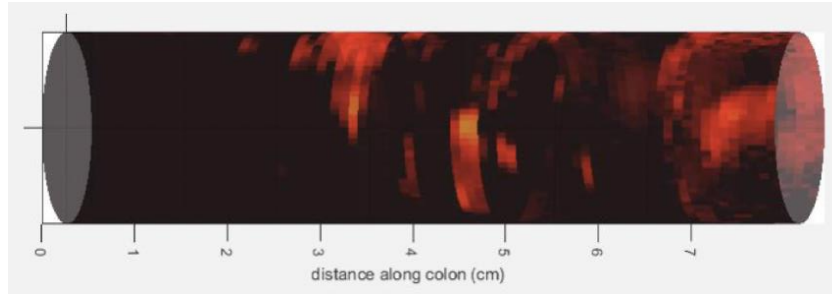


Fig. 1. Colon cancer detection along the length of the rat colon (1)

Reference

- [1] S. Harmsen et al, *ACS Nano*. **In Press** (2019)