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Image-Guided Therapies: From Fundamentals to New Frontiers

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Concurrent advances in medical imaging, therapeutics, and understanding the biological basis of disease progression and treatment response point convincingly to a transformative approach to medical interventions in the decades ahead. Such interventions are marked by a dramatic increase in the utilization of image information from multiple modalities and demand accurate coregistration of structural and functional information across a broad range of spatial and temporal scales. The scope of advanced therapeutic approaches enabled by such advances is broad, ranging from high-precision image-guided radiation therapy and surgery to minimally invasive target ablation, cell-based therapies, and other forms of novel therapeutics. Moreover, the information acquired during the course of information will drive patterns of therapy delivery that are increasingly adaptive and patient-specific. This symposium focuses on the scientific principles of imaging, guidance, treatment delivery, and feedback / adaptation in the context of advanced medical interventions and looks ahead to new technologies being developed for novel image-guided therapies. Four expert speakers have been invited to present on topics central to such advancement: Dr. Siewerdsen will discuss principles of imaging performance, imaging task, and new imaging technologies; Dr. West will address principles of geometry, registration, and uncertainty (e.g., target registration error) in relation to real-time tracking and navigation; Dr. Sherar will discuss a broad spectrum of technologies for therapeutic delivery, including physical, molecular, chemical, and cellular means by which a therapeutic insult can be delivered to disease under image guidance; finally, Dr. Yan will describe principles of feedback and control in the development of adapative therapies. Together, these topics present a “closed-loop” in issues of imaging, navigation, therapy delivery, and adaptation that are central to the advancement of image-guided interventions.