molecular pharmaceutics

editorial

Image-Guided Therapeutics

Molecular, functional, and structural imaging span all clinical areas and are key technologies that enable health sciences research and advance clinical care. In particular, imaging has been playing an increasingly important and transforming role in therapeutic applications, leading to unique opportunities in a new area, the so-called "image-guided therapeutics". This approach has been making its way to the forefront of many basic and translational research areas, including pharmaceutics research. Image-guided therapeutics integrates knowledge and approaches in multidisciplinary fields such as cell and molecular biology, chemistry, and engineering and physics, and has opened up vast opportunities in pharmacokinetics, therapeutic target discovery, drug delivery research, and quantification of multiple biomarkers in disease.

As summarized in Figure 1 and illustrated on the cover of this special issue of *Molecular Pharmaceutics* on image-guided therapeutics, imaging and image-guidance can play a major role in numerous aspects of pharmaceutical research. Early stages of research and development can benefit from rapid, noninvasive longitudinal (and potentially high throughput) imaging assessment of agent pharmacokinetics (PK) and pharmacodynamics (PD), and can in many cases improve the *in vitro*−*in vivo* correlations (IVIVC) of parenteral delivery systems such as local, sustained-release implants. On the application optimization side, treatment planning, guidance of local implantation, modulation of drug activation or release with an eternal force, and therapy assessment all without invasive, cumbersome procedures have the potential to expedite the research and FDA approval processes. These approaches can also revolutionize patient care by customizing therapy to the individual patient, minimizing the invasiveness of many procedures and obtaining rapid feedback on the effectiveness of the therapy.

One objective of imaging-guided therapeutics is to enable, through the development of imaging probes and technological advances, the early detection of molecular events that precede symptomatic expression of a disease process. In addition, imaging probes and technological advances can also be developed to enable early biomarkers of therapeutic intervention. Rapid progress has been reported in the development for early detection of markers in the areas of cancer, neuroscience, cardiovascular, inflammatory, and metabolic diseases. However, translation of these novel discoveries into clinical impact needs a concerted effort of biologists, clinical scientists, radio

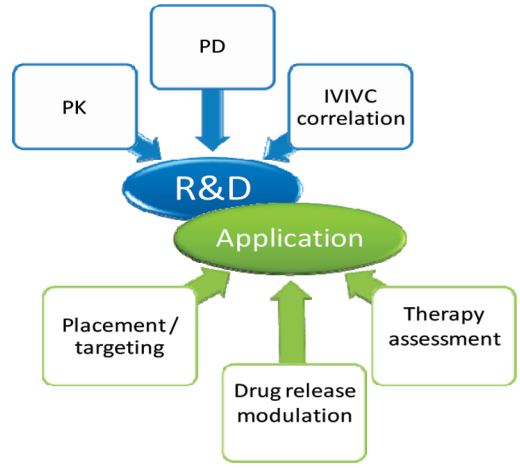

Figure 1. The role of image-guidance in drug discovery and delivery spans the gamut of techniques facilitating research and development (R&D) (PK, pharmacokinetics; PD, pharmacodynamics; IVIVC, *in vitro*−*in vivo* correlation).

and medicinal chemists, and imaging scientists. In particular, the development of imaging probes utilizing new molecules and immunological reagents (antibodies) targeted to a specific molecule or molecular event is a critical step to enable undertaking these endeavors.

By far, most of the image-guidance techniques have been utilized in the field of oncology. This special issue of *Molecular Pharmaceutics* on image-guided therapeutics features articles on oncologic applications, providing various examples showcasing new developments in drug delivery research. Because the success of cancer chemotherapy typically hinges upon circumventing dose-limited toxicity, ideally a drug should act as a "magic bullet" that possesses perfect specificity to cancerous cells and has no effect on the rest of the body. In reality, while most anticancer agents have the potential to be effective at sufficiently high doses, these doses are often associated with severe systemic side effects that cannot be tolerated. To circumvent this, many image-guided approaches have been implemented in areas ranging from new therapeutic target discovery to effectively monitoring tumor pharmacokinetics and drug distribution to modulation of drug release at the target site.

The featured articles in this special issue focus on work in the development of various platform techniques and

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particularly carriers that strive to achieve multifunctionality for site- and event-specific targeting, better utilization of appropriate imaging modalities including MRI, ultrasound, optical, and PET, as well as employing endogenous and exogenous controlled release mechanisms such as ultrasound mediated mechanical effects and thermal effects. These works span from initial demonstration of feasibility and efficacy in cell culture *in vitro* to preclinical small animal *in vivo* studies with quantitative results, revealing great potential and intriguing opportunities for future development.

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