Quantitative Systems Pharmacology:
Application to translational research and personalized/precision medicine

Jessie Lai-Sim Au, Pharm.D., Ph.D.

Founding Director, Institute of Quantitative Systems Pharmacology
Research Professor & Mosier Endowed Chair in Pharmaceutical Sciences, Univ. of Oklahoma
Chair Professor in Systems Pharmacology, Taipei Medical University
Distinguished University Professor Emeritus, The Ohio State University
Chief Scientific Officer, Optimum Therapeutics LLC

A major goal in academic biomedical research is to translate laboratory-based discoveries to clinically useful treatments. The recent advances in molecular medicine have provided the impetus for personalized medicine, and have led to successful development of new agents targeting molecular or genetic lesions. To date, most of the efforts have focused on using genomic information. The current presentation discusses quantitative systems pharmacology (QSP), an emerging research field, that has the potential of enabling precision medicine and eliminating the uncertainty in translational medicine.

Successful therapy requires delivering the right drug to the right target at the right concentration and at the right time, so that the right effect is achieved and off-target effect is minimized. Targeted therapy matches the drug's intended target to the patient's molecular signature. The remaining requirements are met if the drug delivery to the target site is aligned with the time course of drug actions (pharmacodynamics).

QSP is transdisciplinary, encompassing biology, physical and clinical sciences, and engineering. The goal is to use computation to quantify and integrate biological properties (e.g., cell cycle position dictates the response to phase-specific chemotherapeutics, copy numbers of resistance genes determines the effective drug concentrations), drug transport (e.g., to affected organs, cells, intracellular organelles), and population pharmacokinetics and pharmacodynamics, in order to depict and predict clinical trial outcomes.

This presentation will use two of our projects as examples. The first example shows the development of a bladder cancer treatment (randomized phase III trial completed). The second example shows an onoging project that uses a specialized drug/siRNA delivery system to treat peritoneal diseases (IND stage).

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BIOGRAPHY

Dr. Jessie Lai-Sim Au received her Pharm.D. and Ph.D. degrees from University of California San Francisco. From 1983-2013, she was at The Ohio State University where she became its first woman full professor in pharmacy, and served as Translational Research Director and Deputy Director of comprehensive cancer center. Dr. Au is currently Chief Scientific Officer of Optimum Therapeutics LLC, Founding Director of Institute of Quantitative Systems Pharmacology, Research Professor and Mosier Chair of Pharmaceutical Sciences at University of Oklahoma, Chair Professor of Systems Pharmacology at Taipei Medical University, Adjunct Professor of Surgery at Medical University of South Carolina, and Distinguished University Professor Emeritus at OSU.

Dr. Au's research integrates physical, biological and clinical sciences, with the goal of optimizing drug delivery, target site pharmacokinetics and pharmacodynamics in solid tumors, and treatment outcomes in cancer patients. She has translated her laboratory findings to phase I/II/III clinic trials. One of her projects has led to a new treatment for bladder cancer that is being used in the community, and several other projects are in clinical developments. In her academic roles, Dr. Au recognizes a critical need of interdisciplinary translational researchers to achieve the goals of personalized and precision medicine as well as greater success in new drug development, and has recently launched a new graduate program in quantitative systems pharmacology.

Dr. Au has received research awards from the National Cancer Institute (Research Career Development Award, MERIT Award) and American Association of Pharmaceutical Scientists (Research Achievement Award). Dr. Au is Fellow of American Association of Advancement of Science, Fellow of AAPS, and is profiled on AAPS Distinguished Pharmaceutical Scientist panel. Dr. Au has served on government, academic and industry advisory panels, and is a member of FDA Clinical Pharmacology and Pharmaceutical Sciences Advisory Committee and NIH Biomaterials and Biointerfaces Study Section.