In recent years, there have been great advances in mathematical and computational modeling of cardiovascular phenomena. The ultimate goal has been to develop predictive mathematical tools that can be used in medical decision-making and treatment. There have been notable successes in some areas; for example, extensive numerical simulation is used in some hospitals to plan pediatric heart surgery. However, further progress is needed for the use of mathematics-based clinical methods to become widespread and routine. Additional advances will require close communication and collaboration between mathematical scientists and physiologists in order to guide further developments most effectively.

Held January 20-24, 2014 the ICERM workshop "From the Clinic to Partial Differential Equations and Back: Emerging challenges for Cardiovascular Mathematics” brought together physicians, mathematicians, engineers and computer scientists to address modeling challenges in cardiovascular medicine. The workshop organizers represented a broad range of research communities, including industry, medical clinics, and government laboratories as well as university departments of engineering, computer science, and mathematics. Researchers from 10 countries (USA, Brazil, Spain, Italy, Switzerland, India, Sweden, France, UK, and Canada) representing over 40 research institutions participated in the workshop. The diverse backgrounds of the participants and their multi-disciplinary views of biomedical modeling contributed to the workshop's unique "flavor."

The mix of distinct but related disciplines was fundamental both to enriching the range of expertise among the participants and to looking at challenging problems from different perspectives. Posing challenges for the mathematics community and stimulating discussions, clinicians described a variety of medical problems in cardiovascular physiology. Issues raised
included aneurysm formation, vascular inflammation, cardiac resynchronization therapy, coronary plaque progression, and decision-making in neuroradiology. Mathematical scientists presented work on cardiovascular applications that included multi-scale dynamics, fluid-structure interaction, shape and parameter optimization, model order reduction, data assimilation, uncertainty quantification, sensitivity analysis, and simulations on massively parallel computers.

Nearly all participants reported that they made new scientific connections during the workshop. One example is a new collaboration aimed at developing computational models to study hydrodynamic gene delivery to the liver, which can potentially be applied to cure important genetic diseases.

For more information see https://icerm.brown.edu/tw14-1-pdecm.