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From particulate processes to *in vitro* fertilization modeling and optimization

In-vitro fertilization (IVF) is a treatment process for infertility by which oocytes or egg cells are fertilized by a sperm outside the body in a laboratory simulating the similar conditions in the body, and then the fertilized eggs are implanted back into the uterus for full term completion of pregnancy. IVF is divided into four stages, namely: Superovulation, egg collection, insemination/fertilization, and embryo transfer. Superovulation is an important step in IVF and involves the production of multiple eggs using drug induced stimulation. In normal female body only one egg is ovulated per menstrual cycle, but with the use of fertility drugs and hormones, a number of follicles (eggs) can be produced per cycle. This involves daily injections of drugs/hormones and daily monitoring of number and size of eggs produced. The success of IVF depends on the quality and quantity of eggs produced in the superovulation stage. The drug delivery per day depends upon the distribution of egg size obtained previous day. Hence close monitoring is involved. The cost of drugs and monitoring makes this stage very expensive stage in the IVF cycle. Particulate processes like crystallization are well-understood phenomena which involve models of particle size distribution. In this work, we use the analogy between particulate processes like crystallization to derive customized models for IVF patients. The first two days of follicle distributions for each patient are used to develop the model for the effect of hormones on the size distribution as the treatment progresses. Optimal control theory then is applied to find optimal dosage of hormones for each patient. It has been shown in our theoretical analysis and preliminary clinical trials in India that this approach reduces daily monitoring to a minimum. This approach also reduces the total drugs given to patient significantly with better outcomes of superovulation stage. In future, we will be conducting a large scale clinical trial with this approach in the United States. This new way of modeling biomedical processes with size distribution can be applied to other diseases like Cancer treatment.

Biography

Urmila M Diwekar is the President and Founder of the Vishwamitra Research Institute, a non-profit research organization. From 2002-2004, she was a full Professor in the Departments of Bio, Chemical, and Industrial Engineering and the Institute for Environmental Science and Policy, University of Illinois at Chicago (UIC). She was the first woman full Professor in the history of UIC's Department of Chemical Engineering. From 1991-2002 she was on the faculty of the Carnegie Mellon University (CMU), with early promotions to both the Associate and Full Professor levels. In Chemical Engineering, she has worked extensively in the areas of simulation, design, optimization, control, stochastic modeling, and synthesis of chemical processes.

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