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Patient specific modeling of the heart as a tool for early diagnoses and treatment planning.

The perspective for Patient Specific Modeling (PSM) is to create and develop medical decision system based mathematical modeling of the underlying mechanisms and statistics. We will give an example of PSM of the function of the heart including a discussion of patient specific parameter estimation based on the model in combination with new individual patient data obtained from MR measurements of various relevant blood volumes (and flows). Such parameters will characterize the state of the patients in far more details than clinical investigations unveil today. Thus these parameters will define diagnosed heart illnesses in a refined manner and pinpoint exactly where in the physiological system malfunctioning appears. This opens up for early diagnoses and individual treatments targeting the actual malfunctioning part of the physiological system.

Recently precise and detailed volume data have become assessable by help of MR scanning and imaging technologies. The associated finding confirm earlier results except that atria volumes may show one hump or two hump and all intermediate configurations in between during one heart cycle. These findings are reflected in the corresponding ventricle volume curves but are not so pronounced. In addition, these curves vary very much with the condition of the contractile strength of the atria and ventricles and thus it become reduced in cicatrical myocardial tissue (after an infarction) and with the condition of the heart valves.

Data from 40 subjects encompass left atria volume, left ventricle volume, right atria volume, right ventricle volume, flow from left ventricle into aorta, and flow from right ventricle into pulmonary aorta versus time during one heart cycle. Data was recorded for objects at rest and for objects given dobutrex and robinul as well.

Our model describe preload to atria, atria itself, ventricle, and afterload for left heart using ordinary differential equations. Based on data, sensitivities on and correlation between the model parameters will be investigated and parameter estimation on a meaningful subset will be performed. Thus various pathologies, including decreased contractile capacities and stenosis, will be categorizes in terms of the model parameters.