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Life or death decision-making: The medical case for large-scale patient-specific medical simulations

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Abstract: Patient-specific medicine is the tailoring of medical treatments based on the characteristics of an individual patient. Decision support systems based on patient-specific simulation hold the potential of revolutionising the way clinicians plan courses of treatment for various conditions, such as viral infections and lung cancer, and the planning of surgical procedures, for example in the treatment of arterial abnormalities. Since patient-specific data can be used as the basis of simulation, treatments can be assessed for their effectiveness with respect to the patient in question before being administered, saving the potential expense of ineffective treatments and reducing, if not eliminating lengthy lab testing procedures which typically involve animal testing.

For patient-specific medical simulations to become a daily reality in the treatment of patients, various problems in the technical, clinical and policy domains need to be addressed. There are various themes that are common to the various clinical uses of patient-specific medical simulation. They require access to both appropriate patient data and the computational and network infrastructure on which to perform potentially very large-scale simulations. The computational resources required are supercomputers, machines with thousands of cores and large memory capacities capable of running simulations within the time frames required in a clinical setting; the validity of results not only relies on the correctness of the simulation, but on its timeliness. Existing supercomputing site policies, which institute fair share system usage, are not suitable for medical applications as they stand. To support patient-specific medical simulations, where life and death decisions may be made, computational resource providers much have infrastructure in place that can give urgent priority to such jobs, through job pre-emption and advance reservations.

In this presentation, we will explore these themes in relation to three distinct patient-specific biomedical projects currently taking place: the patient-specific modelling of HIV/AIDS therapies, cancer therapies, and addressing pathologies in the vascular structure of the human brain.