Sim-e-Child

A grid-enabled pan-Atlantic platform for large-scale simulations in paediatric cardiology

Sim-e-Child is providing a collaborative environment for multi-scale and personalized models of the growing heart and vessels including computational fluid dynamics for blood flow simulations. It operates as an extension of the Health-e-Child grid-enabled platform and interconnects the Health-e-Child databases with new data from US multicenter studies.

Objectives of the project

The FP7 Sim-e-Child (SeC) project is developing a grid-enabled platform for large scale simulations in paediatric cardiology, providing a collaborative environment for constructing and validating multi-scale and personalized models of a growing heart and vessels.

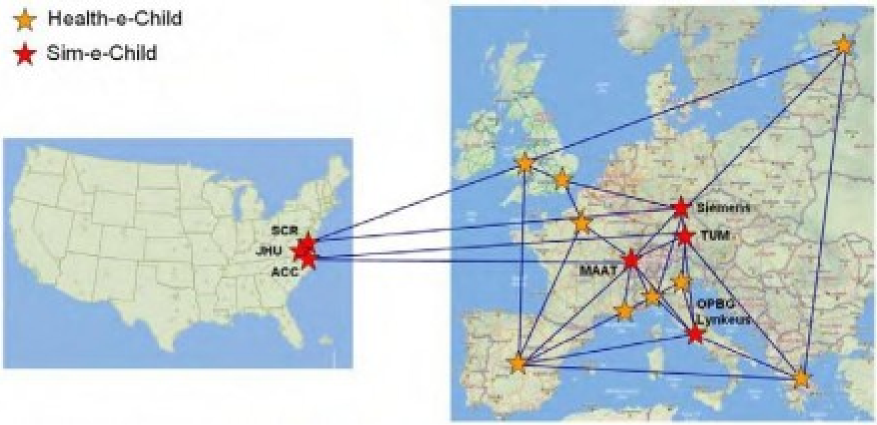
The objective of Sim-e-Child is to strengthen the impact of the Health-e-Child project by creating an international simulation and validation environment

SeC was designed to establish international cooperation, by linking the EC funded FP6 Health-e-Child (HeC) project with leading institutions such as the American College of Cardiology, Johns Hopkins University, Technical University of Munich, and Siemens Corporate Research. SeC is an extension of the HeC platform that:

- Interconnects the HeC database with new data from US multicenter studies;
- Enhances and expands the HeC heart model with existing models of the aorta, aortic valve and mitral valve, and, in particular, with computational fluid dynamics for blood flow simulations;
- Integrates the HeC Gateway and Case Reasoner with versatile tools for simulation workflow composition and sharing of scientific experiments.

The objective of SeC is to strengthen the impact of the HeC project by creating an international simulation and validation environment for paediatric cardiology, supported by integrated data repositories.

The project will advance the state-of-the-art by providing comprehensive and patient-specific models for the dynamic and longitudinal interactions occurring in the left heart, with a focus on the congenital aortic arch disease and repair.



Project Description

The FP7 SeC STREP started work in January 2010 as a follow-up to the FP6 HeC IP. As an early member of the Virtual Physiological Human (VPH) research community, the HeC project worked for over 4 years to build an integrated healthcare platform for paediatrics.

The Sim-e-Child project is developing a grid-enabled platform for large scale simulations in paediatric cardiology

The HeC platform utilised the EGEE gLite grid middleware to integrate innovative predictive disease models, complex data visualization and knowledge discovery applications, with the ultimate goal of supporting clinical decision making.

SeC is extending the VPH work successfully carried out by HeC in cardiology and in developing a Grid powered eHealth platform in three major ways.

1. With the support of the American College of Cardiology and Johns Hopkins, SeC is validating HeC's heart modelling capabilities using ongoing clinical US trial databases (the Coarctation Of the Aorta Stent Trial [COAST] and the National Registry of Genetically Triggered Thoracic Aortic Aneurysms and Cardio vascular Conditions [GenTAC]) in collaboration with the Bambino Gesù Paediatric Hospital (OPBG) in Italy.

2. The HeC models are being expanded by integrating and enhancing existing Siemens Corporate Research models of the aorta, aortic valve and mitral valve.

Case study: Coarctation: Predict risk of stent re-stenosis

In the treatment of aortic coarctation, angioplasty with stenting is a minimally invasive alternative to surgery. However, despite the appropriate indications for the stent therapy are followed, recurrent obstruction due to intimal proliferation still occurs. Non-linear pre- and intra stent blood flow in heterogeneous aortic arch morphologies are supposed to contribute to stent-related pathology. Patient-specific computational fluid dynamic simulation is therefore expected to reveal correlations between morphology of the aortic arch and the related flow pattern with the recurrent obstruction, possibly leading to clinical implications on the decision taking between surgery and stent placement.

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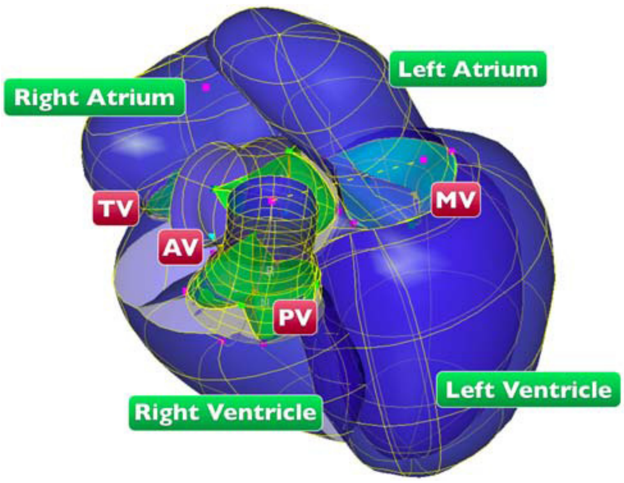
The heart valves represent a critical component for the multiscale modeling, simulation, understanding and prediction of the whole heart function and this work represents the first data-driven modeling of the complete valvular apparatus.

SeC is extending the VPH work successfully carried out by HeC in cardiology and in developing a Grid-powered eHealth platform

Furthermore the final models will include blood flow modelling and flow visualization from the Technical University of Munich. The new and comprehensive heart model will be applied to congenital aortic disease, thus enriching the portfolio of applications available on the HeC platform.

3. To support these activities, SeC is working to developing a grid-enabled platform for large scale simulations in paediatric cardiology, by integrating the HeC's Gateway and CaseReasoner (HeC's application for similarity search and decision support) with tools for simulation workflow composition and sharing of scientific experiments. This integration work is leading to the development of a collaborative environment for constructing and validating multi-scale and personalized models of a growing child's heart and vessels. Advanced clinical measurements will be derived, such as blood flow vorticity, wall shear stress, elasticity, distensibility, stiffness, and fluid structure interactions. The models in development will allow the simulation of interventions on morphology, dynamics, and haemodynamics of the aorta to make personalized predictions of optimal therapy.



Expected Results & Impacts and Preliminary Results

SeC is impacting on the way health knowledge is formalized, acquired, understood, represented, analysed, communicated and validated in paediatrics. Thanks to the accrued investments made by the EC in the area of grid-enhanced computational capacities, it will become possible to allow large-scale patient-specific simulations utilizing computationally intensive data-driven models of the full heart and aorta with fluid dynamics and biomechanics. This capacity is based on aligned clinical databases in both the EU and the US, showing that not only the current lack of uniform clinical definitions/formats, which normally impedes electronic representation, transfer, and aggregation of much patient information, can be overcome, but also that testing new potential decision support tools can be performed on a cooperative basis across the Atlantic.

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- Ospedale Pediatrico Bambino Gesù, (Italy)
- Siemens Corporate Research, (USA)
- Johns Hopkins University, (USA)
- American College of Cardiology, (USA)
- Siemens Program and System Engineering (Romania)

Timetable: from January 2010 to June 2012

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Instrument: STREP

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KEYWORDS
Clinical applications; Decision support systems; Grid technologies; In silico simulation; International research cooperation; Interoperability of health data; Medical image processing and analysis; Semantic integration of health data; Virtual physiological human