Cloud-Based HPC Platform to Support Systemic-Pulmonary Shunting Procedures

Organizations

InSilicoTrials Technologies SpA is an SME that promotes innovation and commercializes in silico tools for healthcare through a cloud-based platform.

RBF Morph is an ISV that develops the RBF Morph software and is an expert in CFD and FEA.

Fondazione Toscana Gabriele Monasterio is a healthcare public entity, a leader in the field of cardiology, cardio-surgery including congenital heart defects.

RINA Consulting provides a wide range of services covering the whole project life cycle from feasibility and specialized technical studies to conceptual and detailed design, prototyping and testing, project management, site engineering as well as operation and maintenance management.

CINECA is the largest Italian supercomputing centre with an HPC environment equipped with cutting-edge technology and highly qualified personnel which cooperates with academia and industrial partners.

End User	ISV	Application Expert	Technology Expert	HPC Centre & Provider
InSilicoTrials	rbf™	Fondazione Monasterio la ricerca che cura	RINA	CINECA

Partner CINECA is part of the NCC Italy. EUROCC ITALY

The Challenge

InSilicoTrials Technologies and RBF Morph offer a portfolio of software and services to clinics & medical research. To expand its business, the experiment consortium decided to work in the challenging field of Congenital heart disease (CHD). CHDs account for nearly one-third of all congenital birth defects and represented the 7th cause of death in children younger than 1 year in 2017. Without the ability to alter the prevalence of CHD, interventions and resources must be focused on improving survival and quality of life. In this context, the Modified Blalock Taussig Shunt (mBTS) is the most common palliative operation performed. Despite being simple in concept, it is associated with significant morbidity and mortality, the most threatening and lethal complications being over-shunting and shunt thrombosis. A computational simulation of effects could support the medical decision, yet this requires substantial know-how and computing power, in order to provide high-quality results and the subsequent surgery in a short timeframe.

Pressione (mmHg): 61, 30, -0.9
WSS (Pa): 290, 145, 0
Velocità (m/s): 3.8, 1.9, 0.0

MBTS · MBTS_cXY · MBTS_cZY
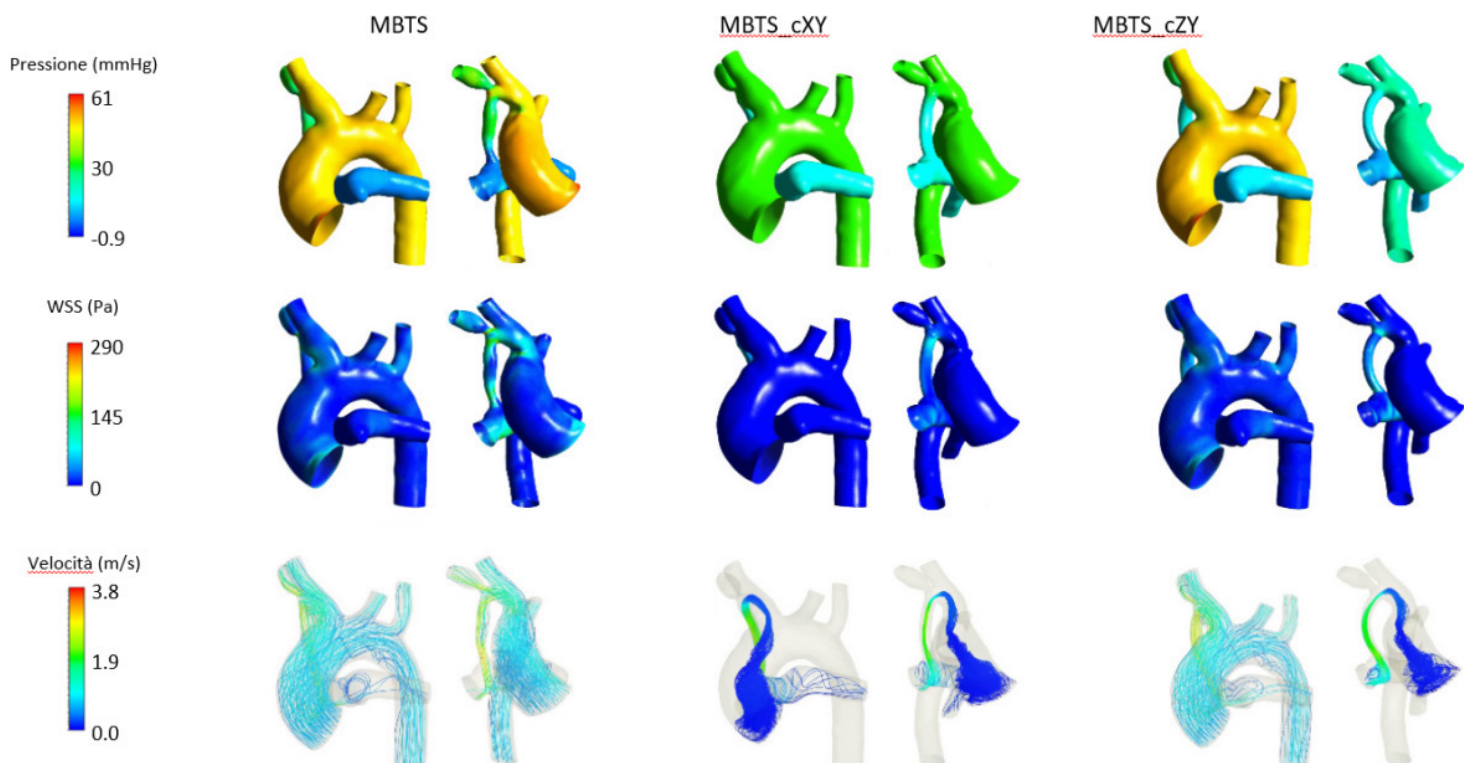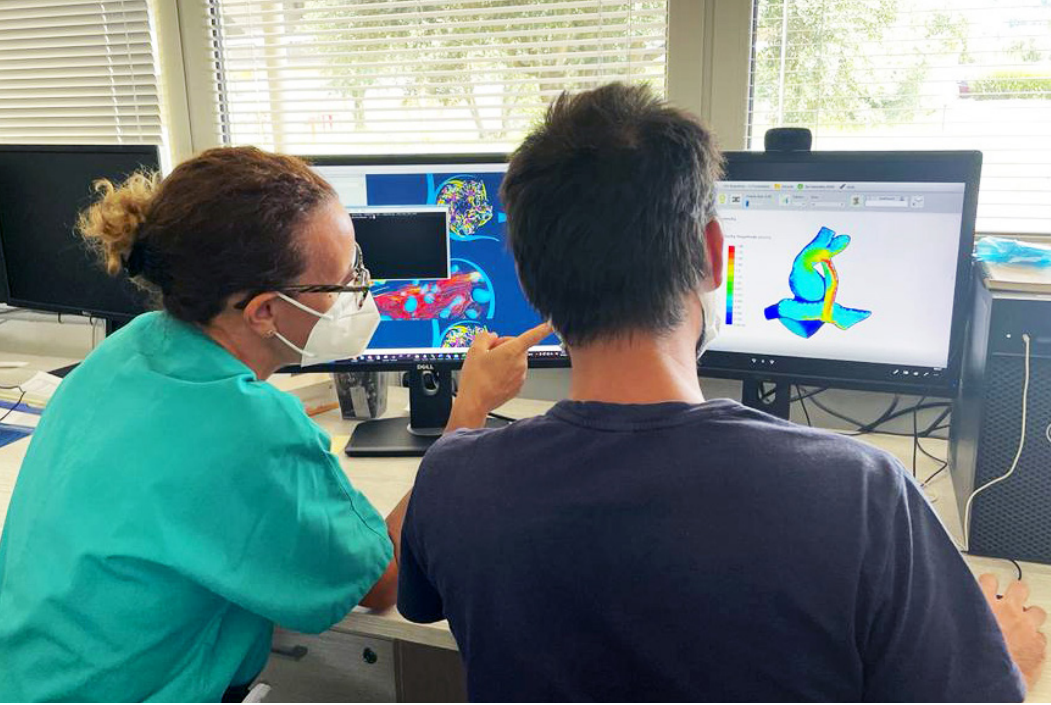
The Solution

The partners generated an affordable decision support web application named Copernicus that, thanks to a "medical digital twin" (MDT), allows surgeons to optimally approach the mBTS medical intervention. Generally, simulating the effect of such a surgery on blood flow requires complex computational fluid dynamics computations using HPC. Typically, effective use of such computations in the field of pre-operative planning is still far from clinical practice, not least because of the specialist know-how needed to run them. Copernicus circumvents these problems by generating the MDT through a Reduced Order Model of a patient-specific vascular district, condensing complex and costly pre-loaded computations such that a geometrically parameterised shunt implantation can be used interactively to vary its dimension and positioning. With a dedicated user interface, the medical staff is thus able to inspect the MDT of the patient and observe how the shunting layout influences the fluid dynamics of the involved impacted area, helping to finalise the decisions on surgical intervention. The use of HPC significantly reduces the time to carry out computing the demanding pre-loaded analysis backing the MDT, a speed-up which is crucial, because important decisions for mBTS preparations must be made in a short time, typically 2 days at worst in the case of complicated morphologies.

The Impact

The impact of the solution proposed by Copernicus at the clinical level is highly relevant: The combination of speed and interactivity permits surgeons to find the best treatment option for CDT, thus lowering the incidence of post-surgery complications and reoccurrence, leading to a decrease in the days of hospitalisation of treated patients and related costs. For Fondazione Toscana Gabriele Monasterio, this could mean savings in the order of over €100,000 per year. InSilicoTrials Technologies will add the tool to its portfolio, pursue certification for clinical use, and commercialise it on the market through a SaaS approach, with shares held by RBF Morph and RINA Consulting, and using CINECA's HPC system as a backend. In addition, both RBF Morph and RINA Consulting will use the results to increase their presence in the healthcare market: RBF Morph by offering new functionalities in their software library, and RINA Consulting by offering consulting services backed by hardware and software leasing to medical device manufacturers and medical research clinics.

Benefits

- InSilicoTrials Technologies: Reach new clients by selling a single service per clinical use after the achievement of software certification (mid-2024), generating an increase in annual turnover of about €450,000 after 4 years.
- Clinicians: Improve surgery outcome, reducing hospitalization per patient by 5-6 days on average. In the case of FTGM, savings of more than €100,000 per year are expected.
- RBF Morph: Expected increased annual turnover 4 years after the experiment is €250,000 with the increase of 2 qualified jobs/year.
- RINA Consulting: The overall expected increased annual turnover 4 years after the experiment: €200,000.
- CINECA: Additional business as HPC supplier (€30.000 by 2026).