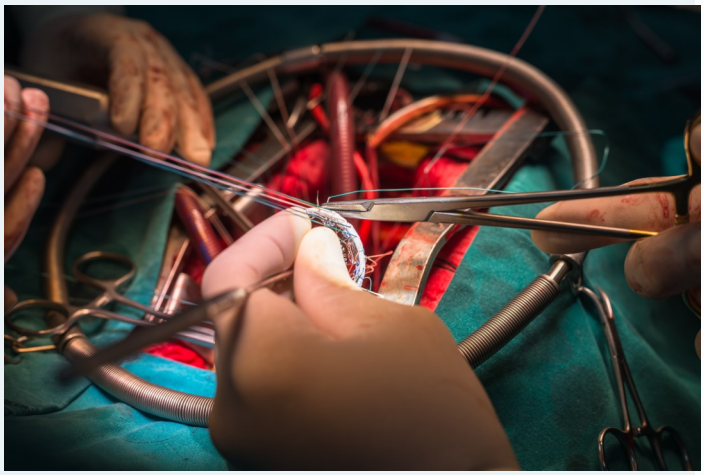
EurValve Project Newsletter

Project Update and News

Issue 4 ● June 2018

Progress Report:

The EurValve project is now in its final year.



Prospective data collection: The prospective data collection is nearing completion. We have collected data and images on our recruited patients from all 3 clinical centres: Eindhoven, Berlin and Sheffield.

Deliverables: 21 out of 31 deliverables have been submitted.

Activity Monitoring: EurValve developed a kit to collect data in the homes of recruited patients having valve interventions over the course of their treatment. Using signal processing and machine learning techniques, this data can be transformed into both activity and location information. The data analysis system is applied to real patient data collected in Sheffield.

In addition to the use of this activity monitoring kit, EurValve has also been using the Philips Health Watch for data collection in its clinical studies in all three clinical centres, Berlin, Eindhoven and Sheffield. Tools developed in EurValve make use of the Health Watch data– two apps for retrieval of watch data for the clinical studies and an automatically generated, comprehensive clinical report on watch data including information derived from it. The data gives unique information on the recovery from valve replacement surgery and is currently being analysed.

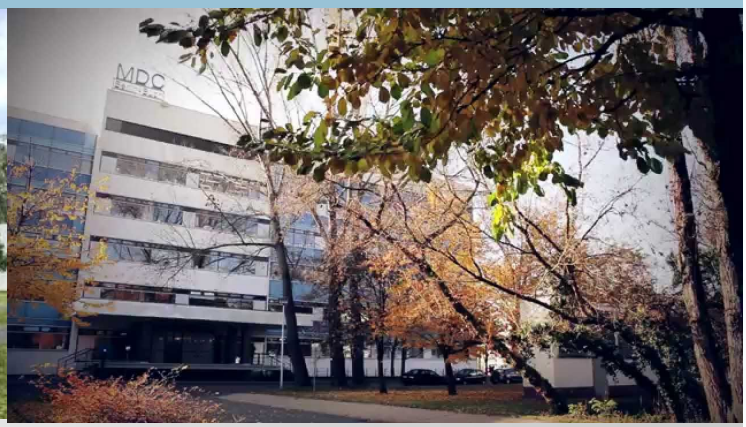
Inside this Issue

www—For further information check out the EurValve website at eurvalve.eu

Beneficiary Profiles

Each edition of the EurValve newsletter will contain profiles on selected beneficiaries. In this edition, we feature Max Delbrück Centre for Molecular Medicine, Philips Eindhoven, Philips Hamburg and Therenva.

Beneficiary Profile – Max Delbrück Centre for Molecular Medicine



MDC MAX-DELBRÜCK-CENTRUM FÜR MOLEKULARE MEDIZIN IN DER HELMHOLTZ-GEMEINSCHAFT

The MDC is a major biomedical research institute. It is the leading Helmholtz centre for cardiovascular research and the leading institute of the recently founded DZHK, the new primary structure for cardiovascular research in Germany. In 2009 and 2013, the MDC's cardiovascular and metabolic research was rated 'outstanding' by an international expert panel. Major state-of-the-art technologies established at the MDC include high-throughput genomic analyses, microscopic imaging, magnetic resonance imaging, the generation, breeding and phenotyping of genetically modified rat and mouse models. The MDC has strong research in mathematical modelling and has state of the art high performance compute capacity, which will be used for cell simulations.
In the EurValve project, MDC will provide the proteomic data from patient samples for the whole consortium, and detailed cellular mathematical models for and simulations of excitation-contraction coupling parameterised by the proteomic data.

Martin Falcke is the principal investigator coordinating proteomic analysis and cellular simulations of excitation-contraction coupling and their integration into other model components.

https://www.mdc-berlin.de/

Beneficiary Profile – Philips Electronic Nederland B.V.

Royal Philips is a diversified health and well-being company, focused on improving people's lives through meaningful innovation in the areas of Healthcare, Consumer Lifestyle and Lighting. Headquartered in the Netherlands, Philips employs approximately 115,000 employees with sales and services in more than 100 countries. The company is a leader in cardiac care, acute care and home healthcare, energy efficient lighting solutions and new lighting applications, as well as male shaving and grooming and oral healthcare.

The Global Research Organisation plays an important role in innovation and produces more than half of the patents that Philips files. R&D activities of Philips Research have led to the publishing of thousands of technical and scientific papers. In terms of publications, Philips ranks 4th among Europe's most important and actively publishing research institutions. In Europe, 4 labs employ about 1250 people. More than half of these people work in the Dutch Philips Research Laboratory, which is part of the High Tech Campus in Eindhoven. The Chronic Disease Management department of Philips Research, Eindhoven is composed of 51, mainly post-doctoral, scientists and performs research in the areas of clinical and home healthcare applications and in particular on care planning and management and on telehealth. This group has expertise in machine learning, reasoning and decision support technologies.

In the EurValve project, Philips Research Eindhoven provides a software module, based on machine learning and on clinical knowledge obtained from the literature, to infer data that is not available but required for using computational, physiological models for personalised valve disease decision support. Philips Research Eindhoven has also provided the Philips Health Watch—a monitoring device for the clinical trial.

Herman ter Horst is a Principal Scientist and works on decision support in healthcare applications with special focus on algorithms that realize machine learning and knowledge representation and reasoning. He has been working on this topic in Philips-internal projects and also in a number of European projects.

https://www.philips.com/a-w/research/locations/eindhoven.html

Beneficiary Profile – Philips GMBH

The German Philips Research Laboratory is based in Hamburg and has about 100 employees, focused in the healthcare area. Its Digital Imaging department is composed of 58, mainly post-doctoral, scientists and performs research in the areas of X-ray imaging physics, image processing for all major modalities (CT/ MR/ US/ X-ray/ NM) and development of new applications covering diagnosis and treatment in cardiology, oncology and neurology. A specific technology developed in this group with a number of important commercial applications is model-based segmentation.

In the EurValve project, Philips GMBH provides model and software to compute biomarkers relevant for valve disease that are the basis for patient specific simulations.

Jürgen Weese is a Research Fellow and was overall coordinator of euHeart. He works on medical image analysis related topics and is responsible for several Philips-internal projects. He contributes to the image segmentation related tasks in EurValve.

Irina Waechter-Stehle is a Senior Scientist, works on medical image analysis topics with a specific focus on model-based segmentation and is responsible for a Philips-internal project on cardiac US segmentation. In particular, she has experience with the segmentation of valves in CT and US images and contributes to the image segmentation related tasks in EurValve.

https://www.philips.com/a-w/research/locations/hamburg.html

Beneficiary Profile – Therenva

Therenva SAS is a French SME founded in 2007 as a spin-off of the LTSI academic research lab (Inserm, French National Institute for Health). With a staff of 17 people, mostly engineers specialised in image processing, and a strong focus on the clinician user experience, Therenva designs medical device software systems for minimally-invasive cardiovascular interventions.

Therenva develops and markets :

- The leading endovascular case planning software EndoSize® (CE-marked and FDA-approved) providing surgeons and cardiologists with an efficient tool for choosing the optimal procedure strategy and implant device based on patient CT images. EndoSize® has over a thousand users;
- The intraoperative navigation system EndoNaut®, providing ergonomic image fusion tools and 3D endovascular device localisation capabilities to the physician in standard operating rooms.

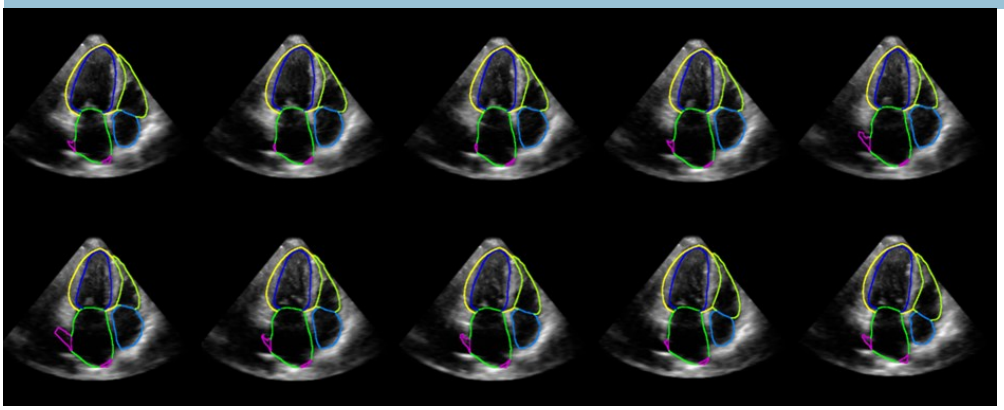
Therenva has developed strong clinical and academic partnerships, especially with the Cardiovascular Surgery Department of the University Hospital of Rennes, a French leading cardiovascular centre.

Therenva will lead the DSS workpackage and will develop the clinical DSS software resulting from this project.

Cemil Göksu graduated from the Ecole Centrale de Lyon where he obtained an engineering degree and a Master's degree specialising in Bioengineering and Medical Imaging in 2001. He joined the Image and Signal Processing Laboratory (LTSI Inserm U642) as a PhD student from 2001 to 2005. His research activities contributed to the design and development of an image-guided system for endovascular surgery. Since 2007, he is the co-founder and CEO of Therenva, awarded by the French Ministry of Research at the 2007 Innovative Startup Contest and first prize winner of the 2008 AGBM Innovative Medical Device Technology Award.

https://www.therenva.com/

3D Model Preparation



Example of dynamic chamber segmentation

EurValve will compare the clinical results from interventions on 120 patients requiring heart valve surgery with those from simulations using models constructed from geometries derived from the patients' clinical images.

- An essential part of the simulation process is the extraction of valve leaflet geometries from appropriate medical images using segmentation software already developed
- A second requirement is for time-series data of appropriate anatomical information that will permit the computation of cardiac output and ventricular work. Typically this would consist of 3D anatomical data yielding left ventricular volume throughout a complete cardiac cycle.

The aim of EurValve is to develop and deploy a modelling-based decision support system for aortic and mitral valve disease that allows simulating, comparing and understanding the effects and risks of different treatment strategies. The decision support system will take all available information into account, in particular the results from different computational models.

The aim of WP3 is to provide and develop models and software tools to determine the input for these computational models and to provide and evaluate the computational models themselves.

The main deliverable of WP3 is a workflow that gives information about the cardiac and cardiovascular haemodynamic characteristics, including those of the valves, of an individual patient. The following steps are required: The patient geometry is determined from a patient-individual medical image. Simulation input parameters are determined from the electronic health record, from pervasive monitoring, from population data, from literature data, from the patient geometry, from machine learning, from a parameter fitting/optimisation process on the computational model itself or from biopsy samples. Then, the flow simulation can run according to a certain analysis protocol. The results will be inputs for the decision support system.

To create a system that is clinically useful, the simulations need to be fast and the required input data must match the clinical routine. To evaluate how detailed the simulations need to be, simulations of different complexity are compared. To reduce the computation time of the simulations, reduced order modelling is applied. To find out which of the input parameters need to be tuned for individual patients, a variation and sensitivity analysis is conducted. To infer missing parameters, machine learning is applied.

Researcher Profile

My name is Krzysztof Czechowicz, and I come from the city of Toruń in Poland. I have a Bachelor's degree in Physics from University of Gdańsk, and a Master's of Civil Engineering degree in at the Gdańsk University of Technology. After graduating, I started my PhD studies in Cardiovascular Mechanics between the Polish Academy of Science and the Medical University of Gdańsk, and after working in several projects in the biomechanical field in Brno and Sheffield, I started working as a Research Associate in Cardiovascular Mechanics on the EurValve project based at the Faculty of Medicine, Dentistry and Health at the University of Sheffield in May 2016.

What is your role with EurValve?

The goal of the project is to have a decision support tool that can be used efficiently in a clinical environment. Most of the models that have been developed recently are complex, so they are very accurate to study the cardiovascular system in general. The downside of those models is that the number of parameters for the models is too big to obtain in routine clinical practice to represent an individual patient. That is why we are using a simple model with a minimum number of parameters that can be obtained for an individual patient, either from direct measurement or through a quick process of parameter estimation. On the other hand, we need to have an accurate representation of the valves, which can be done with CFD and/or ROM. This coupling makes the model multidimensional. Developing this process, model implementation, coupling and tuning the model to be patient specific is my main role in the project. A second strand of my work is to predict what will be the effect of the heart valve intervention for each patient and their life quality. To predict the expected improvement, I introduced the possibility to perform a virtual intervention by replacing the diseased valve in the model with a healthy one. This allows us to quantify how much the patient will benefit from the intervention. One problem still remains and that is that almost all of the clinical measurements are taken at rest, however the symptoms of heart valve disease occur during exercise. To give an overview of what is happening when the patient is performing some kind of physical activity, I am creating a component that simulates exercise, and quantifies the improvement by comparing the model results before and after intervention.

What do you do in your free time?

I am a keen climber and Sheffield is located at the edge of the Peak District National Park. This means that some of the best crags and boulders in the UK are just a short drive or cycle away. The quality of climbing in the area is shown by climbers calling gritstone, the local rock type, "Gods own rock".

Dissemination

A **EurValve Slide deck** has been produced that explains the aims and outcomes of the project. This is available on the EurValve website — www.eurvalve.eu.

EurValve Project Information

Project title: EurValve—Personalised Decision Support for Heart Valve Disease

Dates: 01 February 2016 to 31 January 2019

Coordinator: The University of Sheffield

Partners: EurValve is a collaboration between 13 partners from industry, academia and healthcare

Find out more about EurValve

On our website: www.eurvalve.eu

Or follow us:

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