EurValve: Personalised Decision-Support for Heart Valve Disease
An EC-Funded Research and Innovation Action

Valvular Heart Disease (VHD) currently affects 2.5% of the population. It is overwhelmingly a disease of the elderly and consequently on the rise. VHD is dominated by two conditions, Aortic Stenosis and Mitral Regurgitation, both of which are associated with significant morbidity and mortality, yet which pose a truly demanding challenge for treatment optimisation.

Clinical Motivation: The timing and nature of interventional treatment is crucial in valve disease, but optimisation remains a major challenge in current clinical practice. Operating on patients too late carries the risk of development of irreversible heart failure. Operating too early exposes patients to unnecessary risks, conceivably causing short (e.g. valve thrombosis) or long term sequelae (e.g. early valve degeneration).

Objectives:
The primary objective of EurValve is to produce potentially-useable (after regulatory approval) clinical Decision Support System (DSS) tools that could assist clinicians in difficult areas where extra data might assist the decision. We hope to develop, test and validate a computational tool that would provide extra, derived, 'biomarkers' (quantifying aortic stenosis and mitral regurgitation) obtained from 3D analyses of the patient's cardiac geometry. These data will be added to an existing commercial valve-sizing system that is currently in clinical use.

The target user of this system will be the healthcare professional, the surgeon or cardiologist, who will make the decision on the nature and timing of the intervention. The major advance of this system over current practice is that it integrates and interprets all heterogeneous data available about the patient, integrates population data where needed, and provides a consistent, repeatable, quantitative and auditable record of the information that contributes to the decision process. The DSS system will allow for *in silico* simulation of different treatment options and thus allow comparison of their immediate haemodynamic outcome.

The project will have several components, including understanding the data, building the model, and creating a DSS. The project started in February 2016 and runs for three years.

Validation:
Two clinical trials will be conducted, a retrospective study and a prospective study.
The Retrospective Study will acquire data from as large a patient group as possible, across EurValve's three clinical centres (Sheffield, Eindhoven and Berlin), to facilitate the development of the mechanism to infer missing data, and to provide evidence for the generation of the rule sets that will drive the detailed decision support process. This study will therefore gather data to inform a 'machine learning' process.

The Prospective Study will compare computer predictions of the outcomes of heart valve replacement surgery with the actual results obtained in normal clinical practice. A total of 120 patients across the three clinical centres will be signed up for the study. The enrolled patients will be investigated before valve intervention by ECG, laboratory tests, anthropometrics (blood pressure, body weight, clinical status etc.). They will also be imaged, and the MR scan will employ a slightly modified protocol that could extend the session by 5 minutes. These data will be used for modelling. **I**n the Sheffield cohort there will be an extra observation of the patients' level of activity before and after the intervention, yielding additional information relevant to CV disease: lifestyle, behaviour, risk and recovery. The Sheffield team will monitor subjects for motion and heart rate in their homes, using two wrist-worn devices which link with small base stations positioned around the home. They will be monitored for

at least two weeks prior to intervention. Patients will also be monitored twice after intervention. The first period will begin immediately on their return home, and the second at 12 weeks after intervention. After treatment patients will be followed-up repeating the relevant components of the study assessment protocol, including an MR scan, allowing comparison of the modelled (predicted) against measured outcome data. After this validation step, a randomised controlled assessment of the DSS process itself will be conducted on the data, comparing the virtual decision-support from the DSS with the actual clinical decision-making process that took place.

The EurValve Consortium: The project is coordinated by the University of Sheffield and has 13 international partners: three clinical centres, six academic groups and four industrial partners.

Partners:

Clinical	Academic	Industrial
German Heart Institute Berlin	University of Sheffield	Philips Eindhoven
Catharina Hospital	Cyfronet	Philips Hamburg
Sheffield Teaching Hospitals NHS Foundation Trust	University of Rennes	ANSYS
	Technical University of Eindhoven	Therenva
	Max Delbrück Centre for Molecular Medicine	
	University of Bristol	

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