Project Results

BENEFIT

Advancing evidence based medicine for better patient outcome

EXECUTIVE SUMMARY

The ITEA project BENEFIT stands for Better Effectiveness aNd EFficiency by measuring and modelling of Interventional Therapy. This industry-driven consortium that included universities and clinical end users developed software analysis and imaging methods and tools that present quantified information, personalise patient models and offer treatment alternatives before and during minimally invasive surgery procedures.

PROJECT ORIGINS

Three main challenges were confronted by the BENEFIT project. Firstly, there is the societal aspect of coping with the increasing number of minimally invasive image guided interventions. Secondly, the economic dimension concerns delivering care with quantified targets in terms of quantity, price and quality of care. The third element was to show the technical feasibility of an integrated infrastructure that includes all relevant imaging and data sources, the modelling, analysis and presentation of these data and the integration into a Clinical Decision Support System. Current diagnostic and therapeutic solutions do not offer the flexibility, quality and integration to automatically extract all the relevant quantified data and process flows.

The BENEFIT project addressed these challenges by developing new imaging procedures and quantification and analysis methods to collect information before, during and at the end of an interventional treatment. This information would then be used to develop personalisable patient models such as the TAVIguide cloud-based cardiology tool developed by FEops for pre-operative planning. Furthermore, the follow-up is optimised through the development of workflow models and Clinical Decision Support Systems (CDSS) like the procedure event editor and a high-performance, open, structured database.

TECHNOLOGY APPLIED

The technology developed by the project was
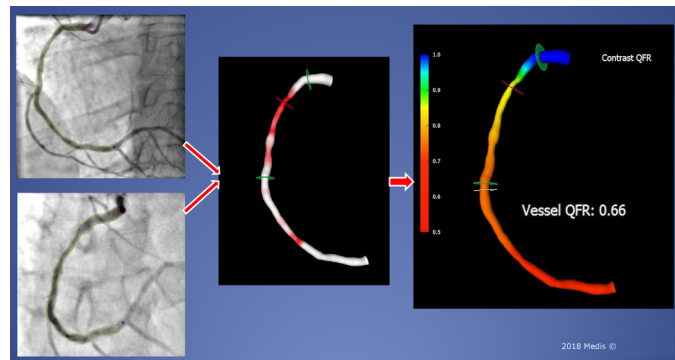
Quantified information to support evidence based minimally invasive surgery

demonstrated across five use cases. The first, on heart valves, involved 4D MRI based blood flow quantification across heart valves and personalised computer modelling that accurately predicts device-host interaction for heart valve replacement. This empowers medical device manufacturers to bring superior products faster to market and enables physicians to improve clinical outcomes. The second use case, which concerned percutaneous coronary intervention (PCI), saw the development of QFR (quantitative flow ratio) for assessing of the functional significance of a stenosis in a coronary artery and OCT (Optical Coherence Tomography) imaging to guide interventions. Use case three concerned the quantification of flow in aneurysms to enable better assessment of therapy success, shorter time to intervention and the integration of brain anatomy and function information with improved biomarkers. In use case four, liver tumours provided the focus in which an accurate

overlay of contrast-enhanced pre-operative to non-contrast-enhanced intra-operative images was developed, resulting in better guidance during ablation (EMC). UMCU also succeeded in combining and analysing multiple MR sequences which increased 5-class classification accuracy of liver lesion types from 57% to 74%. In the same use case Barco developed a way to calibrate endoscopes and surgical displays in real-time so that the perceived colours will be the same irrespective of which endoscope and display are used. Use case 5 focused on improving brain tumour treatment in radiation therapy employing a state-of-the-art Atlas-based segmentation algorithm with local Atlas weighting. In merging the solutions of the three partners (Elekta, Linköping University, Quantib) into a treatment planning demonstrator, the key planning parameters were equivalent to or better than manual planning.

MAKING THE DIFFERENCE

The results of BENEFIT have generated a number of tangible exploitations. These include new tools introduced by Philips for the treatment of cranial aneurysms (MAFA ratio) that generate the results of the treatment while the patient is still on the table. The predictive accuracy for large aneurysms is as much as 91%. For liver metastatic tumours (Virtual Parenchymal Perfusion) the navigation of catheters has been improved and automatic detection of tumour feeding vessels boosts detection accuracy by 26%. This means that fewer feeders are missed, resulting in less recurrence and better patient outcome.

Elekta received CE and FDA approval for its Leksell Gamma Knife ICON radiotherapy system with Cone beam CT for optimal patient positioning and in May 2017 already had 50 systems installed. Quantib received CE approval for its brain analysis software and recently secured €4.5 m in fresh funding to support the company in its international expansion ambitions. Barco can now perform colour calibration for the whole chain of endoscopes and medical displays in less than 5 seconds. The results also had a significant impact on FEops in terms of technology, funding and staffing. This SME received CE approval for its TAVIguide product which helps to improve placement of artificial heart valves by pre-operative imaging and simulation. It also recently secured an investment injection of €6 m to help drive commercial adoption of the FEops HEARTguideTM in the fast-growing market for transcatheter valve therapies. FEops has almost quadrupled its number of staff from 4 to 15 people.

Medis is another partner to gain from the project's results, receiving CE approval for its QFR analysis that helps cardiologists determine whether an obstruction in a coronary artery needs to be treated or not. For DEMCON a separate company, DEMCON Medical Robotics B.V., was founded primarily to develop and commercialise medical robotic systems, such as the superior needle positioning system to assist the physician in complicated procedures.

Ultimately, BENEFIT has advanced evidence-based medicine by providing an open, high-performance structured database for heterogeneous medical data. This closes the learning circle for continuous improvement of the efficiency and effectiveness of a broad array of minimally invasive surgery procedures.

MAJOR PROJECT OUTCOMES

Dissemination
- 70 publications, 3 master theses, 2 PhD theses, 2 book chapters
- 60 presentations at scientific and commercial conferences

Exploitation (so far)
- CE marking for heart valve simulation service
- New radiotherapy system including Cone Beam CT for patient positioning and increased accuracy
- New application for treatment assessment of brain vessel aneurysms
- New application for improved image guided navigation for liver tumour treatment
- CE marking of software for comprehensive MRI brain analysis
- CE marking and Canada Health approval for image based assessment of functional significance of coronary blood vessel obstructions (QFR)

Standardisation
- Member of International Working Group for Intravascular OCT Standardisation and Validation
- Participation in ISMRM Flow and motion working group
- Participation in DICOM standardisation of Tractography MRI (DICOM Supplement 181)
- Support for new standardised data format for BIDS apps for fMRI
- Participation in DICOM working group and AAPM Task Group 196 on colour calibration

Patents
- 7 patents filed
- 1 patent application in preparation

Spin-offs
- DEMCON Medical Robotics B.V. was established as a separate entity of DEMCON B.V.

BENEFIT
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Partners

Belgium
Barco
FEops

Netherlands
Demcon
Erasmus MC
Leiden University Medical Center
Medis
Philips
Quantib
Utrecht University Medical Center

Spain
OSM

Sweden
Elekta
Linköping University

Project start
July 2014

Project end
December 2017

Project leader
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