Coordinator Editorial

VALUE started three years ago, just right before the arrival of the COVID-19 pandemic. A consortium with six hospitals, the pandemic put many obstacles to bringing the project to fruition. Still, the consortium found a way to supply those inconveniences, evolving the solution according to the lessons learnt during this time: The difficulties in accessing the data, not only technologically speaking, because in many cases, there aren't interoperability or ways to relate different data sources, but also legally. Health organizations must ensure compliance with regulations, which makes you get lost in paperwork, slowing down any attempt to benefit from the knowledge extracted from the data. There is a ton of information available in the hospitals, but they do not have enough quality to be analyzed. Since clinical teams don't have a clear purpose for the gathering of data (further than to be consulted in the information system of the hospital), there is not a certain motivation to encourage health staff to be careful, being typos, duplicate or missing data some of the most typical problems found. Then VALUE helps improve the care processes in the hospitals and can help identify weak points in the hospital information system to be enhanced, contributing to better the data obtained.

Nevertheless, the VALUE consortium has been able to carry out the analysis in the different use cases; for example, from the biomechanical assessment done in IBV, they found that fall risk level and age were the main factors determining the strategy used by the subjects at the time of analyzing the influence of Parkinson and Alzheimer diseases on the performance of a modified TUG test (FallSkip Test). Moreover, the words said by Dr Pedro Luis Sánchez, Head of the Cardiology Department of the Hospital de Salamanca (Spain), illustrate how clinicians perceive the solution.

"The data mining tool promoted by VALUE makes it possible to visualize and understand the process map in a simple, automatic and user-friendly way for the healthcare professional, who can make immediate decisions without relying on sophisticated IT tools."

The Value solution

The main purpose of the VALUE solution is to provide the means to optimize the clinical pathways and care flows of health organizations.
VALUE solution is mainly supported by the **Process Mining for Health** solution, developed by UPV. This can be mostly seen as a method, software, and knowledge base. The method is **Interactive Process Mining** (IPM), a paradigm that involves health professionals in the middle of the understanding process until the definition of an Interactive Process Indicator through Interactive Data Rodeos.
**Interactive Process Indicators** (IPI) allow them to analyse the processes objectively, clearly, and exploratively. Interactive Process Data rodeo (data rodeo) sessions where a multidisciplinary team composed of clinical professionals and process miners are aimed at iteratively curating data, co-creating a process indicator, analysing, and validating it by the health professionals and training them in using the Interactive Process Indicator. Interactive Process Indicators (IPI) are navigable models from general to individual, 100% representing the real process together with specific Key Performance Indicators (KPIs) such as CROMs, PREMs, PROMs, PRIMs, ICHOM sets to complete as well as other enhanced views that provide crucial information to understand what is happening in the process. IPIs are translated into runners, a kind of configuration file.
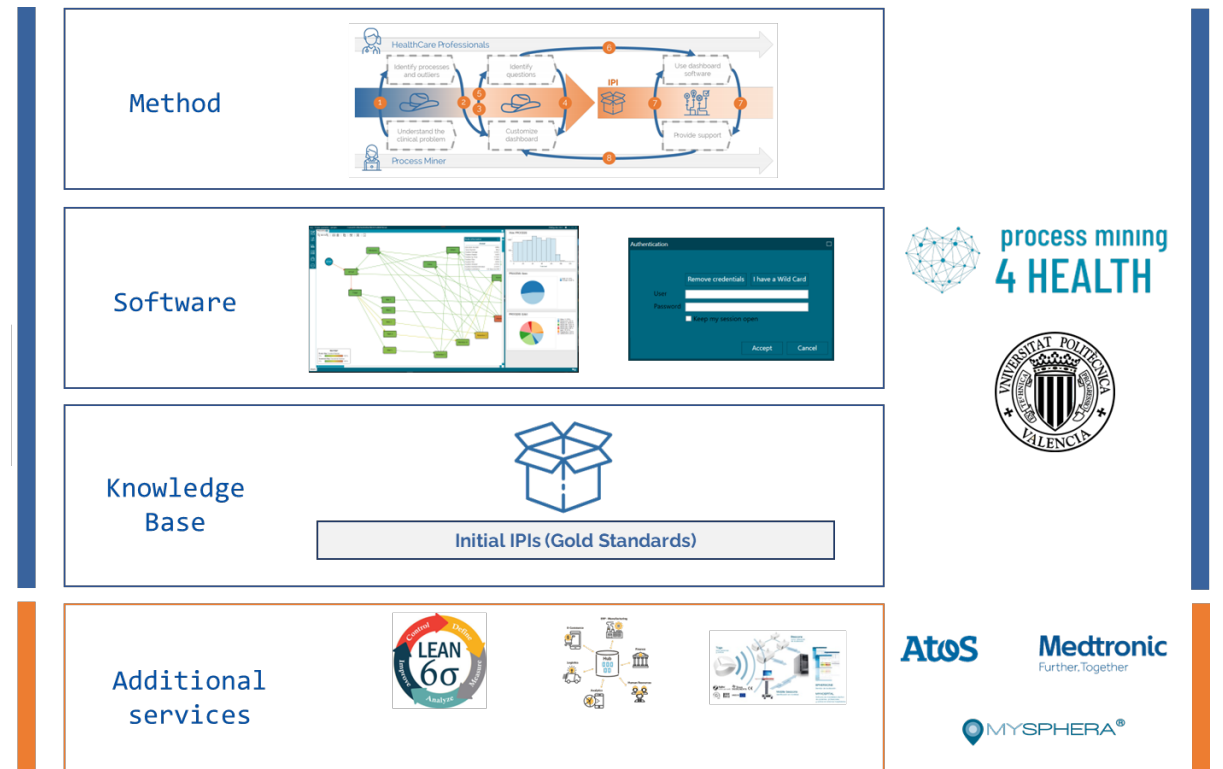
Although each hospital is a different world, IPIs can be considered a knowledge base since they can be used gold standard between them. For example, an IPI for Emergency Departments (ED) compliance with the Manchester Triage System can be used in all the hospitals that use the same standard. It would be necessary to adapt the ingestion piece of the IPI to deal with the information system of the new hospital.
The software is **PMApp**, a tool for generating customed PM dashboards that can process health organizations' data and provide advanced views (IPIs) to empower the analysis made by health professionals. There are two versions of PMApp, 1) PMApp for clinicians, 2) Interactive Process Mining Toolkit (IPMT) for process miners. IPMT includes some tools to compose the runners and thus implement the IPI, as well as PMApp, where a runner is executed to customize the tool.
Additionally, VALUE solution offers other services as the **real-time location system** is, provided by MySphera, which delivers more accurate information related to the process, enriching it. Furthermore, A clinical data hub provided by Atos, enables interoperability between the hospital's data sources.

If the clinical data hub is available, the VALUE toolkit connects directly to this additional module to get the data homogenized, considerably reducing the task of curation, definition, and validation of the IPI.

Finally, to extract the maximum benefit from the solution, Medtronic introduces an expert team in the continuous improvement process to identify problems and their root causes, apply changes and measure their effectiveness with the support of the VALUE solution.

The final version of the VALUE solution is available. If you are interested in using it contact us through the following form: https://valueproject.eu/get-in-touch/.
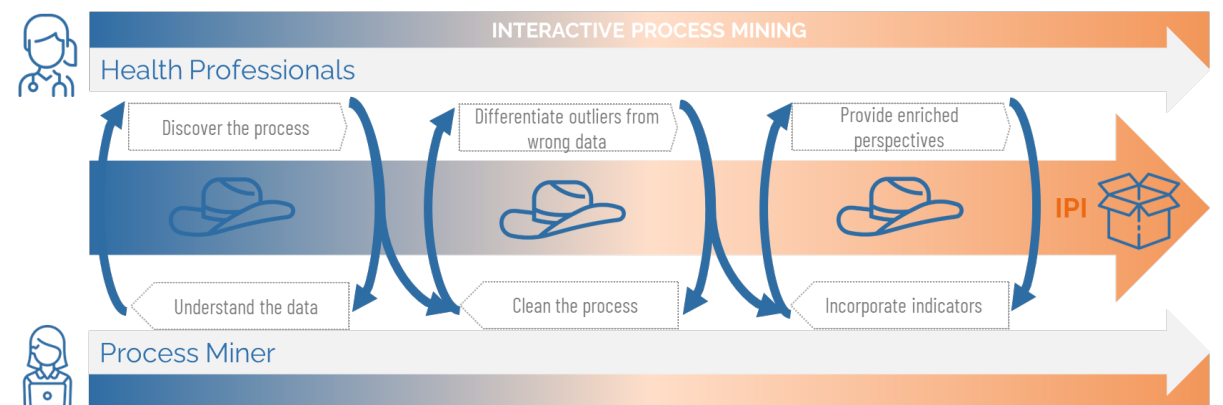
Clinical Use Cases

Value has developed several Use Cases. Next we present some of the results achieved inside of some these use cases.

External consultations process optimization in a Cardiology department.

A focus in heart failure

The use case at CAUSA focuses on cardiac patients suffering long waiting lists, long time to diagnosis and long time to treatment. In addition, the clinical pathway suffers from segmentation between primary and specialized care with a denoted low level of coordination for both, derivation and follow-up, between general practioners and the cardiology department. Such suboptimal setup impact on both satisfaction of the patient and the care team. The use case analyzes the entire external consultation process, with special focus on the management of the patient with heart failure.

The objectives fixed were: (1) reduction of time to diagnosis, (2) increase the discharge rate after first consultation, (3) reduction of "follow up/primary" ratio, (4) measure the Quality of Life of Heart Failure Patient, (5) improvement of patients' and staffs' satisfaction.

The methodology followed by the team was the following:

- Value Stream Mapping of the consultation process
- Identification of parameters needed to extract from the Database of the Cardiology Management System
- Data Quality Check: cleaning and preconditioned
- Interactive Process Mining was applied in different sessions (Data Rodeo) between medical doctors, process mining experts and on-site data experts to assess one – stop clinics.
- Interactive Process Indicators were generated and validated with the doctors and the data experts.

The iterative implementation of the IPI allowed clinicians and managers to have a deeper understanding of the one-stop cardiology clinics process.

- Define and classify the outcome of the clinic in big generic cardiac syndromes or the absence of a specific diagnosis in patients with a structural normal heart
- The median waiting time was 19 days and 20 h, showing a clear improvement point in comparison with national standards
- The discharge rate from the clinic was 47% reaching the acceptable benchmark set by expert consensus, improving communication with other specialists and primary care and the implementation of novel alternatives such us e-consultation could be an option to reduce even more unnecessary referrals.
- Reducing the number of unnecessary requested tests is of key importance. Prior to rationalization of diagnostic and interventions, it is fundamental to know the exact volume and statistics of requests generated by the one-stop clinic. This task was successfully achieved with the analysis of the process.

- Time allocated per patient for a one-stop clinic is usually enough for a general cardiologist to perform an external ECHO if deemed necessary after formal clinical interview and physical examination. The existence of too many early requests of extra ECHOs is perceived as a failure of the main goal of this kind of clinics. The indicator of 10% of ECHOs directly requested from one-stop clinic shows an improvement opportunity.
- HCP had a comprehensive tool that they could use by themselves, without technical assistance, to extract and interpret different indicators at any time, providing a high-quality source of information to improve patient-centered daily medical care

Impact generated:

Possibility to create new planning and scheduling programs for consultations based on data.

Allocation of resources (human and equipment) where needed (example: increase capacity for HF consultations, decrease capacity for monographic consultations with lower demand than expected) cases.

In ST-segment elevation myocardial infarction (STEMI), the time delay between symptom onset and treatment is essential to improve outcomes. The expected transport delay between patient location and percutaneous coronary intervention (PCI) centre is paramount for choosing adequate reperfusion therapy. The "Centre" region of Portugal has heterogeneity in PCI access due to geographical reasons. We aimed to explore time delays between regions using process mining tools.

We retrospectively assessed the Portuguese Registry of Acute Coronary Syndromes and the National Registry of Interventional Cardiology for patients with STEMI from 2010 to 2019. We merged these two databases and collected information on the geographical area of symptom onset, time delays to hospital admission and treatment, and type of reperfusion therapy. We used a process mining tool to build two models that represent the flow of patients in a healthcare system: national model according to the regions of Portugal and regional model according to the districts of the "Centro" region of Portugal.

The national and regional models included 8958 and 773 subjects, respectively. In both models, most patients were male (75%) and 51 to 70 years old (50%). In the national model, the "Centro" region of Portugal showed an increased delay between symptom onset and hospital admission and a higher number of patients submitted to fibrinolysis, a second-line therapy associated with potentially fatal or disabling adverse effects. The regional model demonstrated that this delay to PCI was longer in "Castelo Branco" and "Guarda", both districts with a higher rate of fibrinolysis therapy. Surprisingly, in the regional model, we found an increased delay between symptom onset and hospital admission and a high rate of patients undergoing conservative management (no PCI nor fibrinolysis) in "Coimbra", which must be addressed in the future.

Our data is limited by its retrospective nature and the relatively small size of the regional model which limits mortality analysis and external validity. A prospective study is critical to overcome these limitations and strength the conclusions.

The implementation of a new PCI centre in the most remote regions of the "Centre" region of Portugal ("Castelo Branco" and "Guarda") is critical to offer timely first-line therapy to their population and to overcome these important healthcare access inequalities.

As a hospital, Karolinska has decided to aim towards a goal for all our patients. One of the patient categories most at risk of suffering a medical injury during their visit at the emergency department are the elderly patients, due to high age. Based on the Value-project, this is what we have been working with lately:

- Patients over 75 years of age should have at least the priority YELLOW according to RETTS (Rapid emergency triage and treatment system) which indicate to the staff that they should meet and set up a plan for the patient within 60 minutes from the arrival
- Elderly patients with higher level of care should be rapidly admitted to the ward GAVA without less administrative steps
- The emergency department together with Theme aging has collaborated to form a multi-professional team with a geriatric nurse and a specialist nurse in emergency nursing to early form a plan for the patient
- During the Value-project we have started up the use of the Process mining-tool, which makes it possible to look at processes and flows at the emergency department, based on specific patient categories (to name one example). Based on what appears when using the tool, we can then adapt the measures, arrangements, and care so that it better suits the elderly patient

The main objective of this use case has been to study the potential of process mining in the evaluation of functional clinical protocols. In particular, the use case proposed by IBV has consisted of analyzing the influence of Parkinson's and Alzheimer's diseases, in addition to factors such as age and the risk of falls, in the performance of a clinical test to assess the mobility and risk of falls.

The process chosen for the use case is a test developed by IBV and based on a modification of the standardized Timed Up and Go test for the assessment of mobility and the risk of falls. Figure 1 shows the sequence carried out during the execution of this test.

For the analysis, a dataset made up of temporal data from 685 subjects (516 healthy, 106 with Parkinson's and 63 with Alzheimer's) was used. The study has focused on evaluating the strategies used by the different population groups, in particular, during the gesture of sitting down and getting up. In addition, the influence of various factors such as gender, age, height, weight, history of falls, risk of falls, severity of the disease and duration of the test have been studied.
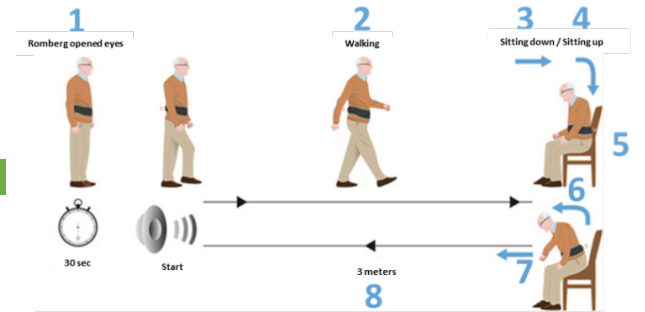

Figure 1. Sequence of the modified Timed Up and Go.

The analysis of the process using the Value tool has made it possible to identify significant differences between subjects with Parkinson's and Alzheimer's disease and healthy subjects in the execution of the gesture of getting up and start walking. Age and risk of falls have also been identified as determining factors. Among healthy subjects, those who are older and have a higher risk of falls opt for the same path as pathological subjects.

The tool has made it possible to successfully analyze the different mobility strategies used by different subjects during the performance of a biomechanical assessment clinical protocol using temporal data. This information is not analyzed by traditional media and offers high added value.

These results open the door to carry out more detailed analyzes of the signals considering, for example, greater segmentations of the movement sequence that identify time intervals between actions or the time that they overlap. Other applications such as the optimization of new clinical protocols, the design or improvement of biomechanical evaluation processes or the creation of new protocols for a more precise characterization of gestures appear to be promising lines of study.

Partners