

Parametric Multicentre Monitoring in Transcatheter Aortic Valve Implantation Procedures in the Czech Republic – the Czech TAVI Registry

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Abstract— *The implementation of new methods in medical practice cannot do without a careful and especially conclusive assessment of results and benefits of such methods for the patient. As such medical procedures are usually expensive, state administration bodies and healthcare payers logically apply pressure on the monitoring of such procedures. Another important aspect is the fact that also the medical specialists wish to have an available feedback and possibility to evaluate the efficiency and safety of the highly specialized treatment applied by them. For such a reason, medical doctors find themselves in situations which require, besides standard interdisciplinary co-operation, also an interdisciplinary co-operation with Information and Communication technology (ICT) specialists, who provide parametric multicentre monitoring and continuous assessment of such medical procedures.*

The implementation of a new treatment procedure in patients with hemodynamically significant aortic stenosis treated with the catheter-based aortic valve implantation in the Czech Republic belongs among such cases (TAVI – TransAortic Valve Implantation).

For the purposes of the implementation of the TAVI in the Czech Republic, a clinical data management system (CDMS) based on the TrialDB2 technology [1] – the Czech TAVI registry - has been created and used for parametric multicentre data collection and evaluation. The Czech TAVI Registry (CTR) offers an environment not just for a secured parametric data collection but also for on-line output benchmarking, providing thus a valuable feedback for the participating centres and applying further pressure for the improvement of medical procedures applied. The article deals mainly with the collection of multicentre parametric data collection and the description of the technological assurance of the CTR, and it stresses the assessment of results and provision of feedback to the participating centres.

By 30 June 2014, the CTR included 819 closed parametric records from approximately 95% out of the total TAVI performed in the Czech Republic. The Registry is kept under the expert guaranty of the Czech Society of Cardiology and The Working Group of Interventional Cardiology, and it is managed by the Institute of Biostatistics and Analyses of Masaryk University.

Index Terms— Clinical data management systems, Czech TAVI Registry, on-line reporting, TAVI

I. BACKGROUND

Currently, the collection of parametric information of the treatment of patients is becoming an inseparable part of the assessment of the efficiency and quality of medical care. Most often, parametric data are collected directly during the real operation of participating healthcare facilities. The assurance of the maximum accessibility and user-friendliness of information systems providing such data collection is therefore a logical requirement. When performing multicentre studies, the most frequent approach is the usage of an existing central anonymous database, where healthcare centres upload data by means of a web application [2], [3], [4]. The administration of a centralised system is easy; there is a possibility to create and update the parametric structure of the study, to administer the user accounts, roles and access rights, to share data recorded in the central database, and to perform maintenance and upgrading of the system. Data for specialised analyses are then used in the best manner. Medical doctors and healthcare personnel who work with the system and upload data into it need just a web browser and an internet

connection to be able to access the system. The access to the application is usually protected with a username and password or another manner of authentication, in which case such access data are also administered by a central authority.

It may be resumed that the collection of clinical data by means of a centralised web system is the most comfortable manner of data collection both from the user's and technical point of views. Such requirements are fulfilled also by the Czech TAVI Registry, which is based on a CDMS named TrialDB2 [1]. The TrialDB2 CDMS has been developed and managed by the Institute of Biostatistics and Analyses of Masaryk University.

The CTR was created under the auspices of the Czech Society of Cardiology, as a response to the launching of the TAVI programme in the Czech Republic in Prague in December 2008 [5].

The CTR is a national registry which gathers information of approximately 95% out of all the TAVI in the Czech Republic. Ten out of eleven Czech centres which perform the TAVI provide data for the registry. Therefore, the registry provides a representative data source covering the whole country. By 30 June 2014, the CTR contained information of 819 performed operations.

II. PARAMETRIC STRUCTURE OF THE CTR – CASE REPORT FORM (CRF)

The CRF is a basic document of each clinical registry, which is created by means of an interdisciplinary co-operation of specialised clinicians, ICT professionals and data analysts. The CRF includes definitions of all the questions to answer organised in logical groups, data types definitions for the implementation in the database, links to external code lists, information of possible logical dependences between questions, and the setting of basic checks of uploaded data. The CRF is in fact a structured compact registry of knowledge compiled within the project.

The structure of the CTR was built with the valuable help of Professor Carlo di Mario, the past President of the European Association of Percutaneous Cardiovascular Interventions (EAPCI). The CTR is structured into four parts and several basic groups of questions which reflect the parametrical description of the whole process of implantation, from the anamnestic data and preoperational examinations through procedural data up to the immediate evaluation of the success of the operation and a long-term monitoring of intervened patients. A simplified structure of the monitored areas of parameters is as follows:

- Patient information - FORM
 - Patient Identifier and Demographics
- Implantation - FORM
 - Heart-team Meeting
 - High Risk Surgery Euro SCORE Questions
 - Medical History and Risk Factors for Coronary Artery Disease
 - Previous Interventions
 - Pre-procedural Clinical Status

- Echocardiography and Angiography
- Quality of life
- Procedural Data
- Immediate Procedural Outcome and Complications (in cath lab / theatre)
- Post-procedural, In-hospital Complications
- Echocardiography Before Discharge (the latest one)
- In-hospital Biology
- Discharge
- Follow-up (1 month after TAVI and consequently with one year period) - FORM
 - Follow-up Header and Complications
 - Echocardiography and Angiography (the latest one from the last follow-up)
 - Quality of life
- Death record - FORM

Some data required in the CRF for the group "Echocardiography and Angiography" is shown below by way of example, more details can be found in [6]. Questions marked with * are mandatory.

1. *Pulmonary Artery systolic blood pressure > 60mmHg (selection)
 1. No
 2. Yes
 3. Not measured
 4. Unknown
2. *Aortic valve peak gradient [mmHg] (number) abs. min:0 min:0 max:200
3. *Aortic valve mean gradient [mmHg] (number) abs. min:0 min:0 max:150
4. *Aortic valve area (AVA) [cm²] (real number - scale: 1) abs. min:0 min:0.1 max:3
5. AVA index [cm²/m²] (real number - scale: 2) computed read-only
6. *Main aortic annular diameter measurement method (selection)
 1. TTE (transthoracic echocardiography)
 2. TOE (transoesophageal echocardiography)
 3. Angiographic
 4. CT (computed tomography)
 5. MRI (magnetic resonance imaging)
 6. Other
 7. Unknown
7. *Main aortic annular diameter measurement method description (string)

The CTR dataset was designed in order to enable an easy interconnection to the ongoing European TCVT (Trans-Catheter Valve Therapy) Pilot Registry supported by the European Society of Cardiology. Only the Czech Republic and Poland represent middle-east European countries in this important project that started at the beginning of 2012. The CTR therefore respects the necessity of interconnection of knowledge at an international level.

III. THE SYSTEM OF MULTICENTRE DATA COLLECTION IN THE CDMS TRAILDB2

There are several systems of multicentre collection of parametric data. Generally, these systems are based on a client-server communication, and data are uploaded into the central database on web forms by representatives of the participating centres. Such a solution using “thin web clients” enhances greatly the accessibility of the CDMS. REDCap [7] is one of the most famous CDMS; in case of more simple studies, e.g. Survey Monkey [8] is used. The CDMS TrialDB2 [1] also uses the same concept, which is based on the TrialDB [9] application developed in the U.S.A. in the Centre for Medical Informatics, Yale University School of Medicine, and further developed by the Institute of Biostatistics and Analyses of the Faculty of Medicine and the Faculty of Science of Masaryk University.

The core of the TrialDB2 data centre is composed of databases administered in the ORACLE 11g system. Such a database is accessed by a web application installed in the application server. The web application is implemented as a package of ASP (Active Server Pages); users may use a current web browser for the access, it is not necessary to install any new software or another accessory. Browsers IE 5.5+, Google Chrome and Mozilla Firefox are supported. The support of rather obsolete browsers is necessary, unfortunately, as in spite of a market prevalence of Google Chrome; IE version 8 is still broadly used in Czech hospitals.

All communication between the client application and the server is carried out by means of a secured encrypted HTTPS protocol. Only centrally administered registered users can access the application after entering a corresponding username and password allocated by the system administrator.

Trial Manager, an independently designed and implemented administrator application, accesses directly the database in the IBA; this application is common for all the registries in the TrialDB2 (Figure 1). It designs, defines and generates CTR web forms including the integrated ASP scripts and JavaScript's for the verification of dependencies between questions and the validation of form data, administration of access accounts, data export into different formats and system operation monitoring.

The CTR is therefore a research database containing strictly anonymous clinical data, which are uploaded by representatives of all the participating centres through a secured web application which communicates with the central database server where all the collected parametric data are gathered and stored. Regular data storage and a mirror server in a geographically remote location are a matter of course.

The CTR is just one of approximately 100 active clinical registries operated by the IBA; it may be stated, however, that it is one of the most complete registries with the highest quality of the filled-in data [10].

User's interface of the registry and data evaluation:

The basic access to the CTR data is done through a web application accessible after entering the username and password. After logging in, the user is authorised to access the registry environment shown in the Figure 2.

The data uploading is performed by means of a set of forms, which include the individual logically structured questions. Questions may be defined as obligatory and non obligatory, and it is possible to complement such questions with checks of range and format of the uploaded data; this prevents incorrect data from being filled in at the very beginning. In Trial Manager, it is also possible to define advanced checking links and dependencies among questions, which, after the ASP pages generation, are automatically reflected in the related JavaScript's. Users work with the web form in an intuitive manner; each question may also include an integrated bubble help (Figure 3).

Each form status may be marked as “Pending“, “Completed“ and in exceptional cases, when the majority of obligatory data is not accessible, the form may be marked as “Uncollectable“ (Figure 3).

All records in the CTR are then validated and checked for possible discrepancies at the level of individual records (e.g. selection of a wrong form stating the operation was performed after patient's death, etc.). Such controls provide for a high quality of data uploaded into the CTR.

The CTR environment offers other functions, such as tools for exporting of the CRF in the MS Word format, data sharing among the individual centres or a listing of all changes performed in the registry, Audit Trail. The web environment also includes an entry into a dynamic on-line reporting of the CTR, which is described below.

In order to achieve a global view of the data in the registry, it is necessary to provide a rather comprehensive view of the registry data at any time both for users from participating centres and the specialised guarantor that methodically controls the registry. For such a reason, an accessible on-line reporting system has been created in the CTR which, on the basis of access rights, is available for the representatives of the individual centres, enabling them to check the performed operations.

The reporting structure has been designed in a close co-operation with the medical guarantor and also participating healthcare centres. The key feature is an immediate possibility for each individual centre to obtain a feedback, which enables the assessment of the centre results benchmarking these with the results of the other centres. Reference values are calculated from mean values reached by all the centres, which prevents an unwanted competition benchmarking of the centres directly with one another.

The reporting system is implemented directly on the CTR Production database in Oracle DB. Reports are visualised by means of the Microsoft SQL Reporting Services technology, connected directly to the Oracle production DB. In such a

manner, reports always reflect the current status of data in the registry on-line, and advantages of the Reporting Services may be fully used (Figure 4).

Each report is a web page; in its heading, it is possible to select the analysed group of patients applying a set of predefined filters and to visualise required statistics of such a group. The Reporting services technology also enables to generate reports in a form of Microsoft Excel files or Adobe portable document format (pdf). This functionality is also used when regular quarterly review reports are sent to the users of the participating healthcare centres.

The set of reports currently contains the following reports:

- Quality of filling
- Indication and procedure urgency
- Patients case mix
- High risk patients stratification based on Euro SCORE
- Procedure data
- Immediate Procedural Outcome and Complications
- Post-procedural, In-hospital Complications
- Echocardiography outcomes

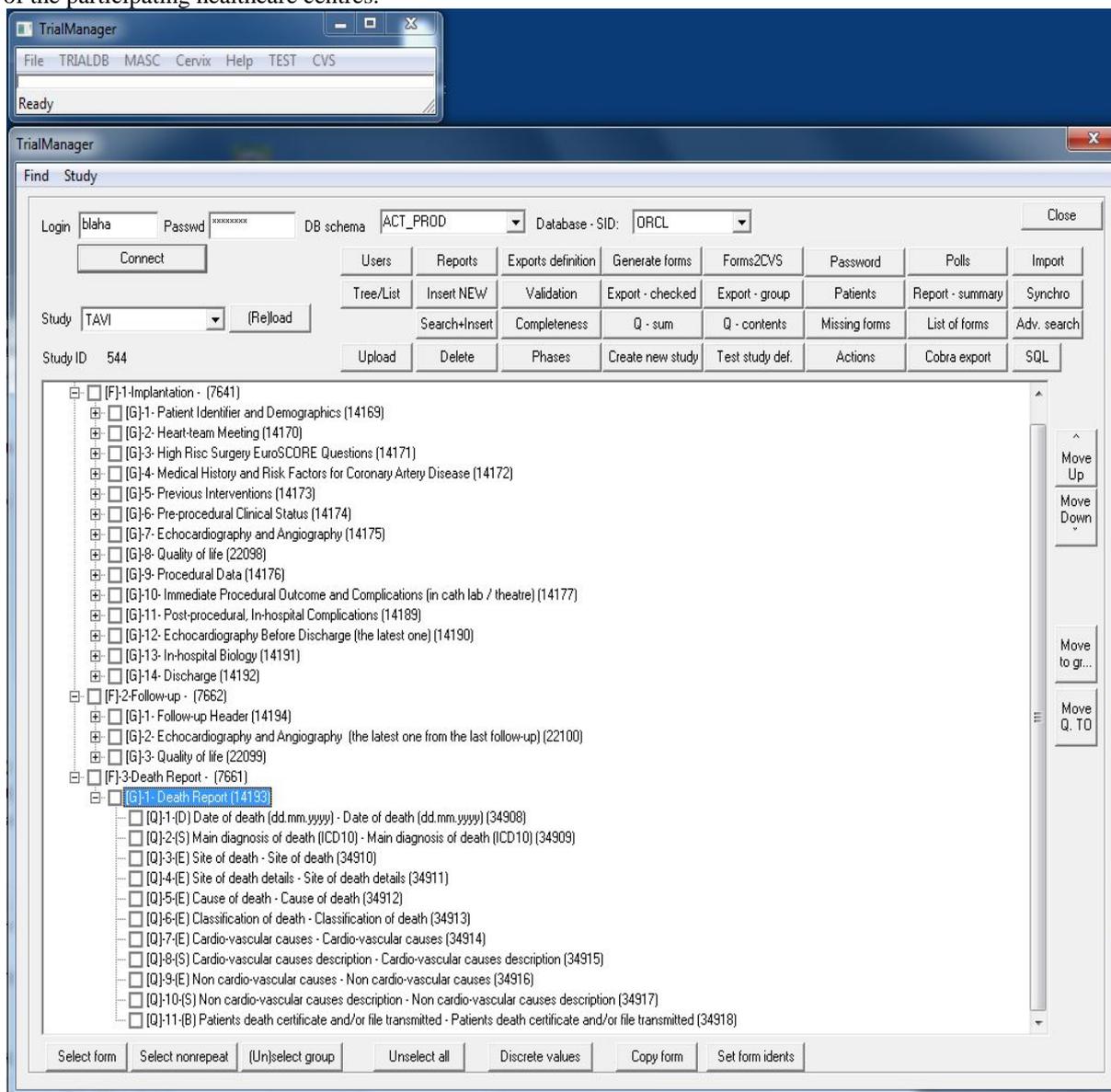


Fig 1. Administrator application - Trial Manager



Current User: Milan Blaha (BLAHAM)

Current project: TAVI

Time to log out: 59:46

Select project

Log Out

Search Patient | Add New Patient | Tools

Search patient

Form

Patient ID

Date of birth (dd.mm.yyyy)

Sex

Initials

Physician

Site

Validation result

Training patient

- Study structure
- Reports
- Helpdesk
- Messages
- Change Password

Last opened patients

Patient ID	Opened date	Action
TV-280526F-VK	14.08.2014	Open
TV-301222F-MB	08.07.2014	Open
TV-790721M-MB	24.03.2014	Open
TV-290125M-AH	24.03.2014	Open
TV-000101M-AK	18.03.2014	Open

Fig 2. Web environment of the Czech TAVI Registry

Data form Death Report

Patient

TV-910625M-ŠM - Training patient

Date of birth (dd.mm.yyyy)	25.06.1991	Initials	ŠM	Enrolled by	Martina Šviháková
Sex	Male	Site	CBA	Date of enrollment	07.08.2013

Data form

Death Report

Date of death (dd.mm.yyyy) *

Main diagnosis of death (ICD10) * Select: Main diagnosis of death (ICD10)

Site of death *

Site of death details *

Cause of death *

Classification of death *

Cardio-vascular causes *

Cardio-vascular causes description *

Non cardio-vascular causes *

Non cardio-vascular causes description *

Patients death certificate and/or file transmitted *

Form status

Form status

Fig 3. Example of the Czech TAVI Registry web form – testing set

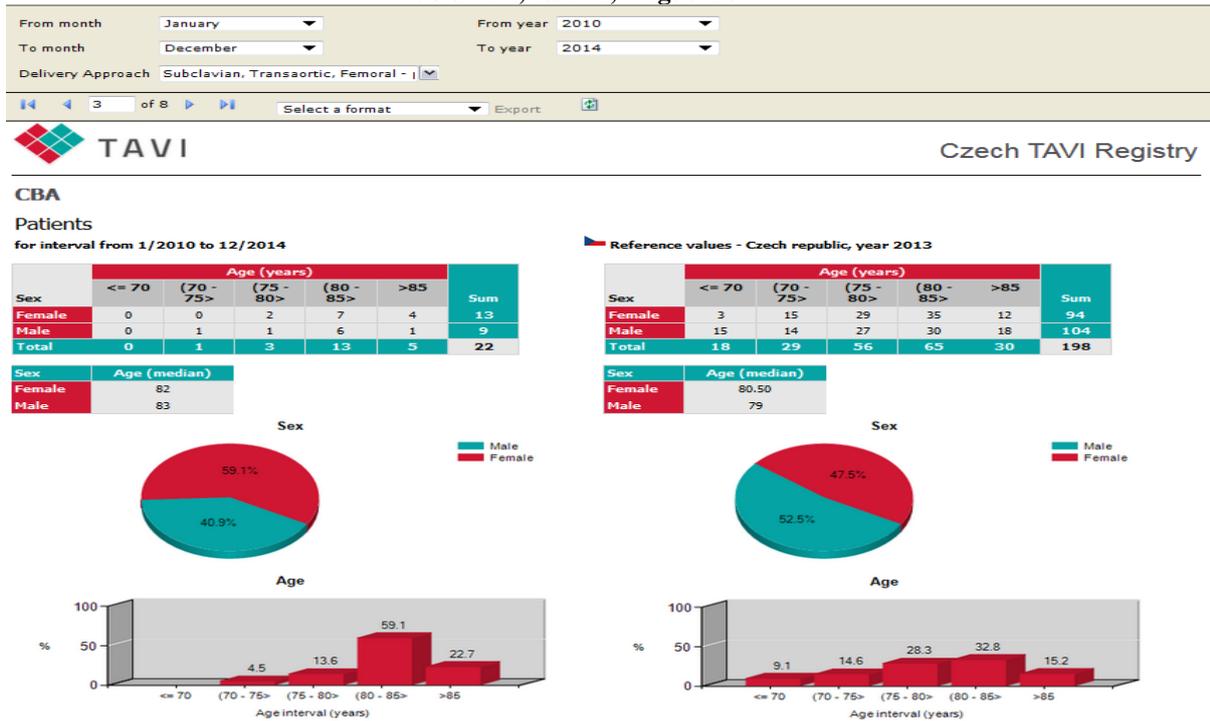


Fig 4. An example of the Patients' casemix report, only model data are visualised

IV. ANALYTIC OUTPUTS

The above-mentioned technological platform is a necessary - not just sufficient - condition for a successful implementation of the monitoring of clinical projects which are connected to the implementation of new technologies and procedures in medical practice. Undoubtedly, a good design of monitored parameters is paramount together with a co-operation of the individual centres participating in each specific project. Nevertheless, it is possible to say that in the case of the CTR, such prerequisites have been successfully fulfilled. By 30th June 2014, 819 patients with TAVI have been registered in the CTR (Figure 5).

It is possible to say that due to the feedback provided to the participating centres and the usage of the CTR as a communication and reference hub, the TAVI has been very successfully implemented and standardised in clinical practice in the Czech Republic. Such a fact may be supported by the improvement of some of the results in time, after the overcoming of the learning curve (12).

The performance of the TAVI interventions in the Czech Republic is standardised and parametrically monitored also due to the CTR, and the CTR database is a data source for partial analytical assessments and scientific studies both at the national and international levels [11].

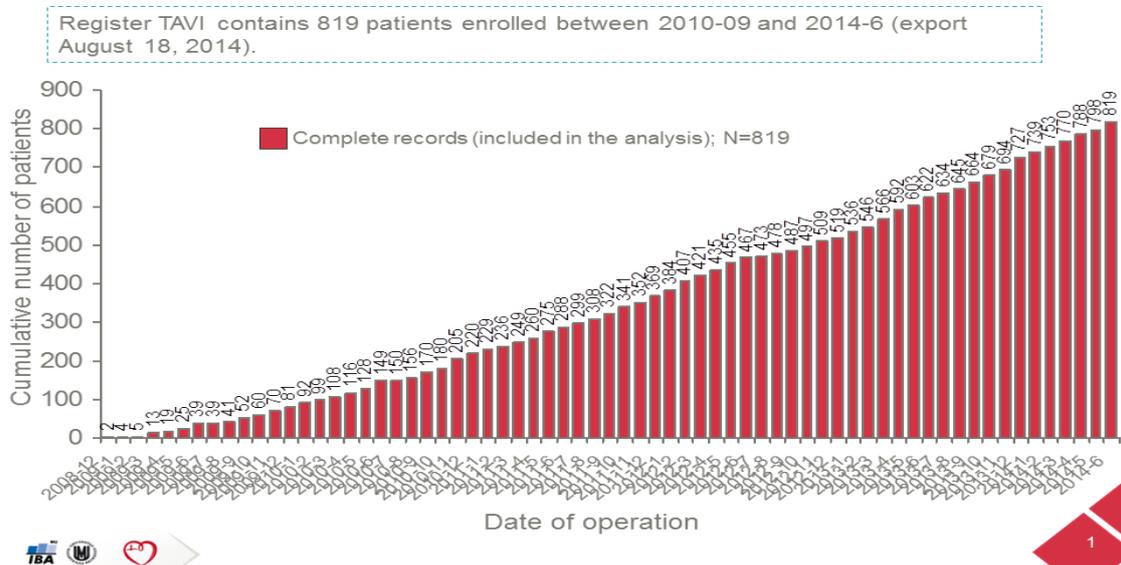


Fig 5. Enrolment in time

V. CONCLUSIONS

When new medical procedures are implemented in medical practice, the parametric monitoring becomes a vital part of modern evidence-based medicine. During interdisciplinary co-operation with ICT professionals, technological means enable to define a complete CDMS. However, it is necessary to point out that any superior system is just a tool which may render the management of difficult tasks easier. This includes monitoring and implementation of new procedures in healthcare, exchange and sharing of information, and simplification of common routine operation procedures in healthcare facilities. The compliance of users is paramount.

The Czech TAVI Registry is an example of a successfully managed project which fulfils its objectives in all the defined areas. It enables a parametric collection of quality data and offers a user-friendly environment. It provides an important feedback in a form of predefined dynamic reporting outputs and the benchmarking of results of the individual centres with the reference values. Within the framework of international structures, the CTR fulfils its communication objective by means of the connection to the TCVT, where it regularly sends CTR data by means of standardised outputs. Owing to the quality and also continuity of data, the CTR may also be used for the evaluation of rather long-term benefits of the implementation of the TAVI in clinical practice in the Czech Republic, including a long-term evaluation of mortality.

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