

THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY (Ph.D.)

Application of Information Technology in data management of
Anaesthesia and Intensive Therapy on National Level.
The advantages and results of Web based system development.

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Introduction

Informatics and healthcare

When 15-20 years ago, the committed followers of information technology wanted to prove the necessity of informatics even in healthcare, they could not have thought of the role these tools would play in the future. The "pioneer-era" cannot be described with the same characteristics in the west and east of Europe - in the western parts, the main thread in the application was based on economical system theory, while in the eastern parts the developments in the medical profession induced the need of introducing the system.

Nowadays of course, the complete information systems built with the same philosophy are the ones that help healthcare. The CEN TC251 committee (CEN: Comité Européen de Normalisation / European Committee for Standardisation) had a large role in creating this system. The CEN is also working on the creation of HISA (Healthcare Information System Architecture) and aims to standardize the patient dossier known as EPR (Electronic Patient Record). Data exchange is simpler with standardization (EDIFACT, HL7, and XML). The eHealth (Electronic Health) program is a fully authenticated part of the eEurope program. Adding up to the above mentioned is the fact that the Internet has become so widely used, that for the first time in humanity's history there is an existing network which is able to send information all over the world, without making any distinction between skin colour or religion, so this way it can really establish a connection between humanity's ethnical groups. The technology's basis was laid down in the 1960's and since then, the process only became faster. The wide networks were used for real time sound-picture-signal transmission as well as telemedicine on an everyday-basis. It was this standardization from where the World Wide Web has grown into our everyday use. The healthcare professional content can serve out every demand: training, consultation-telemedicine, journals -all of these can be found on the net. Within these circumstances, anaesthesiology and intensive care matched the requirements, and with the help of IT's applications, it was able to solve them on a high level.

Informatics and anaesthesiology

The first anaesthesiology report was written in 1894, 48 years after the first successful anaesthesia procedure. After this, it has been under gradual development, this way granting use for the IT. Because of this, it is different from the conventional medical documentation in the following means: it is created in a different way than a class documentation and the requirements it has to match are also different, for example it shows the same event from another aspect in the surgical documentation. The electronic report of anaesthesia is an integral part of a modern anaesthesia workplace, and in the terms of IT, it is the surface of the EAR's (Electronical Anaesthesia Record) creation. Nowadays, this workplace is not restricted only to operating-room or diagnostic therapy surgical intervention, but extended it both in time and place. The IT applications followed this process, trying to make the growing number of jobs and role of the anaesthesiologist more simple. This way the workflow of anaesthesia follows the approach of perioperative medicine, which can be divided up to the following: the data management in ambulance, anaesthesia procedures, postoperative observation and pain

release. The first step is a preoperative examination. This is followed by the operating-room activity, which matches the requirements of the intra-operative data collection and is followed by the post-operative monitoring data collection, but this is not the last step. There is a growing need for organized after operation analgesic administration done by professionals. This need can be fulfilled with the APS (Acute Pain Service). This scope of activities translated to the language of the profession can be divided up into the following: anaesthesiological ambulance, anaesthesia record keeping system, PACU (Post Anaesthesia Care Unit) observation and APS care. Naturally the system's connection to the hospital network is a primary interest; the connection to the integrated hospital system's application cannot be a problem.

The anaesthesia outpatient department is where the anaesthesiologist examination and opinion originated after evaluation of the patients data. The patient's informed consent for the agreed type of anaesthesia and the preparing for the anaesthesia procedure itself also happen here.

The systems most difficult task is creating the intraoperative report. The task is to record every compulsory comment and event into the system, such as the time of intubation, the important moments of the operation and medication. It assesses a great number of things: the data of the completed anaesthesia and operation, the course of anaesthesia, the trends of the recorded parameters, the indentation of events and comments, and the summary of immediate postoperative status.

We also have to make observations and data recordings during the patients stay in the PACU (if this module is available). Its operation serves the safety of our patients, since when they are discharged to the ward, they are fully awake. The MAITSZK also made recommendations for these two workstations.

The stages of perioperative medicine include the after-operation acute pain service managed by anaesthesiology. The IT support and the trustable data handling is assured by mobile devices, following the POC's (point of care) philosophy. The sufficient tool for this is a PDA (personal digital assistant). This tool can connect to the entire anaesthesiology system through a docking station, or even through the use of wireless connection. The doctor, fully aware of the patient's status thanks to this system, can order or change the therapy even from the patient's bed.

The fulfilled work has no meaning, unless the data gained does not get recorded into a databank which aims to serve out anaesthesiology needs. With the evaluation of the databank files, we can match the yearly data service and quality control requirements. It is extremely important for research and prospective examinations, but its data files are good for any type of examinations.

Since there are existing complete systems which match these requirements and the departments can access these systems even in connection with the anaesthesia machines or independently from it, by the way our research followed the other IT application which is the data collection from anaesthesia departments. Data collection is a yearly obligatory task for the data providers of healthcare, which in the early stages happened in paper based form but later on floppy disc.

Objective

According to the requirements of healthcare workers, to solve the problem of data collection, a currently not existing system would be developed, which would:

1. Use the modern methods of IT.
2. The data would be a part of the system according to the international code systems and this way it would be unified. Where this is not possible, the national code systems should be used.
3. The results must be comparable on international levels.
4. They should be introduced with wide professional consensus and agreement.
5. Its approach should be in accordance with the modern anaesthesia workplace's data collecting criteria.
6. It should make the data collection more simple and more approved for the data providers.
7. The summation of data should happen automatically, making the evaluation more easy.
8. Finally, the analysis should provide help for: the professions function, the evaluation of the status of human resources and should be able to model the following year's plans.

The start-up of this task dates back to a past of 15 years. In the country's professional public life, the appearance of ICT within the HSAIT started in the 8th of May in 1995 with the forming of the Section of Computing of HSAIT.

Methods

As shown in the introduction, the work of MAITT's informatics section meant the starting point. The arrangement of anaesthesiology and intensive care data files - in accordance with the international practice - had a base like feature in the fields of methodology. Thank to this, data handling and gathering can be done on a same level in workplaces, and later on in the national system. During the method choosing, the participation in the European Union Research - Development program meant a large advantage. The first step was to build a network, which established connection between the general practitioner offices and hospitals. This program was called PRIMACOM (*Primary care physicians' communication network in Central Europe*). The completed project involved Danish, Italian, Slovene and Hungarian participants and it reached successful communication between the chosen general practitioner offices and hospitals -which are fully acknowledged participants of the project. The successfully completed process was followed by a European Union tender which also utilized network applications called RETRANSPLANT (Regional and International Integrated Telemedicinal Network for Organ Transplant). It was a development project which involved French, German, Slovene, Czech, Slovak and Hungarian participants and it created a patient dossier in the fields of transplantation. This transplantation data could be accessed by all professional doctor groups working in transplantology. The also web-based administrative portal (which was created to transect the project) surpassed the immediate professional experience gain. This is still in existence, being able to assist and handle the whole project's management task system. The project management assisting application, fully approved by the European Union was even able to control, summarise and make the partners financial settlement more transparent. Using this experience and evaluating the usual properties of professional projects, came the idea to resolve data collection by integrating these factors into modern technologies in the field of anaesthesiology. The next important step was in the process of data base developing the "Debrecen Hypertension Study". The main task in this case was the large volume data storage and evaluation, and the experiences originated from it supported the thinking on national level.

When forming the method, the following steps led us to reach the goals mentioned in the thesis to match our goals in choosing the ICT:

- creation of a record structure
- building network applications and experiences in it's use
- the creation and use of an electronic patient dossier and large volume data management and providing the safety of data handling
- gaining practice in every detail of web-based systems for the sake of data handling in safe environments

The development of domestic network applications started earlier. With the use of the

telephone line, we created the Anesztinfo-BBS system, which followed the project of Docinfo. Docinfo established a connection between general practitioners, and in our development with the help of Anesztinfo, 50 institutions used the modems. With the help of a connection between centres, the participants could download material in the directory from the central computer. With the world changing, we formed our web based association system as second in the domestic doctor profession with the domain name www.anesztinfo.hu. Basically, the methodology was at our disposal by 2001. The material which we planned to proceed with this method came from the activity our line of profession's work. The starting point was the yearly collected paper based questionnaire, which initially, was organized by the profession's National Institution. Thanks to the help of the Informatics section, the next step in this was the contribution of computers, but it still wasn't a network solution. However, this process was not so simple, during live use a number of problems erupted, which were analysed. These were the following:

- The difference between the users' operational systems caused problems with running the application.
- The smaller portion of users, especially universities already had experience with the common data base handling applications (e.g. Microsoft Excel). This way the standardized application's conversion to a dbf file format meant extra work for them.
- Due to the not standardised hardware (e.g. printers), it was impossible to base local printing on a standard basis.

By this time, the predecessor of Anesztinfo BBS called www.Anesztinfo.hu meant a robust base for handling the technical problems mentioned above. In the creation of the web based data collecting program, it was a crucial goal to screen out the disadvantages of the systems built in an offline basis. Knowing the technological possibilities, we wanted to match the following requirements:

- Web site for every institution
- authorised operator for each department
- Data collecting and analysing mode
- Yearly obligatory filling out otherwise optional during collection period
- Generating data content and code tablet.

It is also an important task, to provide the possibility for the hospitals using the integrated information system, to use the created data for yearly data collecting purposes. Whenever it is at our disposal, we use record structures in accordance with the official

Gyógyinfok restatement. We used the results of the ESCTAIC (European Society for Computing and Technology in Anaesthesia and Intensive Care) work group. These results showed a need for unification in the fields of European anaesthesiology with 17 commonly defined data. Among the accepted recommendations were CISS (Critical Incident Severity Score) and CNC (Critical Incident). The designed and rearranged data content was held into consensus in 2001 with the Professional Chamber and the Profession Supervisors' participation. The suggestions, remarks made there made the system complete. This way the development became fully approved, and the collection of professional data born in 2002 could start. The new system followed the requirements of European Communication material which is "Quality criteria for health related web sites" COM 2002 (667).

The technological background is provided by a web system based on the SQL database. The portal frame is web based, meaning that with the help of a web browser, every function is useable. The system approves all current browsers. This way the more simple usability and user friendliness are both accomplished, even for our colleagues who averse from informatics solutions. Every piece of information is stored in the SQL server database and the system shows whatever information the current user is looking for. Also, the .NET solution provides clients the ability to use the applications in the form of a central Internet service. This technology ensures the advantages of Application Service Providing. The handling of authorization is managed on multiple levels. The highest of these is the administrator and the lowest is the person who has authorization to input data which grants access to their institution's Web page.

The full functionality of the National Anaesthesiology and Intensive Therapy Reporting system (NRS) can be viewed on the accredited institutions' page. When choosing one of the listed functions on the page, a data entering field appears. The data collecting of anaesthesiology and intensive care happens throughout the following (most important) steps.

- general data of departments
- anaesthesia
 - headcount
 - procedures generally
 - procedures in detail
 - incidents
 - CISS
 - CNC
 - equipments
- intensive therapy
 - headcount

- data of patient's flow
- procedures
- transplantation
- equipments
- pain therapy
- quality

The technology makes validation also available, since when filling the fields, the site automatically corrects typing errors, etc and does not let the data to be filled in inadequately.

If this would conclude the possibilities of data collecting systems, we would only make the job of yearly data collection more simple for data provider institutions and couldn't move onto the yearly collection of data, which is an obligatory task for every professional branch. This is made obligatory by the ÁNTSZ. The regional and national supervisor doctors -with the adequate authority- are able to change the modes of the web page. So the systems abilities are capable of more than just simple data collecting, since when entering this data analyser site, the summarisation of the chosen activities can be done. This way, the system automatically completes the given task, so as defined in the previous parts, all the data collection can be done in every single data filling field. Thanks to this, the national state of anaesthesia and intensive therapy can be followed in an archived state. The available data files can be analysed with the method of data mining for unique requests and concepts. However, the experiences at the professional consensus conference and of the paper and disc based data collection required the completed panels, which would show the needed yearly data from the system. Following the yearly closing and the analysis mode, the analysis screen is available. These follow the data filling steps thematically.

Summarising the development and introduction of the methods, we can safely say that the goals were achieved in the national levels firstly by our web-based data collecting system in 2001. It utilized the most modern methods of IT and code integration also happened. It's introduction was established by a widely held professional consensus. When developed the system, the second module's development made the automatic data summarisation possible. This statement can only be granted by users who have used the system and have experience with it. This examination happened in 2008, after 5 years. Of course it happened with the use of a web based application. The examination's goals were to find out the usefulness of the system and the willingness of data filling. Also, with the dedication of the swot analysis, the end-users can express their opinion about the work stations. The handlers of the OJE system receive an e-mail describing the task, and another request before the examination's closing date. The web site is usually opened for these tasks for one month. The build of the questionnaire followed this logical frame:

- General evaluation - About information technology's application

- Evaluation in connection with the system's build
- The system's professional content
- Evaluation of the system

Further requirements, goals are in the next chapter called Results, in which we summarise the 5 years' experiences and results from the start of the program.

Results

At the end of 2002 and after the arrangements, we started the data collection. Overcoming the initial difficulties, the system showed another of its advantage: the ability of using remote management. Although there was a briefing before the system's initiation and the web page itself has a 'Help' menu point, it occurred that the person doing the data filling could not execute some steps. In this case, the system's administrator - having authority to enter the given (or any) class' (?) web page and is able to solve the problem. From the view of the discourse, the most import results can be examined in the following groups:

- 1 the examination of the professional activities' elements
- 2 following the profession's human resources state
 - a. on the field of anaesthesiology
 - b. in the field of intensive therapy
- 3 the evaluation of anaesthesia's CISS data
- 4 taking a sample from anaesthesia's CNC data and evaluating it
- 5 the acceptance of the developed system on domestic levels
 - a. on the field of the professional branch - the results of the web based questionnaire
 - b. in the case of other professions - the fitment and acceptance of the completed development into the K+F project
- 6 European level graduation of the developed system. European Union appearance - project publications

1. The evaluation of elements of professional activity

In consideration with the fact that the databank required to store data has such a large amount of data, and the number of tablets that can be generated is almost infinite, we will only discuss the most important characteristics of the professional activity's results. The examined time period discusses the data from 2002 to 2007 in every parameter.

The characteristics of anaesthesiological activity are shown in the following. The total yearly number of anaesthetic operations is the same as before. The total number of yearly completed anaesthetic operations divided into types indicated a 31.85% growth in the terms of combined narcosis and regional techniques in 2007. The measured ratio of the laryngeal masks has a very important part in the general anaesthesia procedures, because there is an indication of acceptance of this anaesthesia method - the usage increased by 88%. To accept the views of perioperative medicine in anaesthesiology, there is a need for a workplace that supports it. In the established anaesthesiological outpatient department and PACU numbers, there is no trend or significant change of the patient commerce. The number of endowing places changed, but this is only the result of the continuously shaping healthcare structure, which is verified by the stable traffic. The yearly anaesthesia number related per physician elevated by 13.2% which data describes the dangerous status of human resources.

In the case of intensive therapy, according to the general describing data, the number of patients admitted to departments did not change. This is similar to the numbers of the yearly done anaesthetics operations. The mortality-rate in the intensive departments was 16.61% in 2002 and 17% in 2007, so there is not been a visible change in numbers. The scale between accepted septic patients and their mortality -rate shows numbers available for evaluation. The number of accepted patients shows a 34% gain, and their mortality-rate has only increased by 5.46%.

2. Following the status of the profession's human resources

2.a. Anaesthesiology

In this field of profession, we followed the change of number of specialists-residents-professional assistants in 2002 and 2007.

Human resources			
Anaesthesia 2002	resident	specialist	nurse anaesthetist
	1058	853	961
Anaesthesia 2007	resident	specialist	nurse anaesthetist
	842	861	1315

The discrepancy from the minimal requirements has greatly changed, since the shortage of professionals was 7.74% in 2002 and was 21.31% by 2007. The same approach can be seen in the numbers of nurse anaesthetists, only in reversed tendencies: the shortage in 2002 was 20.63% and it was 4.94% in 2007.

2.b. Intensive therapy

The status of intensive therapy human resources showed a cleared number, it's details are shown in the discussion.

Human resources			
Intensive therapy 2002	resident	specialist	nurse
	667	500	1685
Intensive therapy 2007	resident	specialist	nurse
	473	393	2498

3. Evaluating the CISS data of anaesthesia

When comparing the starting year of NRS with the closing time period of the examination (2002/2007) this is the data we get: in their ratios, the data meets the international results. The larger happenings took place in the of the I. and II. fields. The yearly number of anaesthesia is 477857.

Ciss Score 2002				
I	II	III	IV	V
29489	19034	631	200	64
8.6%	5.6%	0.18%	0.05%	0.018%

The number of serious cases also matches the yearly international number of complications in connection with anaesthesia. There is no significant change in the year of 2007, only in the I-II Score value. The yearly anaesthetic case number is 481280.

Ciss Score 2007				
I	II	III	IV	V
47676	40223	889	36	82
9,6%	8,1%	0,17%	0,007	0,016

In the 5 years of data collecting, there is no significant or trend-like change in tendency, the ratios are basically the same.

4 Taking a sample of CNC data from anaesthesiology and evaluating it

The CNC code system names the event, which we record as an anaesthesiological complication. On international levels, there are a number of classification types, but there is no unified state (like the acceptance of ASA's risk status). Taking the important trends into

consideration, the creation of the following two groups happened: the first names the technical complications and the second collects the physiological changes. The analysis can be done on all complications, but the 26th (hypertension MAP over $> 30\%$ 10') is significant, since this a quality indicator of anaesthesiology. A simple example: when after 10 minutes, the blood-pressure's mean value drops more than 30%, -the narcosis is deep. When it rises with the same ratio, the narcosis is not enough deep (only if other reason can be ruled out e.g. volume loss due to intraoperative vein damage). Of course this 26. CNC code only needs to record the blood pressure changes in connection with anaesthesia. According to the summarisation of data entered by users, the itemised case number of this was 8891 in 2002 and 6951 in 2007. In correlation with the yearly narcosis number, the numbers are 2.5% and 1.8%. There is no significant change here either. The less than 1% difference can be accounted for the diverse in the ratio of the yearly case number.

5. The acceptance of the developed system on domestic levels

5.a On the fields of the professional branch

The system completely fulfilled its function as a web based questionnaire to complete the examination, although the response was very different from the usual in the NRS's system. The number of sent e-mail letters was 182, and 39 replies were capable of evaluation. There were 30 cases in which the delivery was not successful due to technical problems (e.g. full mailbox). There were 4 cases where the filling could not be done also because technical problems. Our colleagues told us about these problems. Furthermore, in 9 occasions there might have been institution level changes which can be seen in cancelled reactions. 139 potential participants could have had replied, but according to the cleared data of the response ratio, only 28.05% did. This result approaches the 1\3 tendency and shows that the data suppliers can be divided up into two sections:

- Type A: completes the yearly dataservice, since it is obligatory but does not have tendency for further cooperation
- Type B: thinks as a participant of the system, has suggestions, and takes part in the evaluation

Evaluating the questionnaire following the logical structure, we can summarise the following:

- About the application of Information for technical use: the IT application has been approved
- In connection with evaluating the system's structure: there has been no significant criticism
- The system's professional content: approved

- The system's evaluation: we received useful notices, supplements

In conclusion the system was able to match the requirements and our colleagues participated in the evaluation process.

5.b. In the fields of other professions

Our SZT-IS-7 IHM project was approved by the domestic K+F community, on the conference which was held by the Neumann College in 2003. This was an opportunity for domestically developed K+F programs, giving them a chance to integrate into the system. With the leading of Dr. Pál Simon, a system was built following the innovation of the results of healthcare informatics K+F. With its help the EKSİ (Healthcare Strategically Research Institution) offered a tender to further the successfully created projects. The Orthopaedic Society registered, and used the knowledge and experience gained in the Anesztinfo's NRS system, and transforming the completed data collection into its own professional profile to use it for government finance. As the resources became thin, this process discontinued with only one completed and successfully passed on knowledge.

6. Qualification of the developed system on a European level.

The European Union approved the ANESZTINFO OJE project into its "best practice" system, and published it in both written and electronic form in its official material. The detailed introduction of ANESZTINFO OJE can be seen on the web page shown in the reference. Also its creation and technical description is recorded in this reviewer. This source is the idea of a printed material (Good eHealth Report 2009) which contains two domestic projects, ANESZTINFO OJE and RETRANSPLANT.

Discussion

Our web based data handling system's analyzing module's (introduced in the Methodology chapter) results make it possible to evaluate the status of the Anaesthesia and Intensive Therapy professional branch. Otherwise, the opinion of data providers illustrates the method itself. In this chapter, we follow the structure of results taking the examined time periods into consideration. In more important cases, (human resources, regional anaesthesia) we do the evaluation with a wider time limit and with the help of data from other resources in order to achieve a more exact evaluation.

1 Examining the professional activity

The total number of yearly anaesthesia types shows a change: within the group, the combined method -narcosis and regional anaesthesia used together, showed a 31.75% increase by 2007, as shown in the results. This is positive data, since it is caused by the growing acceptance of the modern post operative pain relief method.

Examining the regional anaesthesia's types, the professions "customs" can be illustrated.

The following implications can be drawn:

- The number of IVRA (Regional Intravenous Anaesthesia) is almost the same as before
- In the case of caudal anaesthesia, there is a 15% increase
- The largest changes happened in the following two areas, both can be linked to the epidural technique: combined spinal - epidural anaesthesia and epidural narcotics with catheter, in which the number of operations with a catheter significantly decreased: it was 4628 (100%) in 2002 and 2174 (46.97%) in 2007. There has not been a record of a spinal-epidural operation in 2002; however its number in 2007 was 961.

The stable number of IVRA and caudal anaesthetic methods can be linked to the fact that these operations happen in a close professional circle, only in a few institutions. The number of institutions is not persistent, due to the nationwide structure changes, departments cease to exist, and new ones replace them, capable of providing stand-alone anaesthesia care from the private sphere. Due to this fact, we cannot handle this number as a constant value. However, the non-essential changes in the anaesthesia parts suggest the stability of the circle using this method. In other words, it suggests the stability of a professional school community. In the field of patient commerce, the stable case numbers of anaesthesiological outpatient department and PACU can be described as stable. The instability in the numbers of institutions is the result of the changes in structure- similar to the data of IVRA- however; we can see the stability of patient commerce from the data. The yearly anaesthesia number related per physician elevated by 13.2%. This confirms that the doctors have more burdens. This data

becomes more interesting in the human resources chapter, when examining the resident-professional doctor ratio.

Answering our request, the OEP sent us the data in connection with the numbers and types anaesthetic procedures used in the cases of caesarean delivery and femoral hernia in 2008. This granted us the opportunity to examine the escalated segment of healthcare service, since this way we can examine the anaesthesiological method assigned to the given type of operation. We required the help of OEP, because the ANESZTINFO NRS currently only does collection of the anaesthesiological procedures code, hence there are no collection of operations type in our own database. The anaesthesia in the two types of caesarean delivery confirms the forward sweep of anaesthesia, since in 80% of the cases, this is the chosen method. In the case of femoral hernia, ratio in regional and narcosis is almost identical, although the number of local-infiltration anaesthesiology is surprisingly high.

An interesting connection can be found from the data files of intensive therapy. According to the general descriptive data (the number of patients admitted to the departments the increase in usage is 1%. Similar to the base data of anaesthesiological activities, the patient number is stable. There is no significant change in the mortality - rate either. The next connection however, contains information about the quality of work in the units: the number increase of septic patients was 34.08% while the mortality rate in connection with sepsis increased by 5.46%. Given that this is one of the most severe patient types, this data pair indicates the strength of quality attendance.

2 Following the profession's human resources state

2.a. In the fields of anaesthesiology

In the examined time period (2002-2007) data of unfavourable tendencies could be reached from the OJE's system. This is still true, if the steps of database handling development become known. Explained in the chapter, Methods, the creation of a wide professional consensus was primal to help approve the new data handling. We only saw one error of this: in the creation of the human resources program part, to make the exact number and task recording happen. In one censorious condition we couldn't reach an agreement: that in the anaesthesia chapter, when uploading the doctor's head-count, the recorded name and stamp-number should be an obligatory condition in procedures similar to intensive therapy. The cause of this according to the heard opinions is the following:

- In the year 2002, the department applied “mixed” status of physicians – it means that one doctor same time had two work places: one in the OR and second in ICU.
- The closing date of the report is just a moment from the full number of the departments, the workers, who do their job in a circulating system, actually cannot be named.

This restriction has been removed in this state of the system's development. When

reorganizing the national professional supervisor system in 2005, our regional department head doctor's conference held in our professional branch's circle, we got the original concept through the NRS's system, having the approval of the national department head doctor. The data's validation followed the changes; hence an error message appeared when trying to record a doctor into the same two work groups. The data of the two end-points could be matched; the lack of professionals in the examined time period can be proved by facts. After all this, when analysing the tendencies, we can lean on more safe data, and in this case we have a wider time limit (2008) to examine the state of human resources in anaesthesia. The number of specialist in 2002 was 853, and 861 in 2007- this is less than 1% increase. Opposite to this, the number of residents (this notion of resident does not mean specialist in the system but both residents and specialist) in 2002 was 1058 and 842 in 2007. The decrease is clearly visible, since the starting number was 79.6% who entered the process of training. Any kind of change in the number of residents did not increase the substance of professional doctors. The 1% increase suggests that the trained professional doctors disappear from the domestic provider system. The number of nurse anaesthetists showed a 36.8% increase, which makes the job more safe, although it does not dissolve the 15\1994 law regulation, which lets only one doctor to be at an anaesthesiological workplace. This is recorded in the effective minimum requirements. This way, the analyser module of NRS can measure the minimal discrepancy from the requirements. While in 2002 the system was missing 148 doctors and 198 assistants, this number showed an increase by 2007 in the medical work in 363 values. This projects a 245.27% increase, but the lack of assistants is still a problem, since it has dropped to 65 which is a 1\3 ratio. Taking this into consideration, the 13.2% increase of yearly anaesthesia per doctor is an interesting data. The hospitals have the opportunity not to operate all of their operation rooms for a given time. This way, they can assure and maintain-"manage" the minimum requirements (one doctor per operating table). However, the stable yearly case number (the constant work) and the decreasing number of professionals is a risk in the safety of the patients.

2.b. In the fields of intensive therapy

The use of the cleared database achieved in 2007 (meaning that we handled the number of doctors in anaesthesiological different from intensive therapy) strengthened the deficit in this field. The number of professional doctors dedicated to this to this field shows the largest decrease: the recorded number of professionals in 2002 decreased by 78.6% from the starting number. In the case of residents the tendency is the same, the value of decrease is 70.91%. The only result showing increase can be found in the number of nurses, which is 148.24% compared to the 2002 value. The lack of doctors and nurses in the same year was 28 and 721. In 2007 the lack of doctors is 337 the increase is 1203.57%. In the number of nurses the lack is 634 which is still not enough to match the minimum requirements, but the decreasing tendency here is 87.93% measured to the starting ratio. The increase in the doctors field proved our ambition to part anaesthesia with intensive therapy when putting them into the system. In the background of such a change, there was no visible movement in the profession.

3 - 4. The CISS and CNC data of anaesthesia

Collecting the data of the complications increases the safety of the patient. For these purposes, there are separate systems which only work in these questions. This task's results are used and it is being developed by the profession itself, but the civil community has the opportunity to use the system, and upload their data even as a layman. Research shows that few doctors report complications officially, due to a number of reasons. Such is as the uncommonness of the procedure, the fear of punishment and legal consequences. In the development period of our system the solution for collecting complications was natural, but the requirement of compatibility with international databases also made this module indispensable. The frequency of using the application matches the frequency mentioned in the introduction. In 2002, 52 from 152 institutions did not report a CISS event; this is the 34.21% of the classes. In 2007 74 did not report from 159, which is 46.54% There has been no change in the distribution of CISS data, the I-II values appear the most in the system. In judging the quality of professional work, describing the severe of the complications is also important. The sample taken from the physiological part of the describing chapter, which follows the blood-pressure monitoring connection with the narcosis management, did not show any change in the examined period.

Both complication describing systems are a useful part of the full NRS system. However the written data's summarising opinions suggest that this collection requires more attention. Due to this, the expansion of this task part requires separate development and professional supervising. This is proved by the fact that 30%-40% of the institutions did not even take part in this work-this suggests that the quality of the system should be increased. Also, things that if are viewed from a professional stance seem like minor side tasks, although when viewed from the patient safety are base requirements, which can be strengthened by the active participation of the civil community.

5. The approval of the developed system on a domestic level.

The answers of the web-based questionnaire proved the aptness of the technology for executing the yearly data collection. Also the acceptance of the system also happened. The apportionment of answers given to the separate points of the questionnaire differed in the 8th and 11th question. The technical abilities of the 12th 13th 14th questions showed a neutral standpoint, but haven't been rejected. As a reminder, the mentioned points are the following:

- Anesztinfo OJE helps the work need to be done with its summarised data: 8th question
- The perspicuity, organisation of the data entering surface: 11th question
- The enlargement of data entering possibilities is necessary 12th question
- This enlargement process easy manage 13th question
- The "dual field" designed to help data recording increases the safety of work: 14th question

The evaluation of district work involved the 5 head doctors of the profession supervisor network, which was reorganized in 2005. When creating the NRS, there was a county professional supervisor network which worked with 19+1 people. The users approved of the technical - technological possibilities of the 11-14th questions. The positive evaluation of the system's possibilities are not relevant from the view of using the system, it does not affect its functioning.

Important questions from the view of the study such as:

- The reception of ICT
- The role of data
- The efficiency of system development

deserve a separate evaluation.

The reception of ICT technology is clearly proved by the pertinent question group. The meaningless of data can not only be of use for guaranteeing it's handling. The participation in joint work is strengthened by the data suppliers' opinion of the previous availability's need. The answers show the acceptance of the digital culture, since they strengthened the assumption that with its data, the OJE is able to provide support for creating the yearly report. Finally, we examined the productivity of system development. The positive answer (feedback) can be connected to the role of the help menu point in the system. If the use of this menu point is infrequent, that means that the web page has a good construction, is user friendly, and it' structure is available. The answer strengthened the line of development. The evaluation of free text is also edifying, knowing this is the key piece of the system's stability, since the reactions, answers come from the users who are in the group of active users of the web. The following SWOT analyses are out of the ordinary:

Strengths:

- The current version is perspicuous, it's use is fast and simple, the revision and repair of entered data is solved. The data filling is safe, only the registered members can access the system.
- Finally, it doesn't change by year.
- Perspicuous full system.
- Concrete, perspicuous, back traceable.

Weaknesses:

- In some cases, the filling is hard, circumstantial e.g.: codes in intensive departments, patients taken, handed over to other institutions and the difficulty of recording institute data and printing it.
- It is worrying that in the headcount fields (number of doctors, nurses) the number indicating the headcount only appears on the main site, after entering the name and identification number (stamp number) in the required fields. It is quite important, since there are instances, when there is a huge fluctuation in numbers within one year. Why isn't a simple data number enough? Why are names, stamp numbers etc required? Especially when there are only 30-35 nurses?
- Some special operations (CT,MRI, endoscopies) are not in the system. We coded them into the urgent operations.

Possibilities:

- Joining IT system, data acceptance
- Continuous development, professional, content and IT perfection, also correction of errors

Dangers:

- Intensive data will not be identical with the data sent to the OEP, (main diagnosis) coding practices, under optimization, but this is not the fault of OJE.
- It doesn't show every crucial questions, especially not from the staff attendance. Our colleagues working in different work contracts cannot be forced to work in the same way. It's system cannot handle this. According to the numbers, there can be a lack of doctors among many doctors.

The warnings of weaknesses and dangers must be built into the system, and the possibilities show a line of development. Evaluating the SWOT analysis, it shows the acceptance of the system. The suggestions should be written in the following year's report, especially due to the fact there hasn't been a comment containing an important, structural item. As expected, the reorganisation of hospitals and their departments will finish, this way the data entering

requirements will become more perspicuous on the institution's site.

The acceptance of the developed system in other professions appears in the facts among the results, but we did not measure its usefulness.

The shown examples proved the usability and advantages of the web based national data collecting system. The use of the system helped the advance of digital culture in the profession, since the user friendly surface, the easier program handling - in contrast with the old, disc version - increased the willingness of participation among our colleagues. With this help, a more accurate picture could be made of our profession. Hungary joined the European Union in the middle of the examined period. One result of this is that a great number of doctors applied for jobs in mainly the Scandinavian countries and England. One result of this is that the number of profession doctors has an uneven apportionment, sustaining this problem even more. Although the number of nurse anaesthetic increased, it didn't mean any help in the utilization of the anaesthesia workplaces, since the anaesthesia-intensive therapy is an operation bound to the doctor. The more exact numbers describe the same status in the field of intensive therapy, where the situation is even more complicated. The leadership of the institutes can handle the lack of doctors by the programmed operation of the surgery rooms. However, in the case of intensive therapy, the lack of specialists can cause the decrease of hospital beds, if the minimal requirements in the fields of human resources aren't met. The loosening up of this requirement system is not a reasonable step, since the connection between the insufficient number of staff and mortality has been revealed by a domestic retrospective examination. During the treatment of patients with insufficiency of more than one organ, a significant connection has been found between the number of nurses and the increase of survival rate. This information and examination only strengthens the necessity of mapping and following the exact number of specialists, let them be doctors, nurses, and professional assistants.

The trend analysis of the data from the reporting system enables us to draw some consequences about the present stage and the future of anaesthesiology and intensive care in Hungary. In the past couple of years we have had to face the fact that the situation of our speciality is distressing in Hungary. There are basically two reasons for this situation: first, healthcare in general, and especially anaesthesiology and intensive care, is seriously underfinanced in Hungary. As a consequence of this, the salaries of the physicians working in this field are approximately one-fifth of the Western-European average. Second, in contrast to this, migration is free in the European Union (especially for medical specialities) and anaesthesia is a more valuable speciality in western EU countries.

In conclusion: Due to its continuous and computerized follow-up web-based data reporting system can help us in the regular medical service because it allows us to retrieve data for:

- Planning our speciality in the field of resource management considering the human aspect
- Improvement of quality, e.g. via checking the numbers of up-to-date processes in departments
- Improvement of efficacy and calculation of cost – benefit (return on investment) ratio

via analysing the professional processes at departments

Hungary has been an integral part of the European Union already for five years. The main goal of the HSAIC was to collect and to provide valid, updated data on the activity of anaesthesiology and intensive care. The database included both general data (number of cases/year) but also specific data on workload activity. In this introduction we have been only able to present some of them.

As the reporting system works according to internationally accepted guidelines, our data can be theoretically compared with data from other countries of the EU. Data acquisition using the Web- based data collection and Web based data query is flexible and easy to use for all departments. One of the initiatives of the EU eHealth was the recognition that the USA played the main role in information technology advancement. Due to this fact, the amount of data from there was always much larger than the databases of some European countries put mechanically together without any summarisation. The Web page of International Federation of Nurse Anaesthetist shows the number of anaesthesia cases per year in the USA: 50 000000. <http://ifna-int.org/ifna/page?25> The necessity of anaesthesia documentation was described in the Guidelines of Sections by the Board of Anaesthesiology of the European Union for the Medical Specialist but similar data, requested in the guidelines are not available. A desirable next step in this field is to make an adaptation of this or another similar web-based data management system in countries throughout the EU. The extension of the system capacity is only a matter of support. Commercial web technology and interoperability possibilities support the ability to extend the system from national to cross-border applications. In our opinion this should be our goal in the upcoming decade.

6. Summary

In the dissertation we summarised the results of the usage of data-collection in anaesthesiology and intensive therapy with the contribution of information technology and using the developed web-based system on a nationwide level. We have reached our goals the following ways:

1. The system utilizes the most advanced methods of IT. These methods were pioneer during the development period but nowadays became generally used, not only for the direct health care data collecting, but also in the use of multicentre studies.
2. All the data was built into the system according to the international code systems. Although the coding of anaesthetic complications has not been standardized internationally, the similar seriousness system like the CISS was used before.
3. The results can be matched on national levels - the method of code integration is mentioned in the second point.
4. Although the system has been introduced with wide professional consensus and conciliation, we had to modify it in order to create the exact human resource map. To determine the anaesthesiology and intensive care work places and headcount data, we used the validation provided by ICT since 2005. This step was only taken after the new consensus conference, which was held on the regional leader supervisor meeting.
5. The system approach is in accordance with the modern anaesthesia workplace data management criteria and requirements. We already received ideas from our colleagues who evaluate our web-based data collection system about this connection, which could be working between the NRS (National Reporting System) and the electronic anaesthesia record keeping data. Actually, the records are still being written by hand.
6. The data collection became more easy and simple for the local data suppliers, as the web based questionnaire confirmed.
7. The data's summarization works automatically. Without it's help, we could not have proceeded to the data mass, which is needed for the analysis. This function is provided by the NRS's analysis module which is accessible with adequate authorisation process.
8. Finally with the help of the analysis, we have evaluated of the functionality of our profession and the map of human resources. The important conclusions are the following:
 - The data of our procedures and critical incidents are fit to international trends.
 - The data of human resource management shows decreasing a number of specialists
 - The acceptance of the developed system was measurable on a national level with positive outcome and the qualification of NRS occurred in European level because the system is part of the best practice of eHealth report.

Key words: anaesthesia, audit, intensive care, web based data collection

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