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2009

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Abstract
The electronic health card (EHC) is presently being introduced in Germany, however in a much slower pace than originally anticipated and planned. For an evaluation of the applications of EHC a doctor´s practice of a dentist was chosen as reference practice. To analyze the direct effect of the EHC, a process analysis was made of the actual and future EHC processes. For exploring potential user acceptance a patient survey including 49 patients was conducted. The benefits for all involved parties were observable. Based on these analyses, some conclusions are drawn for the improvement of the EHC introduction in Germany.

1. Introduction

The Electronic Health Card (EHC) should have been introduced in Germany since 2006 [15]. Due to many problems the introduction is delayed until now. EHC will replace the actual used health insurance card [13] that only can save administrative data while EHC has additionally functions like cryptography and will act as a communication turntable for all parties, involved in the process of health care providing. The use of networked information technology across boundaries of medical institutions and sectors is a potential opportunity for increased efficiency and better delivery of health care [8]. It creates numerous possibilities such as improved communication possibilities between health care providers and patients [14], smoother transfer of information across electronic boundaries [23], lower costs [10], increased access transparency, and improved treatment quality and safety [11]. So the introduction of the EHC and its extended applications has several direct effects to doctor´s practices. The handling of medical data in the doctor´s practice is affected, so subsequent process reorganizations have to be analyzed [2] (the internal processes have to be adapted to the EHC). This work analyzes these effects and changes. Furthermore, this paper gives some advises to doctors and EHC developers to improve the functions and usability of the EHC. The detailed analyses were made in the reference practice of a dentist. Afterwards the results were compared and transferred to other doctor´s practices.

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The EHC´s introduction is based on the law of modernization of compulsory health insurance in Germany. The functions and regulations of the EHC are defined in § 291a and § 291b of the 5th book of Code of Social Law [15, 16]. The EHC possesses two different types of functions. On the one hand the mandatory functions, like the administrative data and the electronic prescription. These functions allow the physicians to check the administrative data of the patient and to write prescriptions on EHC. On the other hand there are the voluntary medical functions like the emergency data record and, in a later stage, an electronic patient record [5]. The emergency data includes medical information (e.g. blood group and allergies). Fluoroscopic images, laboratory findings, operation reports and other data of examinations can be stored in the electronic patient record. The EHCs will be mandatory for every German citizen. Furthermore, each healthcare provider will receive a Health Professional Card (HPC) and the essential computer equipment (e.g. the connector that interconnects primary systems, card terminals and communication infrastructure). Both cards have a clearly defined structure and set of functionalities. Sensitive medical information will be protected by a PIN and is only available with a HPC of a doctor.

Prior to the introduction of the EHC, four test stages will be carried out. Stage 1 and 2 are laboratory tests with simulated data and stage 3 and 4 are field tests with real data [13]. Stage 3 begun in 2008. Stage 3 is the first field research with authentic data and 10,000 participants. Stage 4 should follow in April of 2010 including 100,000 [9].

2. Data acquisition

To be able to analyze the introduction of the EHC in Germany, for two months we observed all processes in a doctor´s practice, 13 different processes were identified and written down (e.g. prescription issuing, invoice writing). To check these results the employees were interviewed about their daily work. Afterwards the results were compared to the previously observed processes. Finally these results were also compared to the processes in other doctor´s practices, which have been observed briefer.

Furthermore an evaluation of these processes was carried out. In this study a mixture of the methods written questionnaire and interview was used [19]. The participants were chosen randomly. All patients entering the doctor´s practice during the time of the evaluation were pleased to fill out the written questionnaire [20].

Furthermore, twenty randomly chosen patients were also interviewed personally (oral interview) for gaining more background information and to minimize the disadvantages of the written questionnaire[3]. Due to the random choice of participants and the questions unbound to the reference practice the results can be transferred to every doctor´s practice.

3. Process analysis

3.1. Actual process

The process [10] in the reference doctor´s practice was modeled in an event-driven process chain (EPC) notation [4]. For a better overview we divided all processes into the main process and into several process groups. The main process (figure 1) is mostly based on the patient´s clinical pathway through the doctor´s practice.

[3] All advantages and disadvantages of an interview can be looked up in Schnell/Hill/Esser [20].

The process starts with the patient´s entering the doctor´s practice and the registration at the reception. Depending on whether the patient needs a new prescription or a treatment, the particular process group will be applied. The main process continues with the preparation of the therapy and if needed the request of information by the medical assistants at the reception or by the doctor. It continues with a waiting sequence for the patient or the treatment by the doctor. After the attendance, the medical assistants start with the post-processing of the therapy. If needed, the patient receives a prescription.

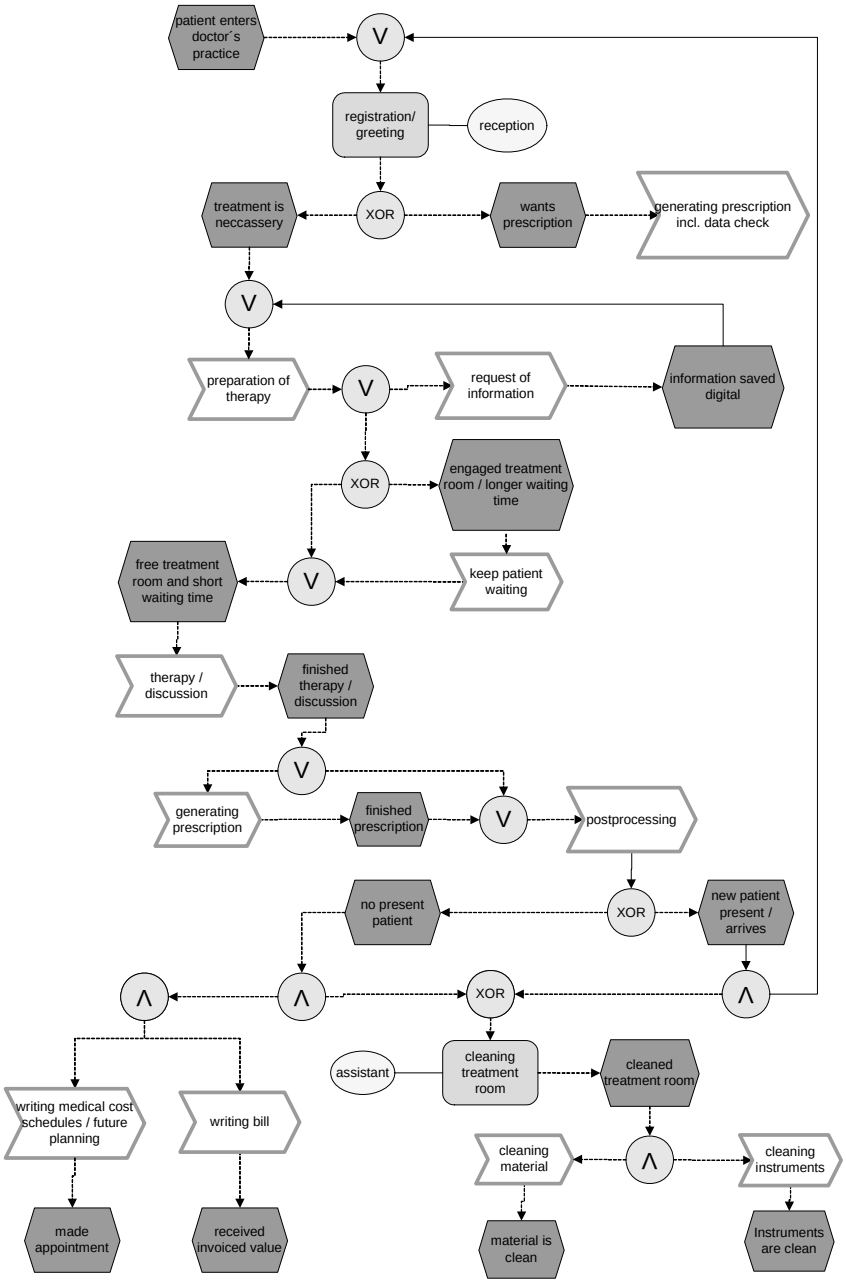


Figure 1. Actual process without EHC

When all these activities are finished and the patient has left the doctor´s practice, process groups, like “cleaning instruments”, which do not involve the patient anymore are applied. Regardless whether a new patient has entered the doctor´s practice or not, the medical assistants have to clean the therapy room and all used instruments. They also have to check the material and, if needed, order new material. Depending on whether a new patient has already arrived, the doctor could start

with the next therapy. If nobody has turned up, he could write bills and medical cost schedules. This whole process is nearly the same in every doctor´s practice. The process only differs in the main focus of medical treatment.

3.2. Process groups

The mostly affected process group by the introduction of EHC is the process group “request of information”. Figure 2 explains this process in detail. If a new patient needs a therapy the reception team has usually to gather information required for a patient`s treatment. This is conducted by consulting former doctors and requesting previous fluoroscopic images. Digital sent images are than stored in the primary computer system. Analog images have first to be scanned by the reception assistants and then be stored in the primary computer system. Additionally the patient has to fill out a BFS form and an anamnesis form with his health issues. The BFS form is an exception in the reference doctor´s practice. It is a form for the BFS health finance GmbH, a factoring agency. This form is needed for billing and has nothing to do with the EHC or the medical therapy. Therefore we do not consider BFS form further.

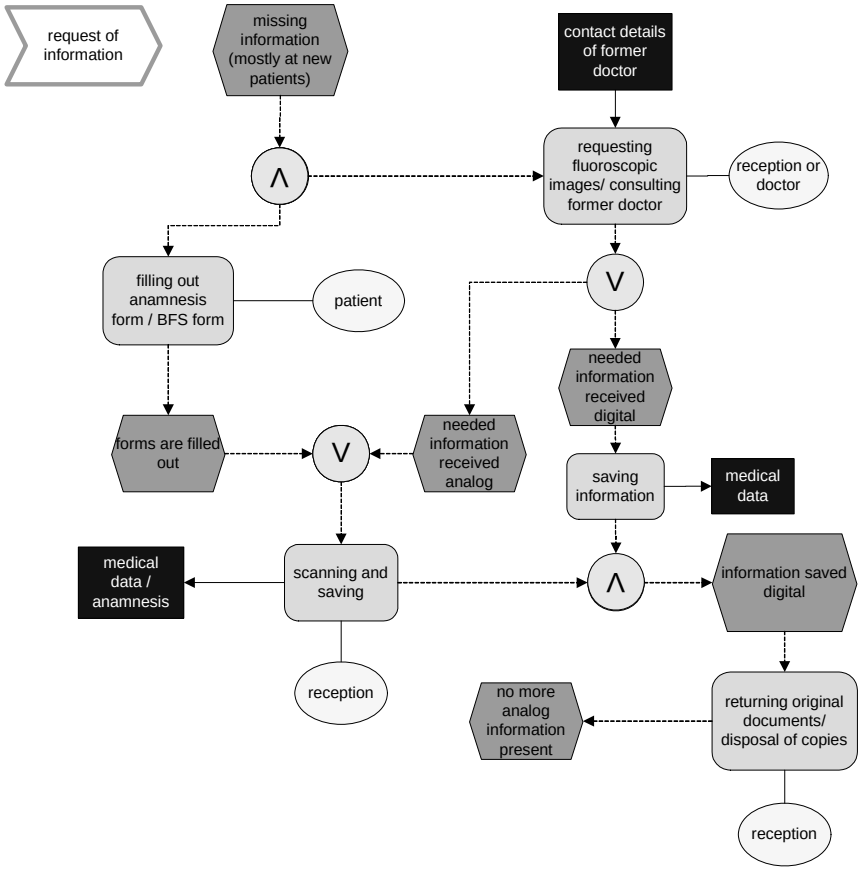


Figure 2. Example process group: “Request of information” without EHC

The medical team has to scan these filled out forms and store them in the doctor´s computer system. When all needed information is collected the doctor can easily use it with his computer in the therapy room. Analog images or documents are no more needed and will return to the previous doctor or will be disposed if it is a copy. The difference of paper based practices is that the data will be collected in a paper based patient record and the assistants have to prepare this record for the doctor. Digital information can also be printed and stored in a paper-based patient record. There are

also some mixed forms possible. Due to the obligatory documentation requirements of a doctor the documents have to be stored at the doctor´s practice [24].

3.3. Future process with EHC

Based on the main process, a future process including EHC was designed. For designing the future process the generic processes of the EHC were used [12]. Also the estimated time spans of the new process steps have been calculated. It was considered that telemedicine and telematic applications could only establish in everyday use if their changes do not interfere with the actual processes or even have advantages for common processes [25].
The main structure of the process groups stays the same. One difference is that the process group "writing data on EHC" is added. The new process group is run out at the same time as the process groups "writing medical cost schedules / future planning" and "writing bill" (figure 3).

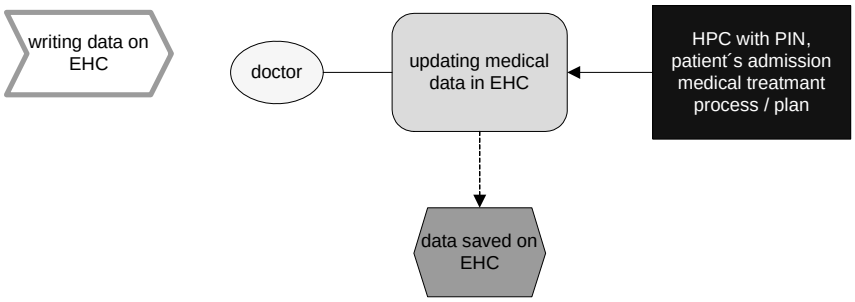


Figure 3. New process: "Writing data on EHC"

The process groups have to be digitalized and be bound to EHC. As one example of the digitalization of the process groups the former shown process group of "request of information" is visualized in figure 4. In comparison to the actual process group only the sequence of the BFS form remains the same. The sequence of requesting information is changed completely. If every patient and doctor uses the voluntary medical functions (such as the electronic patient record) the treatment will become much more effective [18]. With the patient´s admission reception assistants could download the required information and thereby save much time (up to approximately 2 minutes per patient for the doctor in the reference practice, because of no more needed telephone calls to gather required medical information about the patient). If the practice still prefers paper based records information can still be printed out. Due to the voluntariness of the medical functions this functions have not to be used by every time [5]. By comparing actual and future process groups it is possible to analyze the completely saved or lost time.

4. Patient survey

To analyze the usage of voluntary EHC functions 49 patients were interviewed. The acceptance of the patients is the condition that new voluntary functions (e.g. electronic patient record) of the EHC will be used [6]. Therefore, the used questionnaire contained direct questions about the possible usage of the EHC and also included possible indicators for its acceptance[4]. Indicator questions were about participants´ internet, online banking and PIN usage and their security perception while using these services. Another indicator is the fear of losing control of their personal medical data and a unauthorized person´s gaining insight into their data. Direct questions were about the future usage

[4] Indicators are directly observable variables [17].

of the EHC. It was asked, if the patients will use the electronic patient record and who should be allowed gain their personal data.

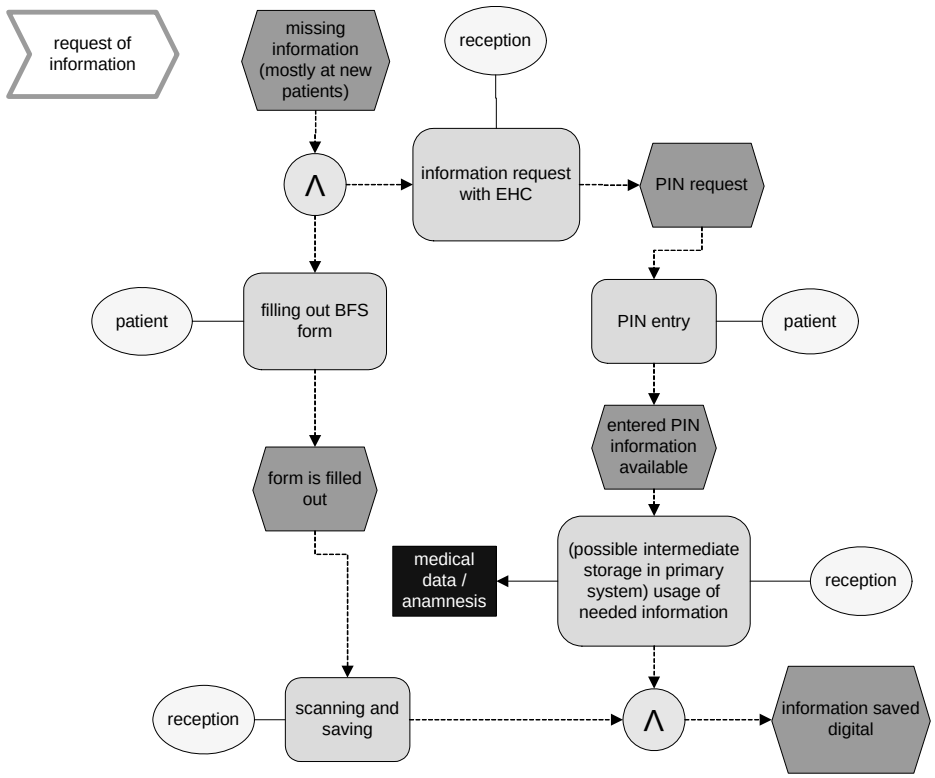


Figure 4. Future process group: "Request of information"

By using the indicators it was possible to deduce improvements for usage and security perceptions by the patients. All important results are shown in table 1.

Table 1. Percentages of desired usage

Would you use the function of the EHC to save your medical data?	yes	no	do not know
	89.9%	4.1%	6.1%
Which kind of data would you prefer to be stored on your EHC?	all data	chosen data	emergency data
	59.5%	38.1%	2.4%
Which doctors would be allowed to have an access to your medical data?	all doctors	chosen doctors	my family doctor
	34.9%	58.1%	7.0%
Who is allowed to have an access to your medical data?	assistant and doctor	only the doctor	
	58.2%	41.8%	

The main result of the evaluation is that 89.8% of the patients would use the voluntary functions of the EHC. Apparently, 34.9% of the participants would allow every doctor to use their data. In contrast, 58% would give insight into their data only to special self chosen doctors. The rest of 7% gives their data exclusively to their family doctor. 59.5% would store all their medical data on the EHC and 38% would like to store specific self chosen data. Only 2.4% of the data patients would store solely emergency data. 41.8% of interviewed patients will allow only the doctor to gain access

to their medical data. This result shows the trust to the doctor but a smaller belief for the assistants. So the doctor will have to download more information on his own and lose more time (a download could need up to 3 minutes per patient). To get further precise results the participants were divided into two groups: age groups and usage groups.

4.1. Age groups analysis

The age groups are divided into four groups: till 30, 31 to 50, 51 to 65 and above 65. We observed curial differences between the groups. For example the internet usage strongly differs between the age groups [21]. The participants under the age of 30 show an internet usage of 100%. With increasing age the internet usage of the participants declines. The age group from 31 to 50 has a usage of 93.75% and the group of 51 to 65 year-old has a usage of 75%. The lowest usage of the internet shows the age group above 65 with only 50%. These percentages can also be compared to a TNS Infratest study [21]. Our survey confirmed these results (table 2).

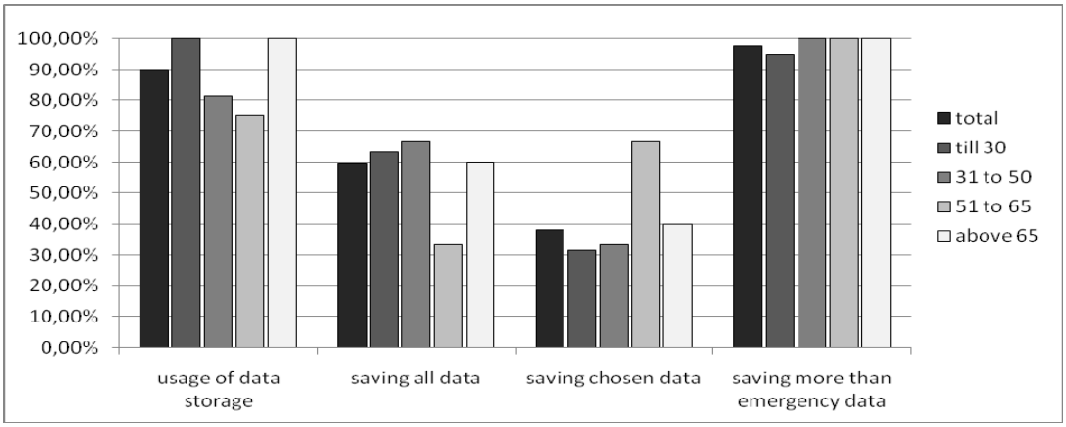
Table 2. Internet usage by age (source: according to [21])

Age	Percentage of internet usage	Age	Percentage of internet usage
14-19	89.4	50-59	58.3
20-29	87.2	60-69	35.5
30-39	82.2	70 and older	13.2
40-49	72.6		

The possible influence of these indicators on the usage of the EHC will be analyzed in the usage groups' analysis.

An important difference between the age groups shows the usage of the voluntary medial functions of the EHC. The complete age groups till 30 and above 65 would use these functions and would store its medical data on the EHC. In the age group 31 to 50 only 81.25% would use the voluntary functions. In the group of 51 to 65 year-old 75% will use them. This shows that there have to be some reasons why the working generation (31-65 year-old) is more skeptical against the voluntary medical functions than the other generations. The exactly percentages of usage of voluntary data storage are shown in the left column of the table 3.

Table 3. Intended usage of voluntary functions by age (by patients)



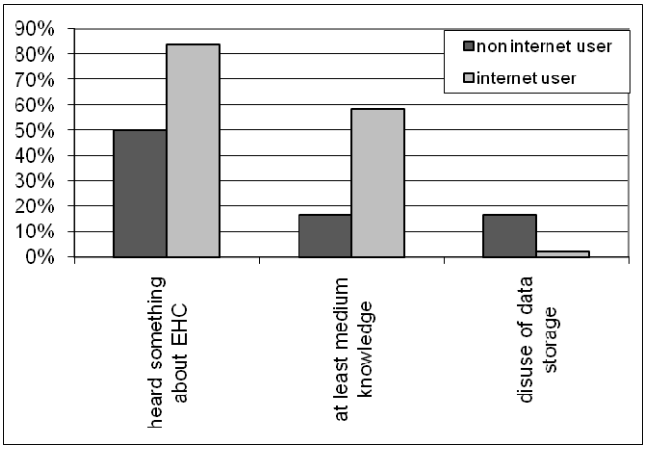
The left columns "usage of data storage" show the former described general usage of data saving of the age groups. The columns "saving all data" represent the percentages of the patients, who will use the storage of own medical data. The average usage of saving all data is at 60%. Only the

patients between 51 and 65 differ significantly with fewer than 35% of usage. This result fortifies their skeptic position and has an effect to the next columns. The columns “saving chosen data” represent the patients who will store self chosen data. I.e. they will only store data from special doctors or treatments. Here the average is at nearly 40% and the group of 51 to 65 differs because of the coherence to the columns before. The columns “saving more than emergency data” are the sum of “saving all data” and “saving chosen data”. This sum is very important for the doctors, because only with more than emergency data they can save time by accessing all of required information via download. The average is nearly 100% and so it can be calculated that if someone uses the voluntary medical functions of the EHC doctors will surely benefit.
Moreover, some demonstrative differences in the usage and security perception of the internet, online banking and PIN were found out [21]. From these differentiations differences in the usage of the EHC by different patient groups can be derived. Another important indicator for the EHC usage is the fear of unauthorized persons, e.g. employers, getting insight into personal medical data. These indicators have consequences on the age groups and have been analyzed separately to get a better coherence.

4.2. Usage groups analysis

One clear result of the evaluation was achieved by analyzing the connection between the usage of the internet and the usage of the voluntary EHC functions. As shown in table 4, the usage of the internet has a positive effect on the knowledge about EHC introduction and the usage of the voluntary EHC functions. Internet users know more about the EHC and would probably store more own medical data on the EHC. This result was also analyzed by gender and has shown that every interviewed male internet user would use the opportunity of data storage. The female internet users are not so familiar with the introduction of the EHC in Germany. Here 83% would use data storage and 12.5% do not know whether they will use date storage or not. A related result was at non internet user. More female than male participants would not use the functions of the EHC. That shows that male participants, with normally higher affinity to technique, would have a higher usage of the EHC functions.

Table 4. Comparison of internet user to non internet user



The security perception about internet applications has also an influence on the usage of the EHC. All internet users who think the internet is secure will use the voluntary functions of the EHC. Most of these patients would also store all their medical data and would allow all physicians to use them. The evaluation also showed that a higher usage of voluntary functions is visible at online banking

users. Furthermore, patients who feel secure about their PIN would probably use the voluntary functions of the EHC.
The last indicator is the fear of unauthorized persons getting access to medical data. Here, a clear coherence between this fear and lower usage of EHC functions is visible. In the group of participants who were afraid of losing control of their data fewer participants would store the data on the EHC than participants without this fear. In this group there is no difference between male and female. This indicator and the PIN are a reason why 100% of the group above 65 year-old would use the voluntary functions of the EHC. In this group nobody is afraid of losing data and most of them think the PIN is secure. These different indicators and their different allocation to the age groups explain the different usage of the EHC within the groups.

5. Conclusion & outlook on future work

Based on the analyses, the EHC should bring benefits to all involved partners. The patients could receive a qualitative better treatment because of a better availability of the medical information required by the doctors [22]. The doctors could save time and money because of easier provision of medical information [2, 7] In the reference practice for example the doctor could save up to 10 hours per month if no phone calls to former doctors would be needed. Based on the evaluation it is obvious, that the health insurance companies should run an information campaign for the EHC. In this campaign it will be important to address the insured persons especially with information about given security measures. It is important to inform the patients about the different used security methods such as the codification of data (e.g. for internet users) and the PIN. User acceptance on the side of physicians as well as patients plays a special role. Assessment of the security measures is a significant aspect of the acceptance.
Furthermore, for the better acceptance of the EHC by the physicians the voluntary functions should be introduced as early as possible. Only these functions could achieve real benefits for the doctors. Finally, it was briefly checked by comparing the derived processes to other practices if these results are transferable. Analysis of another practice showed related processes, the transfer is thereby possible. The processes in general are always aimed at the patients, disregarding what kind of doctor. Only the emphasis of the process groups in the different practices can differ. Thus, the EHC could bring every doctor´s practice a profit if everything will work according to the plan.

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