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An Electronic Out-of-Hours Health Record

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Abstract. In this paper, we describe the design, creation and testing of a new Web-Based Electronic Health Record for Out-of-Hours (OOH) use with special emphasis on coding matters. The context is the Belgian health system, in which a patients´ health record keeper is a specific GP, to whom the OOH reports, generated by any colleague who meets this patient during week-end or night shifts should converge. The system enables structured and secured acquisition of the records, intermediate storage and transmission to the GP´s who keep the respective records.
In the first part of the paper, the design and implementation of this web-based application are highlighted in view of the SOEP registration methodology and explaining how coding was implemented, so that the users apply it seamlessly.
Currently, the web-based OOH health record has been deployed and is en effective use by GP´s of the Domus Medica association.
In the second part, a first evaluation is made, based on feedback by a group of pilot users, this evaluation shows good acceptance by field users.

Keywords. Physicians, Family; After-Hours Care; Medical Records Systems, Computerized; User-Computer Interface; Evaluation Studies; Questionnaires.

1. Introduction

In Belgium, primary health care (PHC) is provided by general practitioners (GP's) and this mostly in private practices [1]. Therefore out-of-hours (OOH) care is organized in rotation in those private practices for each specific area.

When a patient consults an out-of-hours GP, this GP has no access to the patient's health record. What's more, the GP's Electronic Health Record does not allow him to make an electronic record of the patient's visit that can be sent to the patient's regular GP.

To solve this situation, the members of the Flemish GP society (Domus Medica) designed an OOH database application [2]. It was the first large-scale application implemented by GP's for GP's without external funding. Since mid-2003 this database has been made available as Freeware and since then it has been continuously improved, driven by feedback from the GP user base.

Unfortunately, this application gives rise to problems regarding installation and updates on the local PC. Finally, compatibility issues with the operating system and MS Office can be mentioned. The application can hardly be used with non-Microsoft operating systems, such as Mac-OS and Linux or UNIX.

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Therefore, we decided to design and implement a new web-based application that will solve the difficulties experienced with the present MS Access based application. This paper describes the design and the user evaluation of the new out-of-hours health record.

2. Material and Methods

The aims of the web application were to enable out-of-hours record gathering with a user-friendly and efficient interface.

The main tasks of this web application are:

- to record the patient's visit to an OOH GP and send an structured electronic record of the visit to the patient's own GP
- to enable the OOH GP to assign codes to different elements of the report
- to store this coded data on the server for further analysis

We have opted for a web-based system because it does not give rise to installation or configuration issues and it is platform independent. Also, a web-based application can be designed with a ´look and feel´ comparable with websites such as Yahoo! and Google with which computer users have gained familiarity, leading to immediate adoption.

Secondly, we have chosen to use open source programs as much as possible.

Thirdly, we have chosen to provide a 'keep it simple' interface. This means that the functionalities are logical and intuitive and that the GP can master them easily.

Fourthly, we opted for a highly secure environment, especially because the application is accessible via the Internet. This means that there has to be a reliable authentication procedure with an encrypted communication protocol coupled with a logging mechanism in the background.

2.1. Step by step description of the functionalities realized by our out-of-hours health record web application.

2.1.1. Authentication, Access and Encryption

First, the user has to introduce his login and password. These are filled in via the registration window. The password in the database is kept in SHA1 format. If it is correct, the user goes on to the second authentication step.

In the second step the user has to insert the 'paper token' that he received after registering. The web application displays a random number between 1 and 20 and the user has to introduce the letters that are listed after this number on his 'paper token'.

The user has only 6 attempts to complete a correct authentication. If he does not succeed, the account will automatically be blocked.

This page and the following pages are secured in three ways:

- there is only the possibility of using an encrypted connection with strong ciphers
- only connections from Belgium are accepted with the Apache GeoIP module [3]

- every action (authentication, viewing records, sending records, ...) is logged. The user is informed about this feature: he can check his own logbook and acknowledges that he can be sanctioned for misuse.

*2.1.2. Filling in records - Medical Part (**Figure 1**)*

Ideally, the record consists of what clinicians have heard, seen, thought and done [4]. So we did implement the SOEP system [5]: subjective (heard: patient complaint), objective (seen: clinical/technical examination), evaluation (thought: possible diagnosis), planning (done: medication, sending to hospital, prescribing physiotherapy, ...).

For each of these subparts, we provided the possibility to write in 'free text' because it is not possible to code everything (nuances, descriptions, ...). For the subjective and evaluation part it is possible to code with the IBUI thesaurus [6]. We selected the IBUI-thesaurus, because it is much easier for the user to find the correct term because the thesaurus includes jargon, idiomatic expressions, synonyms, etc. Secondly, each IBUI term is linked with one ICPC-2 code and one ICD-10 code: this facilitates scientific research afterwards.

In the web application there are three ways to find the correct IBUI code:

- ICPC → IBUI: first, the user has to click on the right ICPC-code in the ICPC-tree: he gets a list of IBUI terms which are related to this ICPC-code.
- search term → IBUI: the user has to type in a search term. The user has then to select the right IBUI term from a list of corresponding terms
- list of most used IBUI-terms: this list has been copied from the former web application of the Flemish GP association (Domus Medica). (This list is said to contain 80% of the codes used during OOH visits.) The user has only to select the right IBUI term.

In all three cases, when hovering with the mouse pointer over an IBUI-term, the user sees descriptions of the related ICPC and ICD codes.

For the medication under the planning part, we have linked the medication to a Belgian CNK code (Code National – Nationale Kode).

The actions under the planning part (referral to hospital, administration of vaccination, application of pressure bandage, ...), are linked with the ICPC-2 codes.

2.1.3. Record verification and acceptance

After the user acknowledges that the report is ready, he gets a final overview of its contents (without input fields or buttons). He can then choose to accept it as finalized.

2.1.4. Transfer of Record to EHR of patient's GP

The record will be sent to the EHR of the patient's GP in MediDoc or Kmehr-Bis [7] format (depending on the choice of the receiving GP). An external program (MediBridge) does the secured transfer from the server to the PC of the receiving GP.

2.1.5. Storing the records on the server.

All the record fields are stored in the tables of the database server. In this way, it is possible to analyze the data records afterwards.

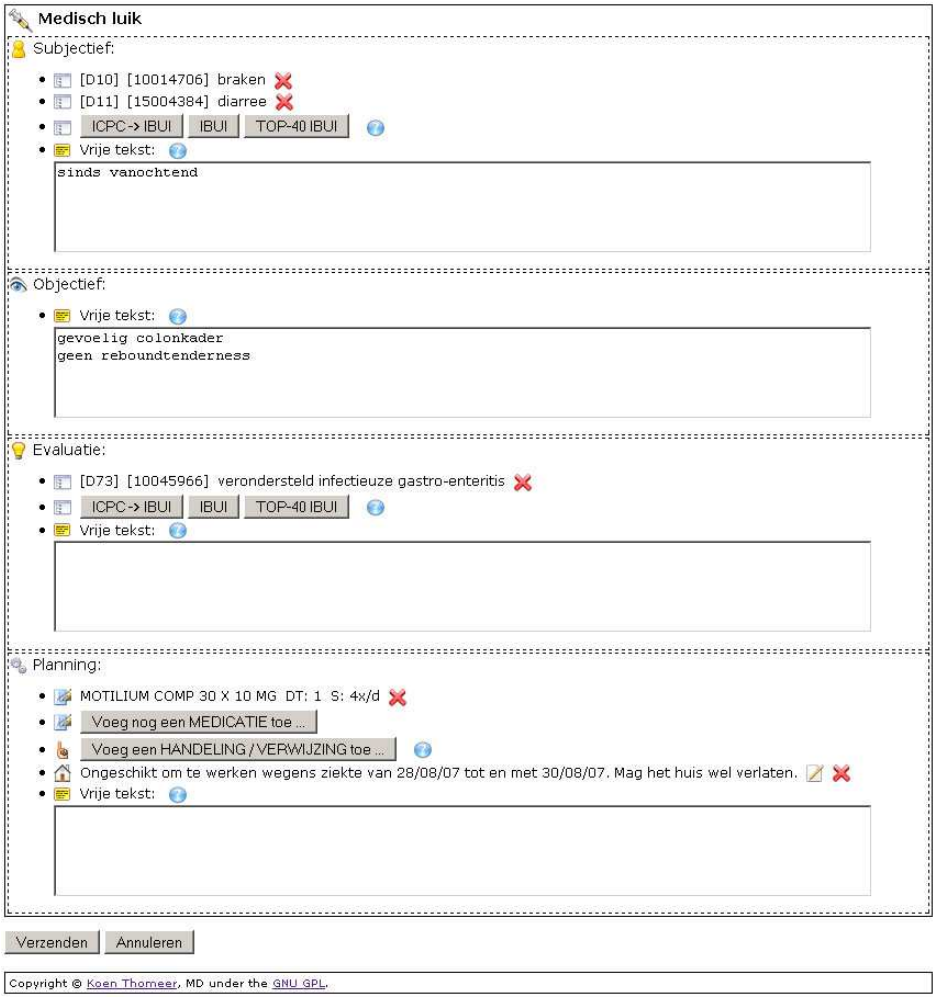

Figure 1. Medical Part (Fill in Record)

2.2. Evaluation of the web application

We have made an evaluation of our web application to find out whether or not it meets externally validated usability criteria, using the computer system usability questionnaire (CSUQ)[8].

We posted a message on the electronic mailing list of the Flemish GP society (Domus Medica). Every GP interested in participating would be accepted. Because we were aiming for less than 30 participants we did not plan to analyze the participants' profile.

To the CSUQ list (**Figure 2**), we did append one question to evaluate the usability of coding the subjective and evaluation part (Q3) and another question to evaluate the

medication module (Q4). Question 17 of the CSUQ was not used in our questionnaire because the Dutch translation of this question leads to about the same formulation as question 16 in the CSUQ (Q18). The user could score from 1 (strongly disagree) to 7 (strongly agree) or say that the question was 'not applicable' to him.

Q1	Overall, I am satisfied with how easy it is to use this system
Q2	It was simple to use this system
Q3	The coding of the Subjective and Evaluation part was simple
Q4	The prescribing of the medication was simple
Q5	I can effectively complete my work using this system
Q6	I am able to complete my work quickly using this system
Q7	I am able to efficiently complete my work using this system
Q8	I feel comfortable using this system
Q9	It was easy to learn to use this system
Q10	I believe I became productive quickly using this system
Q11	The system gives error messages that clearly tell me how to fix problems
Q12	Whenever I make a mistake using the system, I recover easily and quickly
Q13	The information (such as online help, on-screen messages, and other documentation) provided with this system is clear
Q14	It is easy to find the information I needed
Q15	The information provided for the system is easy to understand
Q16	The information is effective in helping me complete the tasks and scenarios
Q17	The organization of information on the system screens is clear
Q18	The interface of this system is pleasant
Q19	This system has all the functions and capabilities I expect it to have
Q20	Overall, I am satisfied with this system

Figure 2. Questionnaire

3. Results

From the mailing list we received replies from 28 respondents who were interested in participating. Out of these, 18 completed the whole procedure (Two Patient Cases and Evaluation Form).

3.1. Analyzing used codes

First we analyzed the results of the two experts, who did validate the codes selected by the users. This gave us a surprising result: on the Subjective and Evaluation part, there was only agreement on 8 of the 15 codes selected by the users.

Due to this lack of agreement by the experts, we did no further analysis of the codes selected by the users. On the other hand, the chosen action and prescribed medication codes were all correct.

3.2. Time needed to complete the two hypothetical cases

The time needed was the same for two cases: about 5 minutes (median) each, with an interquartile range of 2 to 10 minutes. This is a good score, taking into consideration the fact that it was the first time the participants had used the web application. In the comments, some participants mentioned that the learning curve to use the application would be easy.

3.3. Results from the questionnaire

The median of all the subscales (System Usefulness, Information Quality and Interface Quality) was 6, which means this is a good score. The Overall Score was also 6 with an interquartile range of 5 to 6.

The special question about the usefulness of the Coding for the Subjective and Evaluation part (Q3) scored less, but was still acceptable: 5, with a interquartile range of 4 to 6.

The special question about the usefulness of the Medication module (Q4) scored also well: 6, with a interquartile range of 4 to 7.

4. Discussion

4.1. Usability Testing

Our web application obtained a rather good score for usability (median of 6 for System Usefulness, Information Quality and Interface Quality). This means that the 'Keep It Simple' concept has succeeded. However, because of the small and selective sample (the pioneers), we think that these results might be biased. At the time of writing, we only had 28 responses. As deployment evolves, more users become available and a broader enquiry in a wider environment is planned.

4.2. Coding Matters

We surmise that the disagreement among the experts is the consequence of the absence of a National Coding Manual and of courses in coding. This paper does not wish to take a position as to whether or not coding is the task of the GP, but coding does provide a rich variety of possibilities for different stakeholders.

Because our web application does keep the inserted codes in the database, this provides a great opportunity to implement Computerized Clinical Decision Support and use the data for scientific research.

4.3. Open Source

We almost succeeded in using only Open Source software to elaborate this concept. The only problem was the MS Windows based application MediBridge that performs the encrypted communication between the EHRs. We regret that the MediBridge source code is closed, because we have no certitude about the encryption and the confidentiality of the medical data.

We hope that this project will contribute to the advancement of Medical Informatics. Willingness to share advances with others, who can then add their own unique contributions, furthering progress in the field, is critical to vitality and overall growth. This has largely occurred via scientific literature in past decades. Now, as computer technology and software become more critical, sharing computing methods becomes a parallel to academic journals[9].

4.4. The Future

4.4.1. Computerized Clinical Decision Support (CCDS)

Because the GP can code different parts of the visit, this makes it possible for the web application to notify the GP of the existence of a clinical guideline about the coded problem. At the moment there exists in Dutch different websites with good quality guidelines: Domus Medica [10], Folia Pharmacotherapeutica [11] and Nederlands Huisartsengenootschap [12], but somehow doctors do not implement them [13]. This notification component could provide a solution for this issue.

4.4.2. Development of a Centralized Electronic Health Record

This web application has most of the components of an Electronic Health Record. We believe that with the appropriate funding it would be possible to develop a web-based EHR that complies with the recommendations of the EMDMI Working Group [14]. It would have the same advantages as this OOH web application, but to a greater extent.

5. Conclusion

We did succeed in creating a new Web-Based Out-of-Hours Health Record. The usability testing, relying on the responses of 18 GP's, scored very well. It did not lead to suggestions for major improvements. We could not score the correctness of the codification selected by the participants because there was no agreement between two external experts. We believe that this was due to the lack of a National Coding Manual. We nearly succeeded in using only Open Source Software to make this Health Record but we were limited by that fact that we could not avoid using a MS Windows based communication program. We believe that the Open Source concept will contribute to the advancement of Medical Informatics.

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