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Initial User-Centred Design of an AI-Based Clinical Decision Support System for Primary Care

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Abstract. A clinical decision support system based on different methods of artificial intelligence (AI) can support the diagnosis of patients with unclear diseases by providing tentative diagnoses as well as proposals for further steps. In a user-centred-design process, we aim to find out how general practitioners envision the user interface of an AI-based clinical decision support system for primary care. A first user-interface prototype was developed using the task model based on user requirements from preliminary work. Five general practitioners evaluated the prototype in two workshops. The discussion of the prototype resulted in categorized suggestions with key messages for further development of the AI-based clinical decision support system, such as the integration of intelligent parameter requests. The early inclusion of different user feedback facilitated the implementation of a user interface for a user-friendly decision support system.

Keywords. Clinical decision support system, computer-assisted diagnosis, missed diagnosis, primary health care

1. Introduction

In primary care, general practitioners (GPs) are challenged by patients presenting with non-specific symptoms that may suggest a range of diagnoses [1]. Despite advances in medical research and digitisation, challenges remain, such as sharing rapidly evolving medical knowledge with GPs and integrating this knowledge into primary care [2]. GPs have a unique key role in diagnosing uncommon and rare diseases while facing high

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demand for medical care and limited capacity for lengthy diagnostic procedures. Even specialised centres for undiagnosed or rare diseases do not have sufficient capacity to deal with all cases [3-5]. The SATURN (Smart physician portal for patients with unclear disease) project aims to address this issue by supporting the diagnostic process with a decision support system based on three different AI methods (case-based reasoning, machine learning and rule-based system) [6]. Most current clinical decision support systems (CDSS) focus on a single AI method that provides diagnostic suggestions but does not give the GP further recommendations [7]. Key aspects of SATURN include its ease of use and its user-centred design (UCD) [8] where the user is recognised as an essential factor in the design. This will facilitate its integration into daily practice [9].

Therefore, this study aims to answer the question of how GPs envision the user interface (UI) of an AI-based CDSS for primary care.

2. Methods

To answer the research question prototypes of the UI (hereafter referred to as mock-ups) were designed and evaluated in a user workshop.

2.1. Conception of an initial user-centred design and workshop preparation

The mock-ups of the SATURN portal were created using the low-fidelity wireframe tool Basalmiq [10]. The results of the preliminary work conducted as a project requirements analysis (interviews and workshops) and the task model derived from this were used for the development. The task model, which is a form of structuring user requirements according to core tasks and subtasks [11] includes the following tasks: (1) perform data entry, (2) review results, (3) discuss results, (4) schedule further diagnostics, (5) refer to specialists, (6) close case. A task-based prototype [11-13] was designed as a series of mock-ups and used to run through an exemplary user scenario. For the workshops, a discussion guide was developed.

2.2. Workshops with general practitioners

In order to discuss the mock-ups in relation to UCD with GPs as key users, two workshops [14] were scheduled. In these workshops, the mock-ups were discussed online (using a videoconferencing tool) according to the prepared discussion guide.

The first workshop started with an introduction to the topic, a project status summary, and a description of all mock-ups. Important aspects such as the AI methods used were briefly explained to provide background information. In the main part of the workshop, the GPs discussed the mock-ups up to task (2). In the follow-up workshop, the GPs continued the discussion. Both workshops were recorded and two researchers took notes.

2.3. Analysis of workshop results

The analysis of the workshop results followed three steps:

- Paraphrasing the answers to the guideline questions [11],
- Consolidating notes and results of the audio analysis,
- Summarising and categorizing the key messages

3. Results

3.1. Mock-ups

The task-based prototype is represented by 10 mock-ups (M1-M10). For each task, different aspects and presentations were visualised by one or more mock-ups. (Figure 1).

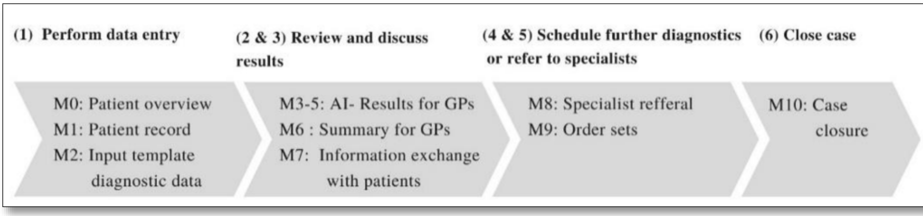

Figure 1. Task model derived from requirements analysis with the mock-ups assigned to the individual tasks.

Each mock-up represents the structure, content, and functionality of the above statically, using standard visualisation elements such as dropdowns and tables. As an example, Figure 2 shows mock-up M2 of the task 'Perform data entry'.

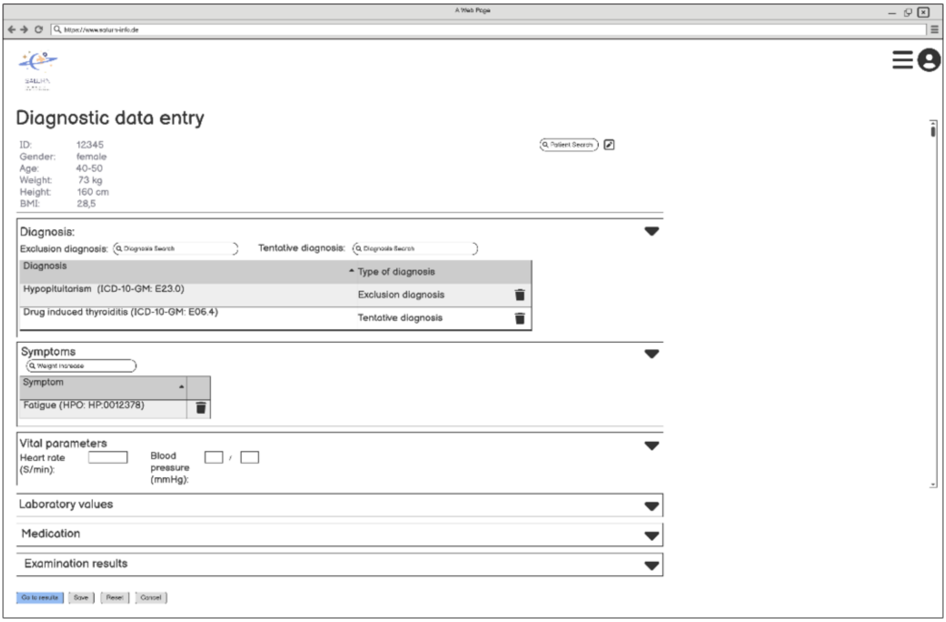

Figure 2. Mock-up for task 1 ‘Perform data entry’- input template for diagnostic data (M2).

3.2 Results of the workshop

As a result of the two consecutive workshops the same five GPs (gender: 40% ♀/ 60% ♂; mean age: 40.8 years) shared their suggestions.

The list of key messages was divided into six categories: Entry and processing (incl. entry assistance), new data fields, visualisation, access authorization, search assistance, provided information. The key messages of the suggestions are summarised in Table 1.

Table 1. Feedback categories with their key messages.

No.	Task	Category	Key message
1	1	Entry and processing	The intelligent request of parameters, based on previous inputs.
2	1	Entry and processing	No usage of mandatory fields.
3	1	Entry and processing	Ability to transfer information from other sources.
4	1	New data fields	Provide basic categories for diagnosis and symptoms.
5	2	Visualisation	Aggregation of all AI results in a clear presentation.
6	3	Access authorization	Individual access for patients, controlled by GP.
7	3	Entry and processing	Patient symptom entry function (portal access provided).
8	4	Provided information	Brief information on tentative diagnosis (in case of rare disease).
9	4	Search assistance	It should be possible to filter information on specialists according to their proximity to the place of residence.
10	6	New data fields	Possibility to document diagnosis history at case closure.
11	1+ 6	Entry and processing	Possibility to enter and edit file attachments.
12	1- 6	Visualisation	Focus on clarity.

4. Discussion

In two workshops, we elicited GPs' perceptions of the UI, using several mock-ups as a task-based prototype [11,13]. In addition to general feedback on our mock-ups, such as the relevance of clarity, we received some important key messages that could improve our design proposals. Examples include the addition of an intelligent parameter request or the ability to transfer information from other sources.

The selection of a group size of five GPs, which is already described by other sources e.g. Geis [11] proved to be a viable methodology that other projects could use. The more general presentation of the mock-ups, which does not cover the wide range of visualisation methods described by Schaaf et al [15], presents a limitation as well as an opportunity for the GPs to more freely contribute their own ideas.

In the further course of SATURN, the workshop results will be transferred into functional requirements. Continuous feedback will be collected over the project's course. The issue of integrating CDSS into the work routine of the individual practitioner, which we identified as an important key message, has already been addressed in other studies [9]. This project and the design at an early prototypical stage can confirm other studies and bring valuable aspects from the user's perspective into view.

5. Conclusions

The early involvement of users in the prototypical design provides valuable feedback for a meaningful implementation of a CDSS that fits GPs' daily work routine.

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