Building Continents of Knowledge in Oceans of Data: The Future of Co-Created eHealth
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Last Mile Towards Efficient Healthcare Delivery in Switzerland: eHealth Enabled Applications Could Speed Up the Care Process

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Abstract. A precise and timely care delivery depends on an efficient triage performed by primary care providers and smooth collaboration with other medical specialities. In recent years telemedicine gained increasing importance for efficient care delivery. It's use, however, has been limited by legal issues, missing digital infrastructures, restricted support from health insurances and the digital divide in the population. A new era towards eHealth and telemedicine starts with the establishment of national eHealth regulations and laws. In Switzerland, a nation-wide digital infrastructure and electronic health record will be established. But appropriate healthcare apps to improve patient care based on this infrastructure remain rare. In this paper, we present two applications (self-anamnesis and eMedication assistant) for eHealth enabled care delivery which have the potential to speed up diagnosis and treatment.

Keywords. eHealth, Care delivery, Swiss electronic health record platform, Telemedicine

1. Introduction

With the advent of new ICT technologies telemedicine gained importance in primary care (triage, consultation) and received wide acceptance in different age groups. In the U.S. for instance, health professionals employed telemedicine approaches to ease the care access and facilitate the patient and care provider encounter. As a result, care delivery has shown a trend of migration from hospitals to ambulatory care using mobile devices. But telemedicine services are strictly limited due to legal issues, reimbursement and data exchange [1].
In Switzerland, telemedicine has received high acceptance in various types of disease management for different age groups. More than half of the Swiss population has 24/7 free access to a medical counselling center [2], since a telemedicine model has been

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supported by most Swiss health insurance companies. Beyond ambulatory care and the treatment of chronic diseases, telemedicine has also been applied for the timely diagnosis of patients with unclear symptoms indicating severe diseases [3]. But current approaches are strongly limited to consultations via audio and video or data exchange by email. Thus, tele-diagnosis is restricted due to the low quality of data exchange.

On April 15th, 2017, the ePDG (Swiss eHealth law) became effective in Switzerland [4]. It supports a national electronic health record system (ePD) for the Swiss society. The success of this ePD depends on the availability of useful applications using this data and providing benefits in healthcare delivery.
We have addressed this topic within a multi-stakeholder research project "Hospital of the future live" [5] which aims to develop eHealth applications along an interdisciplinary care path linking inpatient and outpatient care. In this paper, we present two telemedicine applications originating from this project which have the potential to speed up diagnostic and care processes.

2. Method

Our solution, on one hand, aims at establishing a direct and personalized communication channel for efficient care delivery between patients and care providers based on the ePD platform. On the other hand, ICT-based personal apps for patients are provided. The apps can be accessed through smart devices or a Web browser, which increases the overall accessibility and leverages the economic and medical imbalance between different regions. We integrated students of our bachelor study program Medical Informatics at various stages in this research project. A self-anamnesis application for patients at home has been developed within a living case project using Eclipse Java Enterprise Edition IDE and Vaadin [6] combined with the TIANIspirit EHR platform [7]. An electronic medication assistant has been developed in a bachelor thesis using Android studio and storing data in the Midata platform [8]. For both applications use cases have been defined, discussed with future users and the results have been incorporated into the system design. For evaluation, we verified the applications regarding the challenges of primary care delivery described in the PRISMA studies of Emery and colleagues [9] and Lawrence and colleagues [10].

3. Results

1) Self-anamnesis at home

Consider a known patient who has a long time ailment caused by hip osteoarthritis and reducing his mobility (see figure 1). The general practitioner (GP) in primary care has transferred the patient to an orthopedic specialist at secondary care to determine the requirement for surgical intervention. Prior to the personal encounter, the orthopedic specialist initializes a customized disease specific questionnaire for the patient (1). We included two types of threshold scores for hip replacements (Oxford hip score and Harris hip score [11]) to assess patient mobility and life quality at this stage. High scores indicate a more severe hip joint defect. The inquiry is sent out by email (2) to the patient, containing a link to a secure ePD environment to store the results. The patient can

complete the questionnaire at time and place of her/his convenience (3). The orthopedic specialist has access to the results within the ePD even prior to the encounter (4) and the information is available at the time of inpatient admission (5).

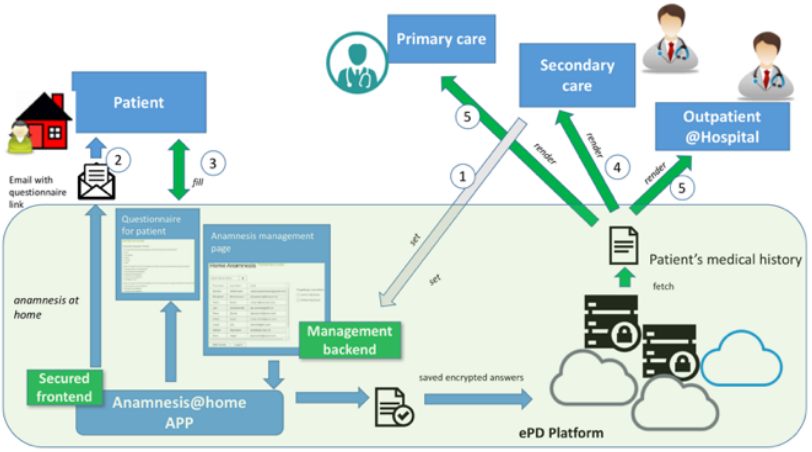

Figure 1. Interaction graph for self-anamnesis application at home with multi-stakeholders

In comparison to filling a questionnaire in the waiting room, the patient can provide a more consistent and well-considered statement of his/her medical history.

2) The eMedication assistant

This application focuses on a personalized eMedication plan which is synchronized and accessible within the electronic health record (see figure 2). Authorized healthcare providers can check the most recent version of the medication in use for a patient before they decide about treatment and further medication prescription (step (2)). Patients just need to share the access address (QR code) of their plan with the trusted care providers (1). Pharmacists can read the medication plan and use additional functionalities to check e.g. for adverse drug events. Furthermore, they can add medications sold other the counter (3). The application brings evidence to all stakeholders and simplifies the self-management of the patient. The app has been extensively described in [8].

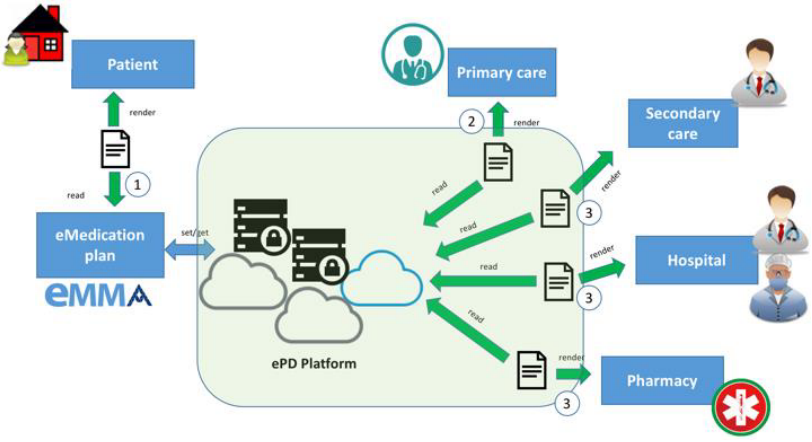

Figure 2. Interaction graph for eMMA eMedication plan with multi-stakeholders

3) Comparative Assessment

Two PRISMA studies [9, 10] reported significant delays in care delivery for cases with cancer diagnosis and treatment due to the following challenges:

1) Lack of direct communication between patient and care providers
2) Low quality of patient documents: incompleteness of patient's medical history
3) Low screening participation and delayed face to face care access due to psychological reasons.

Singh et al. [12] confirmed those reasons causing diagnostic delay and identified errors during patient-practitioner encounter as an underlying common factor. Specifically, errors related to the completeness of the medical history, previous documents and the follow-up cause nearly 60% of the errors. Therefore, we compared both Apps (table 1).

Apps / Challenges	**Self-anamnesis**	**eMedication eMMA**
Direct communication	Email and phone call through App	Mobile App access and direct connection with GP by phone
Quality of record	Highly consistent health record with user-determined access rights.	Integrated view of medication plan with high consistency, user-determined accessibility, HL7 CDA compliance
Improving care access	Email reminder for participation, App reminder	Timer for intake of medication, conversational UI

Table 1 Functional evaluation of both apps regarding the three challenges of conventional care delivery

Both implementations share 1) End to end connection between patients and care providers, 2) Patient centered data management and patient determined data sharing, 3) Consistent and integrated view of patient record (medical history and medication plan) avoiding recurrent paper-based record inquiries. In addition, they establish a direct and personalized communication channel for efficient care delivery between patients and care providers based on the ePD platform. Access through smart devices or a web browser increases the overall accessibility and leverages the economic and medical imbalance between different regions.

4. Discussion

Nation-wide electronic health records such as the Swiss ePD will have the intended impact only if they enable improved cooperation between all healthcare providers linked into the treatment of a patient's healthcare episode. Only then they can prevent delays and problems as described in [9, 10, 12]. Thus, the future task is the development of applications which, based upon accessible patient data, can demonstrate tangible benefits for specific patient groups.

The research project "Hospital of the future Live" has the intention to optimize an exemplary care pathway using eHealth and mobile Health technologies. It aims to offer personalized care delivery with high mobility and to bridge the geographical and temporal divides between patients and care providers. The two applications presented

here have the potential to solve the challenges in current care delivery described in [9, 10, 12]. More specifically, both applications are developed to provide personalized and eHealth-optimized care. A lower psychological threshold to access medical care can improve disease prevention and early detection. Continuous tele-contact is supportive for the treatment of chronic disease. Currently the Swiss ePD is still in its implementation phase, but we plan study designs to analyze the usefulness and effectiveness of such apps quantitatively. This will include the analysis of opportunities and threats arising from data exchange and collaboration between apps.

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