Bridging the Patient Empowerment Gap of National Healthcare Services with QR Codes

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Abstract:
ICT-support plays an important role in the strategies for patient empowerment of most developed countries. However, due to a basic setup with closed VPN-like healthcare networks and security mechanisms tailored to healthcare professionals it is often difficult to provide patient controlled ICT-support. We present a case on medication support in a Danish context and propose a simple solution with general applicability.

The medication support case: in order to support taking medication a patient may want notifications from personal medicine management system e.g., an electronic calendar. Information can be obtained from the medicine package or from the national service, called Shared Medicine Card (SMC). Once the information is found it must be entered into the electronic calendar by the patient. The functionality of reminding on medicine intake could bring more value to more patients, if it was “automatically” available in the patients environment e.g., through apps in phones and PCs, which interacted with the SMC.

However, current design of the national services does not support the integration scenarios for patient oriented systems, due to centralized access control. Thus for small or medium size app developer businesses (SMB) such security and authorization procedures create harsh conditions and long calendar time for developing affordable personalized and integrated telemedical applications.

To bridge the gap we propose a semi-automated integration approach, based on quick response (QR) codes, where medicine prescriptions on medicine packages, and/or the national portal, are also encoded as QR codes, which can be scanned into e.g., a smart phone and automatically converted to e.g., calendar notifications.

Introduction
According to World Health Organization (WHO) only about 50% of patients of developed countries, take their medicines as prescribed [1] and poor medication adherence result in costly hospitalizations. The annual expanses are estimated to more than $100 billion in the U.S alone [2]. Danish health authorities are aware of the importance of compliance
and other medicine treatment challenges. To better support medical treatment of patients, by health professionals, a national healthcare service, called Shared Medicine Card (SMC), was created. SMC is exposed as a web service for integration with systems used by health professionals, e.g. electronic patient records (EPR). Citizens may access its data through a web page, e.g. the “sundhed.dk” healthcare portal [3].

Although there already exist many adherence apps for personal use on the Internet, they require manual typing of often complex data based on medicine prescriptions, which may be a challenge for some patients.

The SMC service has been suggested as a service endpoint, to support medicine reminder and compliance functionalities for citizens [4][5]. However, security, political and other concerns make it difficult and costly for SMBs or open source communities to integrate personalized medicine management systems (PMMS), with SMC [5].

Reports on compliance, argue that a single approach for improving medicine adherence will not be effective for all patients, because of the diverse influencing factors: economical, patients specific preferences, etc [2] [1] [6]. Hence, in order to improve the compliance situation, it should become possible, for SMBs or open source communities to build affordable, personalized PMMS for patients, satisfying data security, at the same time.

One way to support this aim, as proposed in [5], is by redesigning national web services with centralized access control (AC) to support decentralized patients based access control to health data.

In this paper, we propose a different strategy, for achieving the aim, based on QR codes, which does not require SMC web service redesign. The idea arised, as we noted that:

Firstly, medicine packages of Danish drugstores have prescription labels attached, as in fig. 1, left.

Secondly, the information on the labels can be encoded as a QR code, in a standard format, which fits a medicine adherence scenario, as in fig.1, right.

Thirdly, the medicine data exposed in iCalendar format, as in fig. 2 can be tuned to exclude the sensitive confidential information, or become partially encrypted, per user request at the drug store. This proposal is a

![Image](image_url)

Figure 1 Left: Prescription label on a medicine package attached at drug store
Right: Proposed QR code of the prescription information, for the label.
target for usability and human factor analysis, described in section 1 below.

Finally, such QR codes could, also be shown next to the medicine prescription in the protected part of the sundhed.dk healthcare portal.

Method

Research recommendations on telehealth [7], distinguish and guide through the following key areas within telehealth:

**Technical.** It is suggested to investigate the means to integrate the various infrastructure components in a secure and seamless manner and development of new or incorporation of existing technical and tele-communications standards into telehealth, see section 1 “Technical” below.

**Human factors and usability.** The usability analysis, will be conducted using Participatory Design approach [9][4], see section 2 below.

**Clinical.** It is suggested to use randomized controlled trial, cf. section 2.

**Economic analysis.** If the usability and clinical studies show sufficient evidence on improved medicine compliance, we plan to do a long-term economical analysis, in collaboration with drug stores and health authorities.

1. **Technical: Infrastructure and Security**

The preliminary choice for the QR code format is iCalendar, described in the RFC 2445 [10]. iCalendar is supported by several calendar systems including Apple iCal and Microsoft Outlook. We will analyze the degree to which iCalendar and QR code is suited for medicine adherence enhancement scenarios and conduct experiments to validate the technical and organizational requirements. An example of iCalendar is shown in fig. 2.

We believe that this type of integration is a sufficient starting point, for bridging the gap of integration possibilities of NHS with patient empowering systems, in an affordable and secure way, because

**Security:** The third party, QR code based PMMS, or calendar of a patient, can access the patients’ data without gaining access to other citizens’ medicine data. PMMS, or a calendar can keep the data locally on a device without sharing it with external servers. Parts of a QR code, e.g. DESCRIPTION can be encrypted, at drug stores, on user request.

**Architecture for mobile devices:** The integration from medicine packages, does not require network connectivity, which is a security and
availability advantage and reduces costs.

**Architecture for PCs:** If medicine prescriptions in the healthcare portal are also made available in iCalendar format, then the medicine reminder application on a PC may become independent of the use of a camera device.

2. Experimental Design

We plan to conduct four experiments to cover the above. The first compliance and usability experiment will use qualitative methods such as hands-on workshops [9], to validate the conceptual design. The second will test for technical soundness. The third will be a one-month “real life” experiment to test how the design fits the daily rhythms of a small group of patients. Following a redesign, the fourth experiment will be conducted over a period of 3-6 month on patients with complex medications suffering long-term illness. We hope to be able to conduct the fourth experiment in collaboration with “Danish Patients”, an umbrella organization for Danish patient associations, as well as drug stores, clinicians, health authorities and the sundhed.dk web portal.

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References

[8] Surayya.com