An Approach to Improve Medication Adherence by Smart Watches

Fabian SAILER[a,1], Monika POBIRUCHIN[a], Martin WIESNER[b]
and Gerrit MEIXNER[c]

[a] *GECKO Institute, Heilbronn University, Germany*
[b] *Dept. of Medical Informatics, Heilbronn University, Germany*
[c] *UniTyLab, Heilbronn University, Germany*

Abstract. Adherence is an important factor for the outcome of medical therapies. Several reminder applications to raise adherence have been developed, e.g., smart phone apps. Literature suggests that such solutions seem to be inefficient. In this paper, we discuss current research in the field of ultra-mobile devices, i.e., smart watches. In addition, we investigate on requirements of a smart watch-based medication reminder system and present an early prototype.

Keywords. Smart Watches, Medication Adherence, Self-management

Introduction

A successful medical therapy depends on a variety of influencing factors, e.g., adverse drug effects. Furthermore, a patient's medication adherence is one major aspect [1]. Different studies have found that non-adherence is a critical factor for treatment outcome, e.g. [2]. Forgetfulness of patients was identified to be one of the top reasons for low adherence. Non-adherence is an important factor in readmission rates [3]. Consequently, this leads to increased health care costs and less positive health outcomes [4].

According to a recent study [5] many projects assist patients by implementing smart phone medication reminder applications. As new ultra-mobile devices have recently been announced and are about to enter the market, this paper investigates on the usage of smart watches as supportive tool to increase medication adherence.

1. Methods

Smart phones are rather complex multi-purpose devices. Therefore, elderly people or digital illiterates are confronted with technological barriers. In this context, a recent study by Goldstein et al. [6] has found that smart phones do not increase the medication adherence in a group of elderly people (avg. age: 69 years). Furthermore, reminding the patient of taking his/ her medicine via phone has some obvious disadvantages. E.g., this only relocates the forgetfulness of taking the medicine to forgetting the phone.

---

[1] GECKO Institute for Medicine, Informatics and Economics, Heilbronn University, Max-Planck Str. 39, 74081 Heilbronn, Germany, fabian.sailer@hs-heilbronn.de

As of October 2014 multiple medication reminder apps have been developed for smart phones, but to our best knowledge none have been presented for smart watches, yet. Work by Ehrler et al. suggests, that elderly people are potential users for smart watches in a medical context if some constraints are met [7]. In addition, elderly people or digital illiterates need to get accustomed to the usage of smart devices. Most digital natives are already voluntarily seeking for medication reminder apps [8].

2. Results

2.1. Market Overview

To qualify for the use as medication reminder system, different requirements for smart watches have to be considered. A key factor is the ability of a smart watch to operate in stand-alone mode. This is due to the fact that the described disadvantages of smart phones would not be disproved completely if a smart watch needs to be paired permanently with a smart phone. However, some devices support stand-alone operation, as they provide cellular network access. Hence, such devices allow communication with Internet-based services, for instance a drug-schedule web service. Another crucial aspect is related to the operating system (OS) of the device, as some do not provide the opportunity to integrate applications other than the preinstalled ones. Furthermore, the battery should be capable to last for at least one day to avoid recharging at daytime. Additionally, smart watches have to be light-weight and comfortable to wear at a patient's wrist for a long period of time. Table 1 lists several stand-alone smart watches with consideration of the above mentioned requirements

The market analysis showed that most smart watches are not suitable for the realization of our medication reminder application. Therefore, we decided to implement a solution for the *Samsung Gear S*. It is *Tizen OS*-based and enables the development and integration of new applications with *Tizen IDE*.

2.2. Medication Reminder Prototype

Besides reminding the patient of his medication other features need to be implemented. The notification can be visualized by pictures of the drug the patient has to take. These pictures could reduce the drug confusion in case a patient has to take different drugs at once. As usability aspects are of major importance for a patient to accept and use the medical device [9], these should be reflected in a smart watch application's UI.

Another component of the prototype is a medication schedule application, as the display size of a smart watch is limited. Therefore, the addition, modification and removal of planned drug intakes needs to be conducted on another device, e.g., a regular computer or a tablet.

2.3. Evaluation Study

An evaluation study is planned to examine the effects of our reminder prototype. Yet, as these effects are difficult to quantify, we intend to measure the adherence with patient self-reporting methods supported by a questionnaire. It will also use patient

interviews to investigate on usability and robustness aspects. We plan the study to be two sided and randomized, whilst blinding is not possible.

Table 1. Market overview (as of October 2014) of stand-alone smart watches.

Name	Price [€]	OpenOS?	Battery Capacity	Size/ Weight
Simvalley PW-315[2]	170	No - Proprietary	350mAh ≙ 60h	45*40*13mm/54g
Androidly[3]	140	Yes - Android 2.2	800mAh ≙ 96h	64*42*14mm/160g
Neptune Pine[4]	260	Yes - Android 4.1	810mAh ≙ 120h	66*54*14mm/60.8g
Exetech XS-3[5]	300	Yes - Android 4.0	420mAh ≙ 18h	65*44*18mm/66g
qOne Smart Watch[6]	120	n.a.	500mAh ≙ 200h	44*44*15mm/85g
Omate TrueSmart[7]	130	Yes - Android 4.2	600mAh ≙ 100h	45*41*11mm/100g
sWaP Signature[8]	250	n.a.	350mAh ≙ 100h	60*49*15mm/124g
LG GD910[9]	700	No - Proprietary	480mAh ≙ 120h	60*39*14mm/91g
Samsung Gear S[10]	400	Yes - Tizen	300mAh ≙ 48h	40*58*13mm/67g

3. Discussion

In this paper we present a medication reminder solution that aims to reach a large group of patients, independent of age or technical affinity. In addition to the outlined scenario, smart watch-based reminder applications could also be used for diabetics to measure their blood glucose level, or as a discrete reminder for women to take "the pill".

References

[1] Ho PM, Bryson CL, Rumsfeld JS. Medication adherence: its importance in cardiovascular outcomes. Circulation. 2009;119(23):3028-35.

[2] Snyder S, Crandell I, Davis SA, Feldman SR. Medical adherence to acne therapy: a systematic review. Am J Clin Derm. 2014;15(2):87-94.

[3] Calvillo-King L, Arnold D, Eubank KJ et al. Impact of social factors on risk of readmission or mortality in pneumonia and heart failure: systematic review. J Gen Intern Med. 2013;28(2):269-82.

[4] Iuga AO, McGuire MJ. Adherence and health care costs. Risk Manag Healthc Policy. 2014;7:35-44.

[5] Dayer L, Heldenbrand S, Anderson P, Gubbins PO, Martin BC. Smartphone medication adherence apps: potential benefits to patients and providers. J Am Pharm Assoc. 2013;53(2):172-81.

[6] Goldstein CM, Gathright EC, Dolansky MA, Gunstad J, Sterns A, Redle JD, et al. Randomized controlled feasibility trial of two telemedicine medication reminder systems for older adults with heart failure. J Telemed Telecare. 2014;20(6):293-9.

[7] Ehrler F, Lovis C. Supporting elderly homecare with smartwatches: advantages and drawbacks. Stud Health Technol Inform. 2014;205:667-71.

[8] Hayakawa M, Uchimura Y, Omae K et al. A smartphone-based medication self-management system with realtime medication monitoring. Appl Clin Inform. 2013;4(1):37-52.

[9] Svagard I, Austad HO, Seeberg T et al. A usability study of a mobile monitoring system for congestive heart failure patients. Stud Health Technol Inform. 2014;205:528-32.

[2] http://www.pearl.de/a-PX1730-1020.shtml [accessed 2014-10-27]
[3] http://droid.ly [accessed 2014-10-27]
[4] http://www.getneptune.com/ [accessed 2014-10-27]
[5] http://www.exetech-smartwatches.com/index.php/en/ [accessed 2014-10-27]
[6] http://www.qone.me/ [accessed 2014-10-27]
[7] http://www.omate.com/ [accessed 2014-10-27]
[8] http://www.s-w-a-p.co.uk/models/swap-signature/ [accessed 2014-10-27]
[9] http://www.lg.com/handy/lg-GD910 [accessed 2014-10-27]
[10] http://www.samsung.com/global/microsite/gears/ [accessed 2014-10-27]