Willingness to Use Smartphone Application Assistant to Support Migraine Treatment

HANNA-LEENA HUTTUNEN & RAIJA HALONEN

Abstract Migraine is one of the most neurologically challenging diseases. Migraines are divided into two main forms: aura and without aura. The purpose of this study was to investigate the willingness of migraine patients to use sensors and intelligent migraine diary to be used as support for their own care. There were 565 responses to the questionnaire. Out of those responded, 12 migraine patients were selected for a qualitative interview. The research utilised mixed method that revealed that almost all of the respondents were willing to use sensors to be used as well as an electronic migraine diary for self-care.

Keywords: • Migraines • Wearable sensors • Migraine diary, •eMobile • Health care information system • Bled eConference

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1 Introduction

The purpose of the study was to find out the willingness of migraine patients to use the smartphone application assisted by care of migraine. The study was focuses on the willingness of migraine patients to use sensors to act as support for their own care, from which information is automatically transmitted to the electronic migraine diary and from there to a healthcare professionals' information system.

Migraine is one of the health-related neurological diseases and affects 10 to 15 % of the world population every year and need medical treatments 7 - 17 time per year (Pagán et al., 2015; Linde, 2012). Migraine with two main forms, with aura and without aura. In migraine with aura, the pain is preceded by visual disturbances, numbness, muscle weakness and difficulty in speech. Migraine without aura usually begins without the aura symptoms. (Burstein et al., 2014.)

Mobile phones have become an increasingly important tool for healthcare, and eMobile applications have been used for patient care by collecting real-time data e.g. on blood glucose, hypertension, and medications requirements. Mobile application can be used to determine if the treatment is necessary or effective in treating the patient. Health professionals recommend keeping a migraine diary regularly. The patient can use a smartphone application, and enter trigger of headache, pre-symptoms, headache duration, headache time, and medication (Hundert et al., 2014; Nappi et al., 2006.)

The purpose of the wearable sensors is to collect information from the user and to provide feedback to the user in real time. Self-measurement technology means that an individual measures something about biological, physical, behavioural or environmental information. Self-measurement is a rising global trend that has been utilised for activity wristbands, smartphones, rings, mobile phones and mobile applications for several years. (Pantelopoulos & Bourbakis, 2010.)

This research was about willingness of patients suffering from migraine to use ICT-based solutions that support migraine treatments. The study also wanted to find out the willingness of users to use an electronic migraine diary to support their own care. This study research used mixed methods (see Bryman, 2006; Venkatesh et al., 2013. The study included questionnaires with 562 responses and interviews with 12 persons.

The results of this study showed that migraine patients are able to determine the seven biosignals that a wearable sensor should measure to detect a migraine attack. The results offer important information to build a device that will help migraine patients to detect symptoms and assist them in monitoring their own care. Additionally, migraine patients provided researchers with valuable information on the emergence of migraine attacks to develop future devices for migraine diary.
2 Related Work

This chapter presents earlier knowledge related to migraine, ICT in healthcare and applications in healthcare in separate sub-chapters.

2.1 Migraine

Migraine is one of the most challenging neurological and expensive diseases. In Europe, costs have been calculated to be EUR 111 trillion one year (Lymberis & De Rossi, 2004). There are not enough powerful tools on the market to treat migraine patients. Migraine patients feel that the treating physician is far from their illness. Intelligent systems can be used to provide the physician with proper information about the exante symptoms of a migraine patient, aura symptoms, headache, and postural symptoms. Information available of a patient can increase the sense of continuity and trust in access to care and proper care is increased (Burstein et al, 2004; Huttunen et al, 2017; Pryse-Phillips, 2002).

Primary health care physicians rarely see their patients during a migraine attack, and doctors have to make a diagnosis based on patients’ description of symptoms. Patients’ diagnosis are made during a call or in a reception, this takes usually 5-8 minutes. Although very effective treatments are available and the degree of care is good, patients feel that consultations are inadequate. Symptoms and their intensity are difficult to describe later during a short visit. Patients are willing to convey information to the doctor and nursing staff about the various stages of a migraine attack. With real-time data transfer, information is most readily available to nursing staff. (Pryse-Phillips, 2002.)

Working ability of working-age people is decreasing fast in Europe and the United States. Information and Communication Technology (ICT) enables advanced health care. By introducing sophisticated systems for health care and patient home care, it makes real-time care possible. Measuring symptoms of migraine can prevent symptoms from worsening, promote well-being and disease management, and people stay longer in work-life. (Chan et al, 2009; Huttunen et. al, 2017.)

2.2 ICT in Healthcare

The market for self-measuring technologies is growing rapidly in the world, and growth is expected to continue in the future. There are many different types of devices available on the market, and the interest in supporting devices for promoting own health has attracted a lot of attention to the next generation of portable devices (Fritz, et al, 2014, Yang et al, 2016). Wearable devices are designed to measure, for example, pulse, daily rest, quality of sleep, activity, stress and mood. Feedback allows the user to understand and modify their activities and behaviour and thereby promote their own health (Crawford et al., 2015.) The models of wearable devices may differ from, for example, the measurement method, the presentation of the measurement results or the structure, but there are key similarities between the devices (Fritz et al., 2014). The structure of defective devices is generally small and light and can be attached to, for example, a wrist or incorporated into shoes, clothing or sporting equipment.
In a study of willingness of migraine patients to use sensors to act as support for their own care most respondents recognised migraine symptoms and were willing to use sensor technology to support their own care. Migraine patients considered it important that the device measures blood pressure, sleep quality, stress levels, pulse and pain strength. (Huttunen et al, 2017.) The sensor should be located on the wrist in order to read the incoming migraine attack and send it to the migraine diary (see Figure 1). Patients can use sensor technology to measure and monitor their own health better. Studies show that monitoring of one's own care produces better results than using traditional therapy without assisted technology. Nurses can track patients well-being with sensors real-time and regardless of location, and treatments can be started timely (Chan, et al, 2009; Ko et al, 2010; Choe et al, 2014.)

By collecting data in real-time, it can be stated whether treatment is necessary or whether the treatment is effective. Earlier studies have been verified by measuring human biosignals with Basis B1, Basis Peak and Empatica E4. Studies have shown that the quality and amount of sleep have a major impact on the emergence of migraine and a migraine attack occurs in most of the patients during the night (Huttunen et al., 2017.)

2.3 Application in Healthcare

Mobile phones have become an increasingly important tool in healthcare and eMobile applications have been used to promote physical activity and healthy diets, asthma, cardiovascular symptoms, cessation of smoking, and other numerous health problems. The phone application can manage appointments, provide support and utilize as a social environment among others with the same illness, providing peer support to others. In addition, patients can themselves use phone applications to monitoring their own health and sending information about own well-being to application (Klasnja & Pratt, 2012). If healthcare technology is successfully integrated in patient life, it recognizes illnesses and helps healthcare professionals to identify the proper care (Ballegaard et al, 2008).

Healthcare professionals recommend keeping a migraine journal regularly (see figure 2), which includes the date, the triggering factor, the pre-symptoms, the headache strength, the duration of headache and the duration of the medication (Hundert et al., 2014; Nappi et al., 2006). Health.
care professionals have asked migraine patients to use the paper version for which the information must be entered manually. There may be a number of diaries, they are heavy to fill, they can be lost, these lead to a reliability problem. The increase in the use of electronic diaries has become more common as a follow-up to one's own care (Hundert, et al., 2014, Nappi et al, 2006.)

Using a diary in a mobile phone has several advantages. Mobile e-journals allow users to carry the application and add additional information on the application. Automated data input from sensors to the application makes data entry more efficient (Huttunen et al, 2017). This application allows the healthcare professional to see automatically generated reports of the data entered. Based on the reports, the users understand their illness more and can predict future migraine attacks. eMobile applications help healthcare professionals by providing real-time access to information, treatment quality and availability are improved. E-diaries have been shown to be more reliable than paper-based diaries (Jamison et al., 2001; Stinson et al, 2013.)

Figure 2 shows one of the interviewee’s migraine diary in which he has marked e.g. needed medicines for migraine, pain intensity and pain location, and if pain intensity decreased after taking the drug, whether there were any prior symptoms, headaches duration, which has triggered headaches and other symptoms.

4. Research Approach

The current study applied mixed method approach that in its early phases was mostly applied by scientists representing behavioural and social sciences, and nursing science (Tashakkori & Teddlie, 1998, Bryman, 2006), however currently ever more used by scientists representing information system scientists as well (Venkatesh et al., 2013). Figure 3 illustrates the approach and nature of the research material in the study.

The survey was answered through a questionnaire and a qualitative interview. The questionnaire was answered by 562 people with a migraine diagnosis and the questionnaire was analysed using the SPSS 3.0 tool and qualitative interview was made 12 people. Based on the answers to the questionnaire, the interview questions were defined, which were used as helping questions in the interview. Qualitative interviews were recorded and answers were written into text. Similarities were searched from responses and they were classified as background information and device issues. The results of this study show that migraine patients
are able to determine the seven biosignals that a wearable sensors should measure for the
detection of a migraine attack. In this study, we can define a device that helps migraine patients
to detect symptoms and help them track their own treatment. Additionally, migraine patients
provided researchers with valuable information on the occurrence of migraine attacks to
develop future devices for migraine treatment.

The target group of the study was a random group of migraine sufferers. Collection of the data
was carried out in three phases. In the first phase, people were asked to participate in research
through social media. Migraine diagnosis was a criterion for participating in the study. Twenty-
two people with migraine came forward and a migraine questionnaire form in October 2016 in
cooperation with the Finnish Migrant Association were sent to them. There were 16 responses
to the questionnaire, which resulted in a qualitative interview for 12 participants. An e-mail
survey and a qualitative interview were conducted in the fall of 2017. We excluded five people
from the interview because they did not live in the area. The questions for the interview were
compiled on the basis of a literature review and evaluated the suitability and
comprehensiveness of the content. Based on the evaluation of the content, the interview
questions were modified to increase the suitability and comprehensiveness. After question
quality check, invitation letter was sent to interviews. The questionnaire includes background
questions about issues that are compatible with healthcare information

The analysis of the questionnaire was divided into two phases. In the first phase, a migraine
questionnaire was categorised into two main categories, background information and device
issues. The questions of the interview were divided into three main categories, background
information, intelligent devices and migraine sensitive sensors. The results of the survey were
analysed with SPSS 3.0 tool and cross-table was made. The interview material was read several
times to get a full picture and responds were recorded and tabulated. Similarities were sought
from the material, it was organized into categories and named in accordance with the content.
The categories were summarised and combined according to the survey and the interview. Text and percentages were used to describe the material. The background information was classified according to age, sex, hobby, profession, migraine type, pre-symptoms, medication, count of migraine attacks, trigger of migraine attacks, time when migraine attacks occur and if relatives suffer from migraine. The data were analysed for typical symptoms associated with migraine and were classified according to the pre-symptoms and the main symptoms.

Questions about the device were classified according to the users' interest, what kind of smart technology users are used to use, whether users have wearable devices at home, where users use wearable devices, what kind of experiences users have with wearable devices, what motivates users to wear wearable device, what problems users have encountered when using wearable devices and are wearable devices contributed to users health. Questions related to wearable device detecting migraine pre-symptoms were divided according to the pre-symptoms of migraine, whether users would use a device that identifies the symptoms of a migraine attack, what would users like the device to measure, whether users want the device to report directly to the migraine diary, what users feel about the migraine's pre-symptoms device and how users feel if device report directly to health care information system.

5. Results

The quantitative research material was collected in November 2016 using an online survey via Webropol. In total 565 completed questionnaires were returned. Further, additional material was collected by e-mail from 22 persons in November 2017, with 16 completed replies received. In the third stage, a qualitative interview was carried out for 12 persons.

5.1 Background Questions

The second phase of the survey was answered by 15 women and one man. 12 women were selected to qualitative interview age ranging between 9 and 58 years. All respondents were active with physical exercise and had experience using computer at work.

Researchers wanted to know what is migraine patient typical migraine attack type. The interviewees described their typical migraine attacks:

“Behind the right eye starts a strange feeling, which gradually spreads and intensifies to ache. This is accompanied by sensitivity to odour and light, nausea (no vomiting), intermittent numbness of the head, weakening of thought activity. Duration usually 72h, usually starting in the morning.” / Elsa 41 years

“Migraine usually strikes at night (sometimes even in the afternoon). It is accompanied by intense heartburn and more severe pain on the shoulder than in the head. Eyes require covering and preferably a little pressure, heartburn vertical position. In addition, sweat and feeling cold simultaneously and fresh air must be obtained in order not to vomit.” / May 39 years

“The seizure always starts with visual disturbances, and after that comes an aura stage that lasts max. half an hour. The ache phase lasts longer. And many days after the actual seizure there is a bad feeling; dizziness and is unrealistic feeling. Focusing is also poor for many days after the seizure.” / Mireille 50 years
“It starts almost always at night, early hours. It is one-sided and generally pulsating. Sometimes squeezing. Often the pain is at the front of the forehead section and / or behind the eye. It takes 1.5 to 4 hours if I take the acute medication in time. Usually goes away with one tablet, sometimes I have to take two. During the seizure my eyes are sensitive to the light, the smells are nauseating and sometimes I vomit.” / Tina 42 years

“First comes stomach pain, fatigue and paleness. After that hard headache. If the medicine is not taken at the right time, I will start to vomit.” / Sarah 9 years

“The aura begins as a point in the field of vision, expands within 5 to 10 min to a significant disturb in field of vision, either with or without saw edge pattern. In a quarter of an hour, the eyesight may have gone almost completely. After the aura ache + vomiting (sometimes). Significant light and acoustic sensitivity during the seizure and weak feeling.” / Anna 29

“With aura begins with a visual disturbance of approximately 30 minutes, after which there is not always a headache. Visual disturbances may occur every few days and usually on the third time becomes a hard headache. With the aura begins with a hard one sided headache.” / Ursula 29 years

5.2 Device Questions

The questions about the devices aimed at exploring which kind of intelligent technology was used by migraine patients in everyday life and what were the reasons to acquire intelligent solutions.

Eleven respondents had smartphones but one of the respondents did not know it was an intelligent device. Four persons used a tablet and computer every day. Four of them used a smartphone every day to gather information on sports performance and energy consumption. Most persons informed they had acquired a smartphone for monitoring their health status.

The interview aimed for answers to the questions of which of the seven (7) most important biosignals the smart watch should measure to predict a migraine attack (see Table 1). Nearly all responded ‘yes’ when asked if they wanted to let the device to send automatically information about pre-identified migraine attack to the migraine diary. In total, 565 agreed and nine disagreed to press ‘YES button’ and can information be synced directly to the health care information system.
What would you like the device to measure?

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<tr>
<td>Blood pressure</td>
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<tr>
<td>Pulse</td>
<td>370</td>
<td>65,4</td>
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<tr>
<td>Stress level</td>
<td>393</td>
<td>69,5</td>
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<tr>
<td>Quality of sleep</td>
<td>409</td>
<td>72,4</td>
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<tr>
<td>Sleep rhythm</td>
<td>254</td>
<td>44,9</td>
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<tr>
<td>Blood sugar</td>
<td>246</td>
<td>46,7</td>
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<td>Energy consumption (kcal)</td>
<td>115</td>
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Table 1: Seven most important biosignals in the smart watch

Table 1 shows that the vast majority of respondents wanted the device to measure sleep quality (72.4%), pulse (65.4%), blood pressure (70.8%), stress level (69.5%), sleep rhythm (44.9%) and energy consumption (20.3%). These seven features were raised important for the device to measure to predict the incoming migraine attack.

All 16 respondents who responded to the questionnaire were willing to take the migraine report to the migraine diary. In the interviews, the same question was repeated and all 12 were willing to pass the information to the migraine diary. One of the respondents said she had fill the migraine diary manually and find it very laborious. The "reset" button would help migraine patients to be able to monitor the number and frequency of migraine attacks. Data collection helps migraine patients to avoid the oncoming migraine scene when they learn to identify with the migraine diary, when and how the scenes arise. From the responses, it emerged that the device should be fast and easy to use in order to maintain interest in the device.

Migraine diaries of one of the interviewed where he has marked date, the medicines needed for migraine, pain and place of the pain, other symptoms, affect of medicine, headache scale 0 to 10, where there any pre-symptoms, headache duration, which has triggered headaches and other symptoms. Migraine attack has occurred during sports, when the muscles have been tense and when respondent have been ill. The respondents considered it important that the migraine diary is available in a mobile application that can be consulted by a physician / nurse if necessary. The respondents considered that if they press the acknowledge button, the information goes to the health care information system and is available to the nursing staff and can be visited when needed. 87.5% of the respondents considered it important that the device should be available from a health centre, occupational health care, neurologist or other healthcare provider. 12,5% of the respondents were willing to buy the device by them self.

6 Discussion

This study strengthens earlier studies that migraine is a genetic-regulated illness and it is inherited from generation to generation. Migraine is most common in the 25-44 age group and because of hormonal changes, women suffer from migraine more than men (Huttunen et al., 2017, Koskimäki et al., 2017). In this study respondents have been diagnosed with migraine and most of them were aged 30-49. Respondents close relatives had also been diagnosed with migraine, especially women. Respondents had migraine with aura and without aura and one of
the respondents had no information on the type of migraine. All respondents at work did work with computer. Each respondent had some degree of exercise as a hobby. Scientists (Huttunen et al., 2017) find that measuring human biosignals on the wrist is useful in predicting the emergence of diseases. The seven most important biosignals were sleep quality, pulse, blood pressure, blood sugar, stress levels, sleep rhythm and energy consumption. Biosignals provide useful information on physiological changes that improve the availability of treatment. Smartphone applications have become more important tools for measuring your health (Klasnja & Pratt, 2012). The migraine application allows patients to take advantage of their own health promotion. The data stays in the application and goes on the pocket included. There are various mobile devices on the market, whose applications enable healthcare development, as they can be combined with a variety of sensors to evaluate data collected (Huttunen et al., 2017). The study shows that migraine patients are willing to support their self care with mobile application, which will automatically record the migraine diary information. The "reset" button would help migraine patients be able to monitor the number and frequency of migraine attacks. Data gathering allows migraine patients to avoid a migraine attack by reacting faster. Feedback allows the user to understand and modify their activities, behaviours and thus promote their own health. (Crawford et al., 2015). The use of mobile application is nowadays easy and the use of migraine diary as a mobile application would facilitate the daily life of migraine patients. Mobile applications can be used to monitor migraine more effectively and also facilitate patients with medical visits when the diary passes comfortably and provides feedback graphically.

4 Conclusion

As a conclusion, one can state that the preliminary results are promising and they reveal the willingness of the migraine patients to use electronic migraine diaries to support their care. Information from these electronic diaries can be transferred to the healthcare providers’ information systems. In addition, life quality of people suffering from migraine will be promoted in future with such an electronic migraine diary that can be available at all times and all places. When meeting their medical physicians, the patients can show up-to-date information of their migraine.

The study also suggests that a device that measures symptoms together with the electronic migraine diary can motivate and encourage the patients to adjust their living habits, and support self-care at home (see Figure 4). With the information monitored by the biosensors the patients can consider their medication timetable. When migraine is well treated and technology is properly applied, capability to work and physical, non-physical and social well-being can be supported.
Figure 4: Technology helps migraine patients

So far there are only few earlier studies about using electronic migraine diaries, and due to the versatility of the studies it is challenging to define the influence of the electronic application on the care of migraine. More studies are needed to evaluate benefits and costs of electronic migraine diaries for supporting symptoms and care of migraine.

In the future health promotion services will become electronic when technology develops at a speed. Technology can help migraine patient in everyday life when pre-symptoms of migraine are easier to identify and treatment can be started faster. Technology helps migraine patients to stay at work for longer, to have less sick leave and to know their own health care themselves. The sensors used for self-measurement are small and can be used with wearable devices and mobile technology (Choe et al., 2014). Earlier research shows (Huttunen et al., 2017) that migraine patients want to use a smartwatch or intelligent bracelet that can measure the pre-symptoms of a migraine attack. With this study, we can conclude that migraine patients considered it important that the device measures the quality of sleep, pulse, blood pressure, blood sugar stress levels, sleep rhythm and energy consumption. Biosignals enable users to respond more quickly to taking the medicine and reduce the duration of the migraine attack. The study also wanted to find out whether users were willing to use a device that automatically transports data to migraine diary. Of the respondents, all 12 were willing to use a device that reads and syncs the information about migraine attack to migraine diary by confirm button.

As a conclusion, self-measurement is rising worldwide, and migraine patients are willing to use smart devices to support their own care. Measuring the symptoms of patients with migraine can promote well-being and illness management.
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References


