Calm Medication Reminder

CalmMinder

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***Abstract* - Approximately 50.000 people of the Danish population have been diagnosed with epilepsy. Among these 75% of the patients develop the disease during their childhood. To prevent unpredictable epileptic seizures it is necessary to take the medication at a regular interval. It can be a struggle for many children to remember the medication on a regular basis. A solution to this has been created, which consists of a tablet and a computer with a program that can remind the patient to take the medication when he gets up in the morning. This is observed through a pressure sensor in the patient's bed and a sensor detecting if the medication is taken. If not, a notification can be sent to the patient and his relatives. The working prototype has created acceptable preliminary results. However some implementations are necessary to bring the technology into the home of patients. More thorough tests with actual users with epilepsy are also needed.**

Keywords; Calm technology, adherence, epilepsy, teenagers,adolescents, phidget sensors, preventive, home monitoring

I. Introduction

Approximately 50 million of the world population is diagnosed with epilepsy [1]. In Denmark this percentage means that up to 50.000 people are diagnosed with the disease. 75 % of any kind of epilepsy develops during the patient's childhood, and among these children between 30-35 % are in some degree developmentally impaired [3]. Graphs of the prevalence (figure 1) and incidence rate (figure 2) from Denmark show the numbers, with the youth both representing a larger number and having a higher incidence rate than the older population.

Epileptic seizures are caused by simultaneous irregular electrical activity in the brain, which results in the brain ceasing its normal functions. This can cause periods of loss of consciousness, disturbances of speech and muscular convulsions. In other words an epileptic seizure can be described as loss of parts or of the entire body, lasting between seconds and minutes [3].

It is only after several spontaneous seizures that the patient is normally diagnosed with the condition. A multitude of reasons for the occurrence of a seizure has been shown ranging from lack of oxygen during a child's birth, blood clots, cerebral hemorrhage, tumors located in the brain and several other conditions. The severity of the seizures also varies along with the type of seizure. Generally epileptic seizures can be divided into two main groups; partial seizures, which are the largest group and restricted to a certain area of the brain. Generalized seizures, the other group, affect the entirety of the brain.

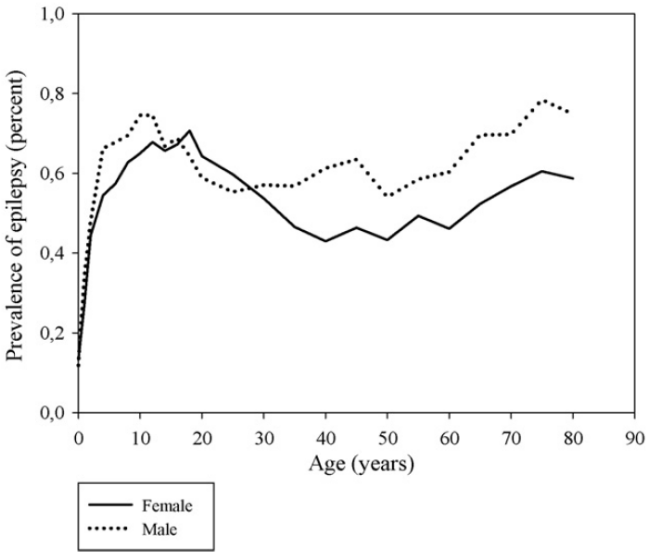

Figure 1: Prevalence of epilepsy in Denmark from 1999[4]

At present, it is possible to medically treat patients where between 60-70 % do not experience anymore seizures [2]. The medicine often causes side effects, but nevertheless the correct medication of the patients is extremely important. If the medication does not have any effect an operation can be performed to try and stop the seizures [2].

Most of the patients conditioned with these spontaneous seizures are affected psychologically. It has been seen in all age groups that patients can have problems remembering and learning. A huge problem for epilepsy patients are that they have a tendency to forget taking their medication on time [5],[6], if medication is not kept on stable routine, unpredictable epilepsy seizures may occur. This especially causes problems for the adolescents during their time in school. Many live in constant fear of a sudden seizure making their everyday life stressful. A medication reminder would be a way to help some of the patients to create some security in their life.

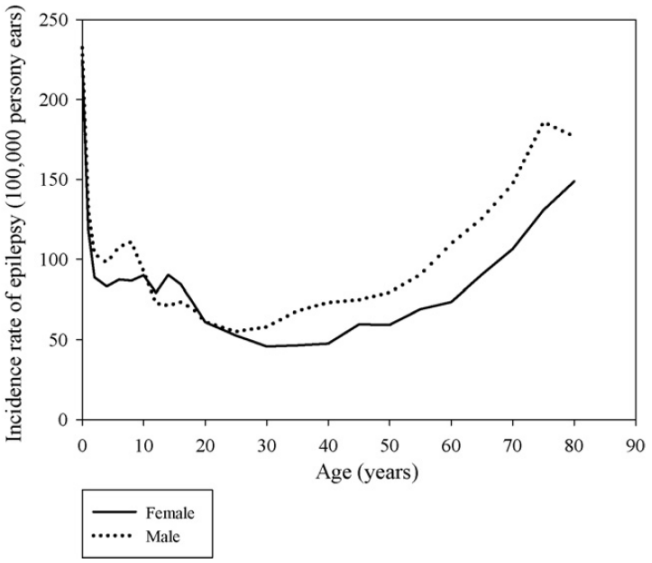

Figure 2: Incidence rate of epilepsy in Denmark based on numbers from between 1995 and 2002[4]

It is a general scenario that doctors recommend the use of a pill box and that it is in plain sight. However it is not a guarantee that the patient remembers the medication, since studies show that one out of three is not taking their medication the way their doctor assumes [5].

We suggest designing a solution that may help increase compliance and ensure the medication is taken each day. This solution could be our concept CalmMinder. When using CalmMinder, it will be registered when the patient leaves the bed and a monitor will remind the patient to take his medication. If the patient does not take his medication within a given time, he will receive a message reminding him so. In the event that the patient does not take his medication and respond to the message, a notification will be sent to his relatives. The manner in which this is registered; sensors are placed in the bed and by the pill glass. A diagram is seen on figure 3, showing our intentions with the product. The full lines are direct relations while the dotted are more loose relations between the different parts.

The aim of this project is to determine whether it is possible to remind the patient to take his medication in a discrete way and if it is possible to register that the patient is taking the medication. Furthermore the aim of this project is to investigate and evaluate the feasibility of CalmMinder as a help to prevent seizures and keep the user stabile in the long run. The aim is also to investigate whether the suggested solution will be perceived to be nonintrusive and calm in daily use.

The expected impact of the system will depend on the number of patients in contact with the system alongside the motivation to use new technology. It is expected that the system will help epilepsy patients remember their medication in the future. At the present epilepsy patients are encouraged to use pillboxes and mobile alarms to remember their medication. With CalmMinder it will not be necessary for the patient to actively remind himself.

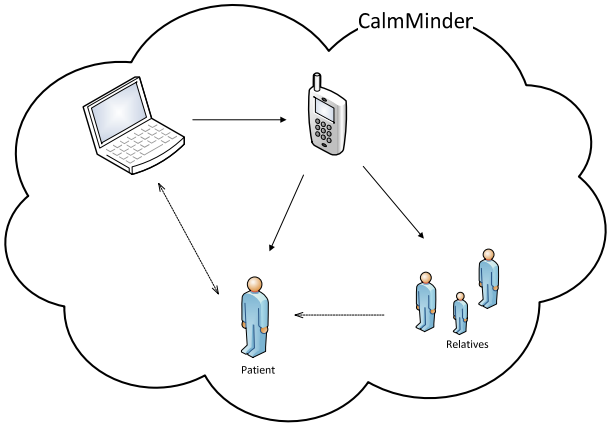

Figure 3: Diagram over the system

II. Methods

Following the Adherence Strategy Engineering Framework (ASEF) method [7] we first investigated epilepsy and its consequences, including the related problems. Furthermore the current state-of-the-art technology was studied and existing adherence strategies was uncovered. No state-of-the-art technologies were discovered during the research. In this context we also examined the pre-existing guidelines and recommendations used by healthcare professionals. The stakeholders' roles and engagement in the process were then identified along with potential bias sources, not currently quantifiable by state-of-the-art technologies.

Storyboards were used [8] for uncovering the timeline around teenage epilepsy patients' morning routines. Doing so, different scenarios were created with different solutions that would help the patients remember their medication. After debating the different solutions, a solution was found involving a program and two sensors which would record the patients' movements since this was the simplest and seemingly most effective solution. After choosing the solution a timetable was designed to keep track of the tasks at hand.

Then relevant sensor technologies were selected to detect the desired data, furthermore a Reduced Adherence Model (RAM) was prepared utilizing relevant adherence verifiers and aids. We chose a sensor that registers when the patient leaves the bed; this sensor was connected to a program which reminded the patient to take his medication if this was not done within 30 min. after leaving the bed. The program was designed by creating use cases to determine every action needed to perform the necessary tasks. To notify the patient to take his medication a message on a monitor would remind him to do so. A physical prototype was built to detect whether or not the medication was removed from the prototype, this would be an indication that the patient had taken his medication. If this had not been completed a notification would be sent to him (via SMS). If there was still no change after 30 min yet another notification would be sent to a close relative.

The prototype was evaluated in several steps. The main part of the evaluation was made through several laboratory tests of the system. The first tests had been of each individual component. After the individual tests were completed a more elaborate set of tests was conducted: “Four day real world evaluations”, where a test user was going to have a working device at his home, testing it during the period of four days. After these evaluation days the test user would evaluate how the device worked during the period. Their feedback was to be collected through interviews with the user.

Since the end product was a prototype, the expectations and demands in the testing phase was lowered to match the appropriate level. The specific demands and requirements are mentioned in the respective paragraphs.

III. Results

A. Scenario tests

The test was performed in three different scenarios. The first scenario the user woke up, got out of the bed and reacted to the reminding message within the timeframe and took the medication. In the test, the test subject did not rise from the bed and the message from the touch screen did not appear. The test subject knew that the medication should be taken so the test subject took the medication and then got out of the bed. The reminding message then appeared and made the test subject confused because the medication was already taken.

The second scenario was for the user to wake up, go out of the bed, not be aware of the reminding message from the touch screen and then receive a message to take the medication. While testing the system, the test subject woke up and ignored the reminding message from the touch screen. After a certain amount of time, the test subject received a notification. The test subject read the notification and took the medication afterwards.

The third scenario is the same as the second scenario with an addition. Instead of taking the medication after the test subject has received the notification, the test subject should ignore it. A notification should then be sent to a relative and remind the test subject to take the medication. In the test, the test subject woke up, got out of the bed and was not aware of the reminding message from the touch screen. After a given period of time the test subject received a notification, but was not aware of it as well. A relative then got a notification and the test subject got notified to take the medication. The test subject took the medication and the reminding message from the touch screen disappeared. The different scenario tests are depicted below (figure 4). The fourth scenario where the user does nothing is not possible for testing.

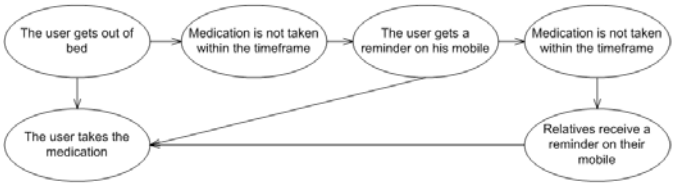

Figure 4: Scenario tests

B. Stress test

The system has endured 50 test runs where 43 were successfully completed. The seven failures were due to wrong sensor measurements and wires that lost connection. The failing sensor was the one monitoring if the medication had been taken. The loss of connection was due to short wires. The short wires connecting the pressure sensor were unplugged when the test subject went to bed. 86 % of the test was successfully completed, fulfilling the requirements of 80 %.

IV. Discussion

The CalmMinder system had been tested for its functionality and sturdiness in relation to be used by epilepsy patients. This was tested by repeating the test scenarios as described in the previous section. Both the functionality and sturdiness of the system had passed the expected demands – a maximum of ten failures during 50 test runs - and it is deemed that CalmMinder would be ready to be used and tested on the patient group.

The optimal test scenario and evaluation of the entire system should be performed upon epilepsy patients with the age between 10-20 years. These tests would be performed during a longer test period (e.g. a week to give a realistic view), to achieve acceptable results.

The current evaluation of the system was performed through two surveys. Through a “Think aloud” test an unknowing test subject went through four different system scenarios that could occur. This test resulted in small but important adjustments to the system as it is now or to future implementations.

The other study was an interview with a person that had a background in healthcare. This interview made it explicitly clear that the importance that the system should not stigmatize the patient. Instead the system should be a part of the technology that is already a part of the home. This changed the original setup where the prototype was to be a suitcase with a built in touch screen and pill glass to a setup where the suit case was replaced with a tablet. This way the system would easier be a part of the patient’s normal day.

Through the tests, possibilities to optimize the system have been made clear. The pressure sensor in the bed was not large enough to ensure the possibility to turn over in the bed, without the possibility that the system registered the patient getting up from the bed. Furthermore it would be necessary to

implement the possibility for the patient to get out of bed during the night, without having to get his medicine.

A. *Perspectives*

Further possible improvements are important in the future for the project. An important part that will improve the trust of the system will be tests upon the target group. This will make it clear if this project has any possibility to work on a larger scale.

Individual settings for each patient are also important to implement into the system to adjust the medication schedules. Another very important aspect of the system will mean that it is integrated into the patients' daily routine. This can be in televisions, computers or another technology that is already present in the household.

At present time the prototype is connected with a lot of wires. It would be an advantage to make the entire system wireless. Many of these adjustments will be able to contribute to each day being less interrupted by the system, which is important both in relation to a calm system and a patient with a chronic disease.

V. Conclusion

The product developed in this project, is able to remind epilepsy patients to take their medication in a calm and non-disturbing manner. Taking in mind that the product is a prototype, a more ideal solution could be developed as a final product to make it more calm. From interviews with healthcare professionals it was discovered that the prototype has potential but could be a more calm technology. Furthermore the prototype could be implemented better as a part of the patient's everyday life.

It is possible to register when the patient removes the medication from its place. At present time it is not possible to conclude with certainty whether this solution will provide a reliable basis for medication reminding. However the results of the stress test have been proven to be more stable than expected.

Acknowledgment

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