Smart Medicine Can: Exploring interactive possibilities for a safer medication management in home care through video prototyping

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ABSTRACT

Errors and mistakes in the medication management procedure often occur in the home care domain, due to a busy work schedule among home care workers, which leads to wrong medication dosages and inaccuracy documentation. These errors can have fatal consequences for the elderly, and therefore it is critical to prevent these kinds of mistakes from happening. We have discovered that there exists limited research focusing on exploring interactive solutions to prevent medication errors. Therefore, our research explores different interactive possibilities for safer medication management in home care, using video prototyping as our research object. These video prototypes were used to get feedback from seven home care workers through online semi-structured interview sessions. Our contribution with this paper is a design suggestion consisting of a physical device and an associated smartphone application, that aims to help home care workers manage the elderlies medication in a safer and more efficient way. Furthermore, we have discovered new knowledge, which designers should consider when designing in the complexity domain of home care, in the context of the elderly.

Author Keywords

Medication management; Medication safety; Home care; Interaction Design; Video prototyping.

INTRODUCTION

Home care is a profession that has been an important part of the healthcare system for several years. The term home care refers to a public service provided in the citizen's own home when he or she is not able to take care of their own needs, due to physical or mental disabilities [1]. Home care supports extended living at home for elderly, who prefer to stay in their own home to receive care where they can remain in a familiar and safe environment. In this paper we will use the term *'Home Care Workers'* to refer to the workers in the home care domain, which involves both formally- and non-educated health care workers in the field. Overall, home care workers are responsible for the elderlies well-being in our society, including a set of services of either social- or healthcare which includes both personal hygiene, house cleaning, grocery shopping and medication management [25].

Since the health system has improved during the past decade, the population of elderly in Denmark is constantly increasing. This increase of the elderly demographic means that there will also be more who are dependent on getting home care, from the home care workers in the years to come [4]. In Denmark financial savings play a major role in the home care domain [3] [12]. These savings have led to the elderly not getting the right treatment, while at the same time worsening the working conditions for the home care workers. Based on these savings, there is not enough finances to employ more home care workers in the municipalities. Therefore, in the future the demographic of the elderly will increase, but the number of home care workers will not, which only will result in more stress among them in an already busy workday. Over time these problems can have fatal consequences for both home care workers and the elderly receiving home care, which is not optimal; Citizens will not receive the care they are entitled to, and in general the care will not be satisfactorily carried out by the home care workers.

In our previous study we investigated which kinds of problems home care workers experience during their workday, by conducting and analyzing semi-structured interview sessions with home care workers and relatives of elderly receiving home care. When analyzing the findings we identified that all the discovered problems were highly connected, and that they all had roots in the issue of home care workers having a really busy and stressful workday. This stress means that they cannot do their work optimally, which can lead to problems during medication management, such as wrong medication dosages and inaccurate documentation.

Medication management is an important task of the home care worker's workday, in situations where the elderly are not able to manage their own medicine due to physical or mental disabilities. This procedure includes both administration, dosing, observation, documentation and medicine storage [25]. However, it is a complex and error-prone process [2] [5], which can have serious complications and fatal consequences for the elderlies well-being, leading to morbidity and mortality. Therefore it is important to prevent mistakes from happening, which is why we want to attempt to optimize the current medication procedure, by making it more safe and efficient through interaction design.

Purpose of this study

There exists limited research focusing on medication management in the home care domain, aiming at exploring interactive technological solutions to prevent medication errors. However,

most of the research focuses on helping the receiver of the medication, rather than the home care worker who administers the medication. Our aim for this study is not to make a fully functional solution, but to explore different interactive design possibilities with the purpose of making the medication management procedure safer and more efficient for the home care worker. In order to explore possibilities to support the error-prone process of medication management, we have to consider the complex work of a home care worker and what leads to errors in the medication management procedure. Therefore, our research question for this study is:

"How can we design a suggestion that supports home care workers managing the elderlies medicine in a more efficient and safe way, in order to prevent medicine errors?"

We used research through design [17] as a way to generate knowledge about what is important to consider, when designing in the complexity domain of home care, which we explored through video prototypes of four design suggestions as our research object. The purpose of these were to examine different aspects of medication management such as dosing, observation, documentation as well as aesthetic considerations. Based on feedback from seven home care workers in online semi-structured interview sessions, we combined the features with most potential from the four design suggestions, into our final design suggestion called Smart Medicine Can.

BACKGROUND

In this section we will introduce different related research, technologies and our previous study regarding home care. We have examined research that explores the complexity of the home care domain, which we will use to establish a foundation for our own design process. We also looked into studies regarding medication management in the health sector, in order to compare our findings with existing research. Furthermore, we will present different technologies that are widely used in the health sector as inspiration for our own design process.

Our previous study

In our previous research [25] we investigated the home care domain by conducting in-depth interview sessions with seven home care workers and five relatives of elderly who received home care. Initially, we focused on exploring all areas of home care, such as: Driving routes, technological devices, communication, social interactions and medication management. After analysing our data, our focus was solely on the medication management procedure, as we discovered that a lot of errors occurred such as wrong medication dosages and inaccurate documentation, which we saw as a critical problem.

Overall, we identified one essential issue that had a major impact on the other issues; Lack of time during a home care worker's workday. All of the interviewed home care workers stated that they did not have time to do all their work tasks due to a busy work schedule, which led to a lot of stress. This meant that they were not always able to do their job properly, which could result in errors in the medication procedure. Another interesting discovery we made was that there were conflicting statements from our participants; 7/7 home care workers stated that errors occur regularly in relation to medication handling, but 7/7 home care workers also pointed out that they had a good structure for administration of medication management. These statements were interesting, because they indicated that the aids for medication management were not sufficient enough to avoid error regarding medication, even though they stated otherwise. Another issue we discovered was the lack of socialization between the home care worker and the elderly, which is something we also want to explore further in relation to medication management.

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The complexity of home care

Different studies have investigated and pointed out the complexity of the home care domain, which is important to consider in our own work. Home care workers have different collaboration needs than workers in inpatient settings, because their work requires them to drive to different locations; In Denmark, they visit approximately 34 million elderly yearly [11], which means that home care is a profession that requires thorough planning and documentation to avoid mistakes. Elderly get visits from various home care workers each day, and therefore it is essential that there is good communication and collaboration between them.

Administration of information within home care teams is an essential and difficult procedure to manage. Gutwin et. al [10] investigated the work and collaboration patterns of a home care team in a Canadian health district, by conducting interviews with home care workers. In their study they identified and discussed different problem areas of collaboration difficulties

in the home care domain, which centered around *scheduling of visits, disseminating information to other members of the team, finding answers to questions, short-term treatment coordination* and *long-term treatment planning*. They considered how each of the areas could be supported by an electronic health record. Their findings show that documentation is important in home care, because it helps all the home care workers in the team to keep track of their different actions during a specific visit. In their study two important design principles regarding collaboration conflicts stood out; *"helping home care workers maintain awareness of others in the group, and providing communication facilities that are tightly integrated with the medical record"* [10]. We will use these two principles in our own design process, in order to create a common solution to ensure a safer medication management procedure, while also supporting communication and collaboration between the home care workers.

McGree-Lennon [16] argues that the true potential of home care technology still has to be realised mainly due to the complex and dynamic nature of the home care domain, rather than lack of sufficient progress of technology. The research describes the complexity of the home care domain in a set of features one should be aware of when working within this field. This involves features such as complex care conditions and relationships, control and ownership of data and reluctance of use. Some of the features presented in this study were not used in practice, and therefore we will consider these in our design process as a guideline.

Healthcare technology

Patient safety is one of the top concerns in health care that doctors, nurses administrators and staff aim to improve, and it is a standard requirement in health care [2]. No matter how long one has been in the profession, it is impossible not to make human mistakes. This is why there have been huge advancements in patient safety in the past decade, due to improvement of technology [26]. In the past decade technology has become a huge part of the health sector, in order to make the health workers' jobs more efficient and information about the citizens more accessible [10].

An example of a technology that has had a major impact on patient safety is barcode scanning [26], which offers patient identification that ensures that the correct medicine is being given to the right patient. This reduces errors during the medication procedure and ensures patient safety by eliminating manual data collection. Scanning a patient's unique barcode can give health workers easy access to a patient's medical records and access to previous notes and other medical information tied to that specific patient.
A device such as *DoseCan* by DoseSystems [6], is a medicine box that reminds the elderly to take their medication, while ensuring the caregivers or family members, by sending a notification if the elderly does not take their medicine. DoseCan contains all the medicine in dose packages, and dispenses the medicine at the time it is supposed to be taken.
The most commonly used smartphone application for home care workers in Denmark is *Nexus Mobile II* by KMD [8], which is used to support and keep track of all their work tasks including driving routes, the elderlies medical records and time schedules. It is currently being used by 61% of all municipalities in Denmark.
A newer application that over the years intends to replace KMD is *Cura* by Systematic [27], which focuses on ensuring a more effective communication between home care workers, and a simpler documentation procedure compared to its competitors.
Another kind of technology used in the home care domain is the *Emergency Bracelet*, which is a wearable worn by the elderly, that provides them a safer environment in their private homes. The purpose of this device is that the elderly can contact the home care worker in case of an emergency, by pressing a button on the bracelet. These examples of technologies will be used as an inspiration later in our own design process.

In our previous study we discovered that some of the home care workers exclusively used traditional paper to document, and to get information about the elderly they visited. This indicated that the technology is not optimally utilized, despite the fact that it could lead to improvements and more efficient support during medicine management [10]. Those improvements could be easier access to the elderly's medical records, as well as faster access to the documentation procedure. Furthermore, it has been argued that technology could be utilized to create a functioning communication tool between a team of home care workers [10].

Medication management in healthcare

Different studies have examined the home care workers medication management procedure in depth, and thus examined the reasons for errors during the process.

In a study by Lindblad et. al [2] they explored what constitutes the complexity of the medication management process and how home care workers handle this complexity. The study was conducted in Sweden, and their data was collected through observation of home care workers during their workday and followed up by interviews. Through their data, they discovered that the medication management procedure in home care is very complex, and therefore the need for the home care workers to adapt to change, have a manageable structure and good communication is very important. This study confirms our findings from our previous study regarding errors in medication management, and therefore we will take this complexity into account in our own design process.

In our previous study, we discovered that home care workers spend a lot of time double-checking the elderlies medication before giving it to them, which leads to more work and stress during their work day. In a study by Koyama et. al [15], they conducted a systematic review of studies where they evaluated evidence of the effectiveness of double checking to reduce medication administration errors. The purpose of the study was to explore if double checking would reduce medication administration errors in a hospital setting, and whether it was an effective procedure. They concluded that there was little evidence in the reviewed studies, that double checking would be more efficient than single checking. This could indicate that a lot of time could be saved and stress could be reduced, if

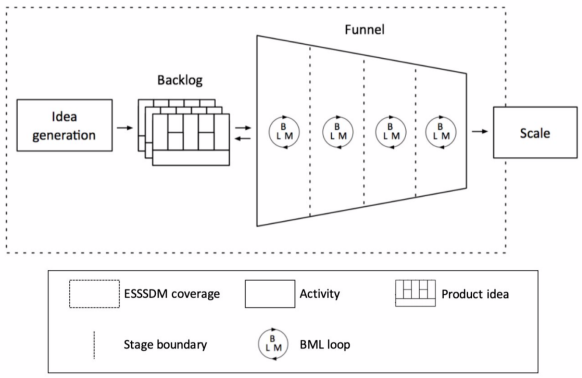

Figure 1. Shows the ESSSDM.

the double checking part of the medication management procedure would be removed, since it may not have any significant effect on minimizing errors. This study provides us with the knowledge that double checking is not a guarantee of medicine management errors being reduced, which is something we will consider in our own design process.

METHOD AND RESEARCH PROCESS

In this section we will describe the methods, and how we used them in our research process to explore our research question.

Early Stage Software Startup Development Model

Our research process is supported by the *Early Stage Software Startup Development Model (ESSSDM)* proposed by Bosch et. al [13], which is a combination of agile and lean methods. Bosch points out that there are many agile development practices and lean principles that can be difficult to implement and apply in practice, and therefore this model offers a manageable and clear procedure for product development. Our reason for choosing this model to explore our research question was due to the possibilities of working with different ideas, in parallel at the same time. We see this as an advantage in the early stages of a design process, in order to not favor one single idea from the beginning.
In addition, the model is based on decision-making support, which means that we could get feedback from home care workers along the process, in order to decide whether to move forward or abandon an idea.

The ESSSDM consists of four steps; *Idea generation, Backlog, Funnel and Scale*. This research focuses on the Backlog- and the Funnel steps, as we consider the Idea-generation step as the work we did in our previous research.

We have adapted this model to better suit interaction design, instead of just entrepreneurship. We have used the overall stages from the model, such as Idea generation, Backlog and the Funnels BML-loop. We do not follow the exact process of the four validation parts in the funnels BML-loops, but we have used them as inspiration for our own validation process. The next sections describe our research process based on the model's four stages.

Stage 1 - Idea generation

The Idea generation phase is where ideas emerge, based on users needs and what problems they might experience. For this step, Bosch suggests Exploratory interviews, which is about talking to relevant stakeholders to get an understanding of their current situation.

We will consider this stage of the model as the work we did in our previous research [25]. This knowledge has been used to get a better understanding of the medication management procedure in the home care domain and the related problems, which has been used to reflect on how we could design different ideas for a safer procedure for our Backlog-stage.

Stage 2 - Backlog

The second stage is where all the potential ideas for concepts are put in a prioritized backlog. The purpose of this stage is to compare and prioritize among ideas, and decide which of them to explore further in the Funnel-stage.

Our backlog consisted of a large number of sketches of different interactive and digital concepts, to support home care workers' medication management process, which was based on our knowledge from the previous stage. These concepts varied from different smartphone applications, wearables and physical devices, and they were all inspired by technologies that are already being used in the home care domain such as DoseCan, Nexus Mobile II and the Emergency Bracelet.
All of the sketches from the backlog were discussed between us, combined and explored further in the Funnel-stage.

Stage 3: Funnel: Build-Measure-Learn

The purpose of the third stage is to put ideas from the backlog into a funnel, where multiple ideas from the backlog are being investigated and validated in parallel through *Build-Measure-Learn (BML)* loops suggested by Ries [14]. During this research we iterated through one loop, which we will explain in more detail in this section.

Build

The purpose of the Build-part of the BML-loop is to build the ideas, in order to measure their potential with users.

We used the technique *Minimum Viable Product (MVP)* suggested by Ries [14]. This can be described as the simplest version of a product built with a minimum amount of effort, and the least amount of development time. This technique is about implementing only necessary functions in a prototype, in order to get feedback from users, before spending too many resources on building a fully functional product.

By combining different sketches from our backlog, we came up with four different design suggestions we wanted to explore and get feedback on through the BML-loop. We named our designs *Pill Grabber, Social Connect Bracelet, Pill Tree and Check In Can* (see Figure 2). Each of them had their own main functionalities, which were intended to explore different aspects of medication management such as dosing, observation, documentation. Their physical aesthetic appearance was different in order to examine what kind of design had potential in the context of the elderly. We focused on the suggestions being able to work in the complex domain of home care, and

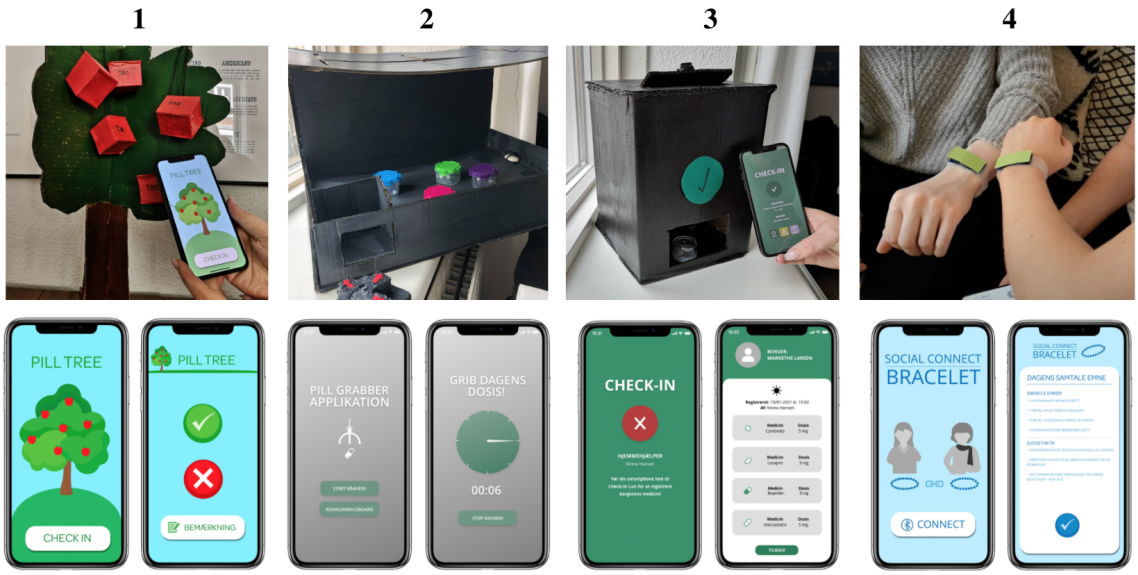

Figure 2. Shows pictures of the four design suggestions and their associated applications. From left to right: Pill Tree, Pill Grabber, Check In Can and Social Connect Bracelet.

they were all inspired by the different technologies presented in our background section.

The four suggestions were created as low-fidelity prototypes, where the physical devices were made in cardboard and the applications were designed in Adobe Experience Design using wireframing. All four design suggestions have some features in common, which is automatic documentation, an overview of the elderlies previous and upcoming medications and the opportunity to write notes. The differences will be described below.

The purpose of the *Pill Tree* in picture 1 (see Figure 2) was to explore the aesthetic element of a pill box, where we created a tree where the pill boxes are designed as apples. To activate the tree, the home care workers place their phone with the application close to it, which will then dispense the apple containing the pills based on the time and date.

The *Pill Grabber* prototype in picture 2 (see Figure 2), focused on creating a concept that could make the medication more fun for the elderly, by involving them in an interactive game. They play this game together with the home care worker, where the elderly have to capture the dose of the day within a time limit, by using a controller. The associated application has a leaderboard feature to keep track of the elderlies scores, to create competition between them. This suggestion also explored the aesthetic element of a pill box, where we created a game machine containing all the pill dosages in colored boxes.

Check In Can in picture 3 (see Figure 2), has similarities to Pill Tree by automatically dispensing the medicine the elderly have to take based on date and time, but it has a more neutral aesthetic look of a simple box. The associated application has the same features as the other design suggestions, but it also contains a medicine list for the double-checking procedure,

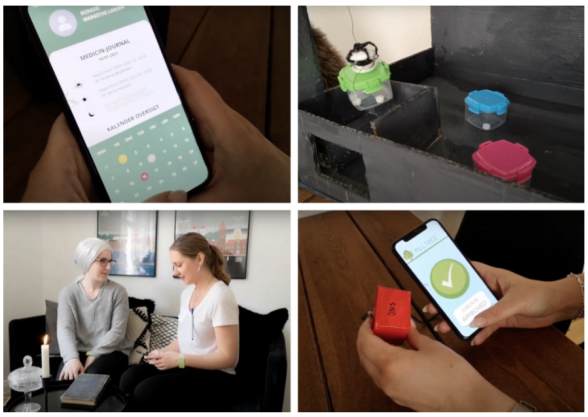

Figure 3. Screenshots from our video prototypes.

and a calendar system to get an overview of the elderlies past and future medication.

The *Social Connect Bracelet* in picture 4 (see Figure 2), aimed to create more socialization and presence between the elderly and the home care worker. This is done by placing two bracelets, worn by the elderly and the home care worker, close together for a few seconds, to register and document the medication. In addition, the associated application will provide suggestions for fun topics and facts as inspiration for conversations between the home care worker and the elderly.

It has been argued that video prototyping is an effective technique for design exploration, presentation and evaluation [19] [28].
This technique offers a wide range of benefits in relation to interaction assessment, and is also cheap and quick to create. Video prototyping did not require a lot of experience with

video editing or expensive equipment, as it was just small video clips that were put together quickly. Therefore, our research question were explored through video prototyping, which allowed us to present our four design suggestions for the home care workers, using a Wizard of Oz approach [30]. This technique allowed us to simulate and visualize different functionalities of our designs, and to quickly translate high-level concepts into low-fidelity prototypes, in order to give a preview of how the designs should work in a realistic scenario. Each video prototype showed how the different designs should be used in practice, in the context of a home care worker visiting an elderly during a workday (see Figure 3). The videos had a narrative approach where the different interactions of the concepts were explained. The videos were each 1 minute long and were presented in online semi-structured interview sessions with home care workers, in order to get feedback and discuss the different interaction features and design aspects.

When showing the video prototypes, we experienced that the participants automatically began to reflect on their current work situation. This resulted in a discussion of problems in relation to medication management that we did not discover in our previous research. Therefore, we will argue that video prototyping is not only beneficial for getting feedback on ideas, but also for getting participants to reflect on situations they would not otherwise be able to through just answering questions.
Our video prototypes were based on Ries' MVP approach, meaning the videos only presented the most necessary and essential functions to get feedback. However, we as interaction designers with no personal experience in the home care domain, had to choose what we considered as essential functions, which sometimes did not match with our participants' opinions. This was expressed when some of our participants began to ask questions regarding the dosing system for some of our design suggestions, or safety conditions, which were aspects we did not consider as necessary at that time.

Measure

This stage is about how to validate and get feedback on the different ideas that were built in the previous stage.

To get feedback on our design suggestions, we recruited seven home care workers (see Table 1) for our interviews, with various age ranges (from 22 to 60 years old) and work experiences (from a few months to 30 years). The reason for recruiting both educated and non-educated home care workers is due to the fact that home care is not a job that requires education in Denmark [22].

We used the semi structured interview technique [21], which combines features of the structured and unstructured interview approaches. This technique made it possible to speak more freely with the participants and create an open discussion about the video prototypes. The interviews were conducted online on Zoom through video call and screen sharing, which worked very well. However, not all of our participants had the same amount of experience using smartphones or computers. This resulted in a single interview having to be canceled at the last minute and moved until our participant had the opportunity to get help from a relative to open Zoom.

		Participants	
Name	*Age*	*Experience*	*Education*
HCW 1	60	25 years	Educated
HCW 2	28	4 years	Not educated
HCW 3	27	4 months	Not educated
HCW 4	59	30 years	Educated
HCW 5	30	6 years	Not educated
HCW 6	28	7 years	Under education
HCW 7	22	7 months	Not educated

Table 1. Shows a list of all the recruited home care workers. HCW = Home Care Worker.

Having the interviews online had a great advantage, because COVID-19 did not make it possible for us to have the interviews in person. The participants were shown a visual presentation which included an overall agenda, introduction to our research and videos and pictures of our four design suggestions. They were asked questions about the designs after each video, where they were encouraged to give their honest opinion about them. Each interview session lasted approximately 45 minutes, and were all recorded (with permission) and afterwards transcripted for analysing.

During the interviews, we noticed that the age difference between our participants had a significant factor in how they perceived our presented designs, and how open they were to technological changes in their profession. HCW 1 (60 years old) and HCW 4 (59 years old) had both been in this profession for over 25 years, and they were generally more critical to our solutions; They both mentioned that they were not particularly good at technology, and that they preferred their current work routine. We noticed that the younger and less experienced home care workers we interviewed were more open to changes.

Learn

This stage is about deciding what to do with the ideas which should be based on the insight from the previous stage.

To find meaning and patterns in our collected data, we used the *thematic analysis* method [23] to get a broader understanding of our participants' views and perceptions of our presented video prototypes. We conducted the analysis separately to identify our own set of data, which were later discussed and combined between us. The procedure of doing the analysis separately, was a way for us to find patterns and themes, without affecting each other's choices of what should be coded in the data. To ensure inter reliability between our coding procedures, we calculated our disagreements, using the calculation formula suggested by Miles and Huberman [24], which had 89% of agreements as result. This shows that we in general agreed upon which patterns and themes were important to highlight, and that there was a high consistency between our coding procedures.
All of our findings were written down on post it-notes and hung up on the wall for discussion. The post-it notes were divided under the different themes we discovered during the analysis, which were; *Physical and mental disabilities, Dou-*

ble checking procedure, Home care is taboo, Socialization issues, Protection of personal information, Essential features and *Design reflections*. All the findings from the analysis will be reviewed in more detail in the next section.

FINDINGS

Our findings were obtained in the Measure-part in the BML-loop. Not only did we gain insights into our participants' thoughts about our design suggestions, but our video prototypes also provided an opportunity to discuss relevant issues and deficiencies in medication management that our participants experience during their work day. The findings were used as guidelines when designing our final design suggestion.

We organize our findings through the identified themes that were mentioned in the previous section. This section we will review these themes and discuss them in relation to supportive quotes from our participants.

Physical and mental disabilities

There are many reasons why elderlies receive home care, but in most cases it is due to physical or mental disabilities, which means that the elderly no longer are able to take care of themselves and their everyday tasks at home. Many elderly suffer from dementia, which leads to loss of intellectual functions, that causes both memory loss and reduced ability to function in everyday life [7]. Another example is parkinsons, which causes symptoms such as slow movements, tremors and muscle stiffness [9]. These disabilities were discussed in relation to our Pill Grabber-design, where the elderly have to grab their medicine dosage by using a controller.

> *"[...] but there are also a lot of the elderly who cannot participate in that kind of activity. We visit a lot of elderly who are demented." - HCW 1*

> *"[...] there are some of the elderly who need medication, if they for example suffer from for example parkinsons, then they simply cannot handle such a game." - HCW 2*

Some of the home care workers stated that the idea of including the elderely in a game during the medication procedure could provide them with a happier everyday life, as they may experience loneliness because they rarely get visits from relatives. However, as the above statements from HCW 1 and HCW 2 indicate, many of the elderly would be excluded from this activity because of physical or mental disabilities.

Double checking procedure

For safety reasons, an essential part of the medication management is double-checking; The home care workers need to check if the pills in the medicine box matches the pills on the medicine list before giving it to the elderly. We discovered that this could be challenging, especially for less experienced home care workers as HCW 5 stated:

> *"Sometimes I'm not sure if it's the right kind of pills, so I have to see if the list of medicine matches with the amount in the box because sometimes I can't tell the difference between the pills... Sometimes I just have to guess based on how many pills there are in the pillbox and compare that to how many pills there are listed on the medicine list." - HCW 5*

HCW5's statement indicates that she does not always have enough knowledge to determine the names of the different pills, which is resulting in that she sometimes has to guess based on the amount in the box and the amount listed in the medicine list.

As the double checking procedure is today, a home care worker has to know the different names of the preparations solely based on the size and shape of the pill, which are often similar to each other. Many of the more experienced home care workers become familiar with the elderlies medication and therefore feel more confident in knowing the different names of the pills, but for the less experienced this can be difficult. Despite the fact that the number of pills matches the number listed on the medicine list, it does not necessarily mean that it is the right pill that is dosed. This means that incorrect medication can still occur, which is a problem that is hard to detect.

Home care is taboo

By discussing potential aesthetic design possibilities (such as a tree as Pill Tree or a game machine as Pill Grabber) with our participants, we discovered that receiving home care is actually something that many elderly feel is very taboo, as HCW 3 stated:

> *"I think maybe most people would like something a little more neutral in their home. [...] There are many elderly, who may not want to show others that they actually get home care... perhaps because it is a bit taboo in our society." - HCW 3*

This statement indicates that some elderly do not want to show or tell that they cannot take care of themselves and their wellbeing, and therefore home care becomes a sensitive subject for many of them. In relation to this, the aesthetic design of the classic pill box used for storing medicine was discussed. In the following statements HCW 2 and HCW 5 express that many of the elderly are really aware of keeping their medicine hidden from their surroundings:

> *"The elderly just want to keep all these medicine boxes away so it doesn't just scream to their surroundings 'see me, I'm taking medicine and I'm sick' [...] I have thought many times when I visit the elderly how sad it all looks sometimes, just that they have such a huge pill box standing on the table... It is not very decorative, and it just makes them appear like someone who is very sick." - HCW 2*

> *"I know that citizens actually do not like to show that they get home care, and a tree like that... Or the other game you showed... these would probably draw a lot of attention to them by the people who visit them." - HCW 5*

The findings we identified under this theme states that the aesthetics when designing in the home care domain, in the context of the elderly, is very important to consider. Many elderly do not like to show that they receive home care and take medicine, because it may symbolize that they are sick

and can not take care of themselves, and they may feel that getting home care is a taboo.

Socialization topics

In our previous research we discovered that there was a lack of socialization between the home care workers and the elderly. This has resulted in many home care workers having a bad conscience after their visits, because they did not have enough time to socialize with the elderly, who really enjoy talking to them.

A part of the overall medication management procedure is to observe the elderly while they take their medicine, which could be a perfect opportunity for the home care worker to have a chat with the elderly.

Our intentions with the Social Connect Bracelet-design were that the functionality of registering and documenting the elderly's medicine via two bracelets, could be incorporated into the emergency bracelet, as most elderly are familiar with this technology. However, it was mentioned by several of the participants that for safety reasons, they could not see this work in praxis. They currently experience that the elderly often forget to put their emergency bracelet on or that it is being misplaced, as HCW 7 explained:

> *"It often happens that the elderly do not get the emergency bracelet or necklace on in the morning, and that could easily happen here too I think, and what do you do then? If you can just document the medication from the phone in terms of safety, then there are probably many who would just cheat that way and not connect via the bracelet..." - HCW 7*

Our video prototype of the Social Connect Bracelet-design made the home care workers reflect on how they socialize with the elderly during their workday. Here we identified an issue we did not find in our previous research; Some home care workers may find it difficult to figure out what to talk about with the elderly during their visit, or may at times feel that the conversations are the same during each visit, as HCW 6 explained:

> *"I have my regular driving route, and I know those elderly very well. But sometimes it can get a little meaningless with the basic topics like 'how are the grandchildren' and 'good weather today'. It could be a little more fun with these conversation topics here. It can also be difficult when I come out to citizens I do not know, if I have taken another's shift." - HCW 6*

In addition to HCW 6's statement, another problem is to find a conversation topic at all, when you are not familiar with the elderly on the route or is from a younger generation, which was stated by HCW 1:

> *"We have many younger home care workers who come directly from high school, and for them it can be difficult to figure out what exactly you can talk to an 80-year-old woman about. [...] I'm sure these fun facts could be something you could really bond over." - HCW 1*

Most of the participants pointed out that they liked the daily suggested conversation topics in the associated application of the Social Connect Bracelet, because it would provide an opportunity to have many different conversations with the elderly. Furthermore, this function can be used as a form of ice breaker for those home care workers who do not know the elderly very well and find it difficult to start a conversation.

Protection of personal information

In all of our four design suggestions the home care worker could always access the citizens medical record through the associated application of the design, to see earlier documentations and notes no matter where they were located during their working day. The purpose was that they could always go back and see if everything had been done correctly, if they were in doubt whether they had forgotten to document the medication for example due to stress during a previous visit. However, HCW 1 expressed a concern about this feature:

> *"I am actually not allowed to just go into our app and check up on Mrs. Sørensen I visited yesterday, if I am not on my way to visit her. We cannot just go in and search between the various citizens and see what has been written in the past, it is actually illegal." - HCW 1*

In the above statement, our participant mentions that it is against the law to access a citizen's data, unless they are on their way to visit that specific citizen. This made us aware that patient data is a really important factor that needs to be taken into account, when working with sensitive and private data such as medical records.

Essential features

We confirmed which of the included features in our four design suggestions that were necessary to keep for our final design suggestion. We discovered that the most essential features are the opportunity for documentation, a complete medication list for their double checking procedure and the opportunity to write notes. The feature of a complete medicine list was confirmed by HCW 2:

> *"I remember a situation where I did not recognize a pill in the elderlies medicine box, and I would never have figured out what kind of pill it was, unless I had that medicine list on the app I used... So it's really good there is a medicine list included in your ideas." - HCW 2*

This statement confirmed that adding a medicine list to our final design suggestion is important, in order to make sure the elderly get the right kind of medicine.

Automatic and electronic documentation and the opportunity to write notes regarding the elderly were essential features in all of our design suggestions. We discovered that automatic documentation and opportunity to write notes was already implemented in the application the home care workers used on their job, which was stated by HCW 1:

> *"We have it all on our phone, where we can go in and find the medicine, so we can see how many pills and what kind of medicine it is, and then we press our phone "given" or "not given" or writes a message if the citizen does not want to take their medicine..." - HCW 4*

Our participants mentioned an important feature that we had not included in our four design suggestions, which is the

option to see the elderlies *P.N. Medicine* [29], which is an abbreviation for the Latin word pro necessitate. This kind of medicine is only taken when it is necessary, for example in case of an elderly having a headache. This information was stated by HCW 5:

> *"The elderly also have P.N. Medicine, which they can take if they need it. I often visit elderly who sometimes get bad headaches, and then they need to be given aspirin. This kind of information is really important for us to be able to see, in order to give them the right medicine!" - HCW 5*

Design reflections

At the end of each interview session, all four design suggestions were discussed in relation to each other. The participants were asked to choose which features from the four designs they thought should be included in our final design suggestion and which should be deselected. Some of the participants combined the different features they liked, and proposed different ideas for a future design. In the following quote, HCW 2 attempted to combine elements from the Social Connect Bracelet and Check In Can:

> *"I thought about what if you could combine the two suggestions that are left (Check In Can and Social Connect Bracelet). Then you connect with the bracelets to access the journal on the application and then through it, you could press a button that would get the machine to dispense the pills." - HCW 2*

This statement provided us with feedback on how we could combine some of the features from our different prototypes in our final suggestion. This means that our video prototypes did not only provide us with feedback on our ideas and make them reflect on their current work situations, but also to make some of the participants begin to think in newer design suggestions. Our video prototypes focused on including only the features that were most needed for our participants to provide feedback. However, the participants reflected on other aspects of our concepts that were not included in our videos, which they thought were very important to take into account. HCW 1 mentioned that we should consider the importance of how the dosing system in the Pill Tree, Pill Grabber and Check In Can design suggestions:

> *"I am a SOSU assistant, and sometimes I help dose the citizens' medicine... I can not help but think about what your dosing system could look like, but it may not be something you have thought about? I am afraid that it might be really complicated for those of us who have to dose the medicine." - HCW 1*

Another thing that the home care workers were concerned about, was the safety regarding the storage of the medicine, more specifically how it would be secured, so the elderly cannot access the medicine in the medicine boxes. HCW 7 stated an example of why this was important to consider:

> *"If the pill boxes are easily accessible on the tree, then they must at least be locked in the specific box so that the elderly cannot just go and open the box. On the tree here, the medicine is easily accessible for them, and I think that is not a good idea. We have had situations where some of the elderly have tried to access their medicine in their cabinet... there needs to be some sort of security system so they cannot get access when we are not there..." - HCW 7*

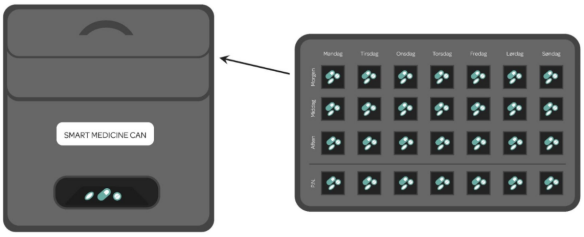

Figure 4. Shows an illustration of the two parts of the physical part of Smart Medicine Can.

The interviews have provided us feedback that confirmed our own design choices regarding our design suggestions. Furthermore, the participants also provided us with knowledge regarding essential features that need to be included and also what legal matters you have to consider regarding the elderlies personal information.These findings will be used for our final design suggestion, where the best features from the four design suggestions will be combined, as well as new features that aim to support some of the discovered problems from our findings.

DISCUSSION OF FINAL DESIGN SUGGESTION

In this section we will introduce our final design suggestion and discuss it in relation to our findings and the related research and technologies we introduced earlier.

Smart Medicine Can

Our final design suggestion, *Smart Medicine Can (SMC)*, is an interactive dispensing system, which aims to make the medication management procedure safer and more efficient for the home care workers. It consists of a physical device (see Figure 4) and an associated smartphone application that was designed in Adobe Experience Design using wireframing. The application and physical device consists of different features, which collaborate with each other. SMC has been designed to support all the complex aspects of the home care domain, and supports both dosage of medication, the double-checking procedure and documentation of the elderlies medicine.

Simple dosing and automatic dispensing system

During our interviews, some of the participants began to discuss how the dosing system in the physical device would look. This led us to think about how we could design a dosing system, which resulted in a system that is divided in two parts that can be separated (see Figure 4).

The top part of the can is where the medicine is dosed into 21 containers, which is divided into seven days, each of which contains the morning, noon and evening medicine. Furthermore, another important part of the dosing system is the possibility of getting the elderlies P.N. medicine dispensed, which can be done through the application by selecting the type of

Figure 5. Screenshot of the Smart Medicine Cans application granting access to the elderlies medical record.

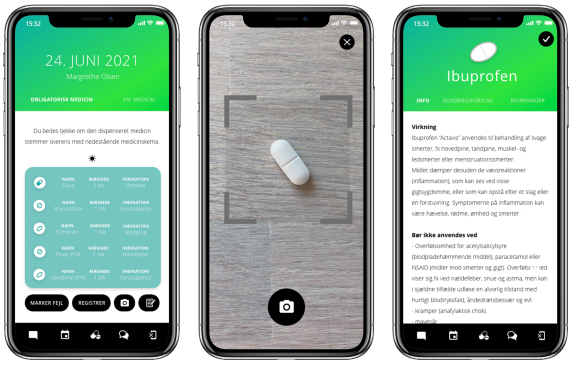

Figure 6. Screenshots of the Smart Medicine Cans applications medicine list, pill scanner feature and information regarding a pill after pill scanning.

P.N. medication to be dispensed, when necessary.
The bottom part of the SMC is where the elderlies medicine is being dispensed automatically, based on date and time. This was in general something all of the participants found beneficial in our four design suggestions, according to medicine safety and time savings. It can be discussed whether there is a need for a home care worker to be present, or whether the elderly can just take the medicine themselves if the SMC automatically dispenses the medication. We consider the home care worker's presence to be essential, because a solution such as the DoseCan cannot guarantee that the elderly actually take the medication being dispensed.

How to access to Smart Medicine Can

As McGree-Lennon study states, control and ownership of data are important to take into account, because patients' private data must be respected and their personal information needs to be stored safely. In our study, one of our participants mentioned that having access to the elderlies personal information at all times is illegal, and therefore our design suggestion only grants access to the elderlies personal information when checking in on the elderlies individual SMC, using their smartphone. Each SMC has their own unique tag that is adapted to each elderly medical record, like a social security number. Once the access has been granted (see Figure 5), the dose the elderly must take at that specific time, will be dispensed from the can. The home care worker who checked in, is automatically registered by their name, under the documentation for the elderlies medicine.
This procedure was inspired by the barcode scanning mentioned in the background section, because it has proven to have a positive impact on patient safety, and easier patient identification.

Safer double-checking procedure

When the medicine has been dispensed from the SMC, the application automatically opens the medicine list, where the home care worker is required to double-check the medicine before giving it to the elderly (see Figure 6).
In this study we discovered that some home care workers find the procedure of double-checking very difficult and time consuming. The procedure requires the home care worker to have knowledge about the pills being given to the elderly, but

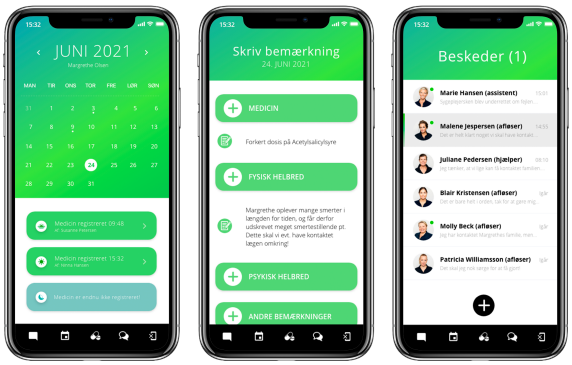

Figure 7. Shows the collaboration and communication facility features of the final design suggestion; First picture shows the calendar system, where a green box means that the medicine intake is documented, and the blue boxes indicate that there is no medicine intake registered yet. Second picture shows notes for medication, physical health, mental health and other notes. Third picture shows the chat system.

they do not have the means to help them identify pills if they do not recognize them. The uncertainty of not knowing the pills that are meant to be given is a critical problem, which is why our final design suggestion contains a pill scanner that is interconnected with the medicine list in our application. The pill scanner uses the smartphone camera to scan the pill, and then the pill will be identified through a database, where all relevant information about the different pills will be displayed. Such technology and databases already exist such as XTC Pill Scanner [31] and Smart Pill ID [20], which could be implemented in our application.

As mentioned earlier, in the study by Koyama et. al, it has been argued that there is little evidence that the procedure of double-checking medicine is not more efficient than single checking. However, since double-checking is required, we cannot omit it in our final design suggestion, but we have made a suggestion to how the procedure could be optimized.

Collaboration and communication facility

Collaboration between home care workers was both confirmed in the study by Gutwin and from our participants in this study,

and therefore this is an essential feature in our design (see Figure 7). Our final design suggestion provides the home care workers with a calendar system, where they have an overview of the previous and upcoming medication of the elderly. The calendar page has an overview of the elderlies medication, which is divided into three sections morning, noon and evening. The section shows which home care worker gave the medicine and the date and time of the check in, in order to maintain awareness of what actions others in the group have done. Furthermore, the home care workers can write notes about the visits if necessary, and also have the opportunity to chat with other home care workers.
However, even though the participants in our interview session liked our calendar feature from our four design suggestions, it can be discussed whether it would be simple to use. The participants did only see our four suggestions through a video and therefore did try it themselves. Also, since the participants do not have the opportunity to try our final design suggestion, we cannot not confirm that the calendar and documentation part of our application would be easy to use for them and also if it even would be a positive contribution to home care.

Socialization topics

Once the home care worker has done the double-checking, the SMC application will suggest daily conversation topics that can create socialization between the home care worker and the elderly, during the observation part of the medication management procedure (see Figure 8). Each day the application will suggest new fun facts and conversation topics.
All participants were very enthusiastic about the idea of the different conversation topics in the Social Connect Bracelet-concept associated application, because it could be helpful if the home care workers found it difficult to talk to the elderly. This feature was designed to create an aid for home care takers who find it difficult to talk to the elderly, and it is therefore not a mandatory part to use during medication. However, it can be discussed whether other home care workers would use it, because it is an optional feature, and some might not find it difficult to talk to the elderly.

Design aesthetics for the physical part of Smart Medicine Can

We will argue that any physical design that is intended to be placed in the context of the elderlys home in relation to medicine, should be able to be hidden away or be incorporated into the elderly's already existing decor. This is because it was stated by some of the participants, that some elderlies see home care and medication intake as taboo, and therefore do not want to draw attention to this when they have visitors. Therefore, our final design suggestion is meant to be hidden away, in order for the elderly to feel comfortable around the storage of their medicine.

Another thing to consider is reluctance of use, mentioned by McGee-Lennon, because some of our participants that had over 25 years of experience, expressed that a lot has changed over the years regarding the use of home care technology. This meant that they should almost constantly familiarize themselves with new procedures and therefore would prefer to have a more durable system. This indicates that in the future one needs to focus on creating a more

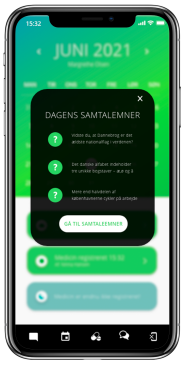

Figure 8. Shows a screenshot of the Smart Medicine Can applications Conversation topic of the day feature. An example of a conversation topic is; "Did you know that Dannebrog is the oldest national flag in the world?"

long-term solution, so that home care workers are not forced to get to know a new system on a regular basis. An example of this kind of change is the Nexus II that was released in 2018, but is already being replaced by the new Cura system in 2021.

CONCLUSION

This research concludes with a final design suggestion for medicine management in home care, which leads to answering our research question: *"How can we design a suggestion that supports home care workers managing the elderlies medicine in a more efficient and safe way, in order to prevent medicine errors?"*

Through video prototyping, we have explored interactive possibilities for a safer medication management process in the complexity domain of home care. When designing in this area many elements such as time, stress, finances, collaboration needs and patient safety play a huge role, and we must conclude that this is an area that is difficult to design within.
In addition, we have also discovered that it is difficult to design within the home care domain in the context of the elderly; Many of the elderly consider home care as a taboo area, as they feel that it symbolizes that they cannot take care of themselves to their surroundings, which means that the elderly needs to be comfortable with the design of the medicine storage. Another thing to consider is that many elderly have mental or physical limitations that make them unable to engage in different interactions. This is essential for designers to consider, in order to make sure that they do not exclude elderly with disabilities. We can conclude that video prototyping as a research object, is a very easy and efficient technique to use for presentation of a design. This technique has contributed to both feedback, discussion and reflection of our design suggestions from our participants, which led to new discoveries within the home care domain and medication management.

We have discovered that there is limited research focusing on exploring interactive solutions to prevent errors in the medication management procedure in the home care domain. Most of the research focuses on assisting the elderly who take the medicine themselves, and therefore our focus has been on designing a suggestion for the home care workers, with the

purpose of helping them manage the medication for elderly who cannot manage it themselves. Our contribution with this paper is a suggestion consisting of a physical device and an associated smartphone application, that aims to help home care workers manage the elderlies medicine in a safer and more efficient way. Furthermore, we have discovered new knowledge, which designers should consider when designing in the complexity domain of home care, in the context of the elderly.

FUTURE WORK

For future work, it should be considered to evaluate our final design suggestion with home care workers through video prototyping, as we found this technique easy and effective to provide feedback. This could provide insight into whether the suggestion will actually contribute to safer and more efficient medication management.
There are many opportunities to create more socialization between the home care worker and the elderly, which can be explored more in depth in the future since this was not our focus during this study.
When we designed the physical part of our final design suggestion, Smart Medicine Can, the focus was mostly on functionality, rather than aesthetics. Therefore, the aesthetics could be explored further.

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