Elderly Home System Improvement for Medicine Management

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User Centered Innovation
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1. Introduction

Participating in a design project that leads to a creative new solution is an excellent way to develop new skills by experiencing the design process first hand. The problem presented during the first class session was to create a solution to improve some attribute of human life in the home health care field. Our assigned team of five met the first feeling a little overwhelmed. We were challenged to find a worthy problem in need of a solution. Team Westside quickly completed the forming stage with introductions and discussion about meeting times and structure. In order to tackle this problem, we agreed to each shadow an elderly person that week and document observations before our next meeting. Our team "storming" sessions are more like a mild Portland sprinkle as all members perform to the "norms" and have good social skills.

Team Westside, prepared with a wealth of observations and problems presented the idea of medicine management in a class verbal report. The idea was briefly discussed with the class and validated. We were charted to continue with generative design research and left with a better sense of direction. Our team performed over 50 hours of research using end user ethnographic techniques. The culmination of this effort pointed to the problem of elderly frustration with managing different and changing medications. Our team had quite a bit of data for this specific problem so this was the area we shifted our attention to find a solution.

The problem was, how can we reduce the user frustration at the end of their life as they need to manage multiple and changing medications? The team agreed to use a divide and conquer approach at this time with literature researchers and field researchers. We were ready to start searching for solutions. Many solutions were shared using various prototyping methods that included: sketches, pictures, Youtube video clips, and system maps being shared back and forth. Several of these were tested with some of the original interviewees. We had time to actually test a couple of ideas and have them rejected.

One idea that seemed viable took a larger design view. A system change using one of the pill box designs was presented to a pharmacist. During the interview when he said "yeah, I think that could be a good idea", we knew we had an idea we could run with. The solution we developed was a system of multiple pill prescriptions being packaged by the pharmacy and mailed or picked up by the end user in weekly or bi-weekly doses in the pill box packaging. This system not only was validated by a pharmacist, it was also validated with a couple of elderly people in our observation sample. While this solution in the end was quite

simple, the process to get there was complex and the changes alleviate other problems and we believe that frustration will drop for our target end user base.

2. Problem Space

"Home care" means that health care services are provided to a person in their own home [1]. Home care may include assistance in different daily life activities, such as bathing, dressing, eating, preparing meals, taking medications etc. In comparison with institutional care, assistance at home is less expensive and results in greater patient satisfaction [1]. In the next few decades demand for home care is expected to grow as the baby boomers reach retirement age [2]. It is projected that there will be about 88.5 million people older than 65 years in 2050, which is two times more than in 2010 [3]. Thus it was decided to choose elderly people as a focus group of our study as this was a worthy problem and our team would be able to recruit an ample number of people for observations.

The most common problems among elderly people are visual and hearing impairment, mobility problems, heart diseases, mental problems, memory loss etc. Additionally, 6.5 million American adults 65 and older report experiencing significant vision loss. Projecting to 2050: cases of early AMD are expected to double by 2050 from 9.1 million to 17.8 million for people 50 and over, cases of diabetic retinopathy among people 65 and older are expected to quadruple by 2050 from 2.5 million to 9.9 million [4]. Almost all of these problems were observed when our team compiled our lists.

The prevalence of nursing home residents with a primary diagnosis of mental illness in 2004 increased with age, ranging from 18.7% among those aged 65-74 years. Dementia and Alzheimer disease were the most common primary diagnoses among nursing home residents with a primary diagnosis of mental illness, and the prevalence of each increased with age. Among nursing home residents with any diagnosis of mental illness (among any of 16 current diagnoses), mood disorders and dementia were the most common diagnoses among residents aged 65-74 years and 75-84 years.

Among residents aged 85 years or older, dementia (41.0%) was the most common mental illness, followed by mood disorders (35.3%). In 2004, approximately two thirds of nursing home residents had a diagnosis of a mental illness, and approximately one third of these had a mood disorder. Memory difficulties, especially short-term (e.g., walking into the kitchen to get something and then forgetting why you went in the kitchen) and delayed-intention memory problems

(e.g., planning on buying specific items at the market and then forgetting to do so when you are shopping) are very common among older adults .

The study by Ylva Hellström and I. R. Hallberg in Sweden indicated that elderly people mostly needed help with such personal activities as bathing, remembering things, and dressing [5].

Depending on the problem there are different solutions available [6]. For example to help people who are facing difficulties with preparing meals food delivery services, home nursing can be offered. For those who have mobility problems and reduced fine motoric skills, thus struggle with walking, clothing and undressing, eating, and personal hygiene there is a large range of solutions from walking sticks and wheelchairs, functional toilet seats to special forks, spoons and mugs. People with memory losses and dementia can use reminder devices, notice boards, diaries, refilled medicine containers, etc. Vision and hearing problems can be partially solved by using eye glasses, voice indicators in devices, hearing devices, Braille writing, special switches.

3. Methodologies and Tools

We designed our research methodologies to try to use many of the tools and processes presented in class. Our research consisted of a literature review, field observations and personal interviews. In order to directly understand the issues and needs faced by our users, we decided to perform the field research as a starting point. The methodology we agreed to pursue was Ethnographic Inquiry Approaches [20]. This approach allows us to follow and observe users in their daily lives without disturbing their habits, and provides us with detailed data for further analysis and use different perspectives to better empathize with the needs of our subjects. This approach uses more of a shadowing than an interview technique. We used an opportunistic sample methodology to obtain a larger sample quickly. This process is defined as sampling "the people you can get most easily" [21]. Each team member was to visit and observe an elderly person writing down observations in their home. The recruitment process was simply asking them if we could visit and observe them for a team project.

Figure 1 shows that our process was not very linear. Our 5 team members broke into the research team and the field team and it was a constant back and forth for a couple of weeks of observations, check the literature to see what it said, prototype and then get input with one of our sample users.

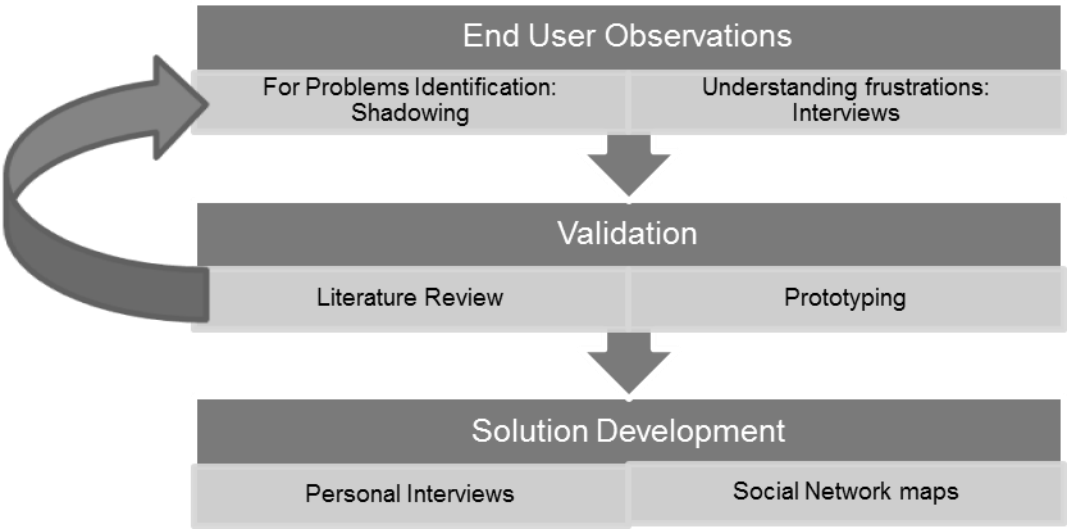

Figure 1. Project Methodology and Process

Data analysis tools and methods mainly consisted of lists, contextual analysis and problem frequency. We selected the problem that was mentioned the most frequently as a result of our team discussions and documented interviews and observations. . It became obvious that we needed a method to consolidate our input and perform a better analysis of the data. We used a cognitive map approach. The process included writing the different frustrations and needs on sticky notes and members moving them around the map. Then we sketched linkages and evaluated causal looping and clusters.

4. Results

User Ethnography Research Results

The first step was to screen and recruit participants for observations. As many of our team members had relationships with elderly people, we started from that perspective. Through our previously established relationships we were able to recruit and complete over 28 hours of observations with 5 different people through a sample of convenience.

Before we performed the observations we agreed upon a set of observation rules. We were not to interview, but rather shadow the participants and to observe for any frustration and or task difficulties and document them. We were also to record the date, the name, age and any health conditions that they wanted to share. There was no specified time length and the initial observations ranged from 15 minutes to almost a full day in length.

We completed five different observations of individuals, took notes, and compiled a long list of all the issues observed by all team members. Our team compiled and grouped observations into different categories such as mobility issues, memory issues, and medical issues, and taking medicine. We formed a cognitive map similar to the exercise performed in the first night of class. Through this process, we were able to use the map to facilitate a decision to target medicine management. From our sample, there was a bulk of information and participants who shared various frustrations with home medicine management.

The scope of our study, after analysis of the observed data and consultation with our instructor, will be to target "Issues with Medicine Management with the Elderly". We decided to target this subject because it was the broadest problem with the elderly population, yet it was focused enough for us to be able to study the issue and offer some potential solutions. In addition, we had ample data from our set of observations.

Literature Review Results

Our team chartered two team members to investigate and conduct research on existing products to solve medicine management issues. We needed to conduct the research to make sure our solution or approach was unique and novel.

Our team then conducted a literature review to compare against our field research on currently used memory aids for taking medicines by the elderly in their home. The study conducted by Jiska Cohen-Mansfield and colleagues [7] identified that the most frequently used memory aids were calendars and phone/address books (92% of participants), paper notes (75%), alarm clocks (49%), having someone, usually a spouse or a child, to remind (36%), using a pill dispenser labeled with the days of the week (17%), and timers (9%).

During the study participants were asked how they remembered which medication they had to take, at what time and in which order. About 33% of respondents said that they did not have a problem with this task. Another 17% used compartmentalized pillboxes or pill dispensers, which they filled regularly. About a quarter of study participants used different reminders such as putting the bottle with medications on the counter, on the coffee table, in the medicine cabinet next, or on the sink. Authors noted that some reminders more quite complicated, for example, using markers and post-it notes write down which pills had been already taken and which left, or using separate envelopes with pills to take several times a day. One respondent said that he "lined the bottles up on the counter and put each one back on the shelf as the pill is taken." Another interesting approach was keeping medicine in different places depending on the

time when they should be takes, e.g. morning pills were in bathroom, night one – in the bedroom, etc.

Still reminders did not always work out. People forgot to look at them, or update. Some respondents said that they lost or misplaced their reminders, while others had difficulties with reading labels and hold the dispenser.

Generative Design Research/ Contextual Observations

As stated in the methodology, the process was highly iterative. Upon agreement of our target problem, medicine management, we agreed to perform interviews using another opportunistic sample. Some of the same individuals were interviewed and three additional recruits were added to the sample. Therefore, we now had a pool of eight participants who formed a representative sample of the population we were studying.

Planning for the observations included team discussion and agreement about the scope and focus of the interview and sensitizing materials. We discussed using the plastic pill box to help focus the conversation and a possible aid. Two of the participants had multiple boxes very similar in nature. One 80 year-old man taking medicines to manage a heart condition shared how he used and filled his pill box, and a 77-year-old woman had over 10 similar boxes, some on chains. Figure 1 is representative of these boxes.

Figure 2. Boxes Used by 80-year-old Male and 77-year-old Female Participants

The results of the interview were either transcribed or summarized and placed into the group folder for later discussion. The team performed a discussion type content analysis where we each read, then shared and listened to the data gathered by each interviewer. All participants were open and interested in helping. Upon discussion our team agreed that most of the elderly interviewees enjoyed the attention and found the interviews to be more of a social exchange.

They enjoyed helping us with our project. We believe the information was provided in good faith.

There was quite a bit of data compiled as a result of the interviews. Some of the findings include:

- Some had prescriptions changed before the course was complete leaving them with partial bottles at some point.
- All of them had multiple pills required to be consumed at various times of the day.
- Most of them had systems to remember how and when to take their medications.
- Some of them relied on others in their household to help them remember.
- Some of them admitted to forgetting sometimes.
- Most of them showed frustration with taking the medications.
- Most of them had been frustrated when their medicines changed

We were able to effectively use this tool to agree on common pain levels and needs. We agreed that while changing medicines created a special situation, it appeared to cause the most frustration. Figure 3 shows the cognitive map our group used to assess the pain and frustration levels of our participants.

5. Problem Definition

Find or develop a device or product which is easy to be operated, can take multiple items, separate doses in a daily manner, and have enough space to last at least 7 days. Reduce user frustration. Give them some dignity and independence at the end of their life, as they need to manage multiple and changing medications?

6. Prototyping

At this point we performed our first prototype. This process consisted of evaluating the different types of pill boxes and dispenser mechanisms. Here are some examples of the prototypes and modified prototypes that we came up with.

1. We first thought of coming up with a categorized pillbox that can have different sections day wise and person can take it easily depending upon the day.

Figure 3. Pill Organizer

This Pill organizer has 7 compartments with medicines for each day. The main problem with this product was person has to look at prescription and categorize all the pills for each section which can go wrong anytime due to old age factor

2. The second prototype to address this problem was Pills dispenser.

Figure 4. Pill Dispenser

In this type of product, user has to input all the medicines taken from pharmacy and put in Pills dispenser. Such type of pills dispenser helps the patients by avoiding opening the box and look out for the medicine. With this product, just press the button and medicine is out to take; this product was useful when a patient has to take only one medicine. In multiple tablets scenario, user again has to scroll for correct one.

In our research, we saw people facing problems with categorizing the pills: putting the wrong medicine in the compartment or unable to segregate them when multiple products need to be included.

Validation of the first prototypes: User Testing

It was interesting to note: our prototypes were not well received.

The problem wasn't with the type of box. It was how the box was filled. They weren't really interested in a better box. We had interesting feedback after we

performed some user tests. The users weren't particularly interested in changing their pill boxes or methods. They viewed that as an extra level of frustration. This was surprising to us. We had initially assumed that a simpler disbursement solution would eliminate frustration this was not the result at all. Our group had hit a bit of a roadblock and needed to look for a system solution. We tackled this problem by creating a social network map to analyze the interactions beyond the elderly medicine taker.

System Prototyping

We then thought of family member who can help the patient in categorizing the pills but then it's limited to only those patients who are staying in family. In US, majority of patients live alone and independently. So, the need was to provide a service to patients for the categorization of pills.

We then looked upon various NGOs and volunteer community who can help patients by providing service of such type but then covering a wide range of patients across entire United States is a very big challenge.

Research Iteration #2: Systems.

We agreed to divide the team and conquer this problem. We split the 5 of us into 3 different teams: the social network mapping team, the field interviewer of a pharmacist, and the literature research team. We created a larger social network map to identify other resources we would need to interview to get a handle on the problem and performed research to verify completeness of the model.

The research team quickly found a number of studies focused on characteristics, architecture and possible models of a medicine dispenser that can be used by elderly [8] [9] [10] [11] [12]. They also found an interesting critical point in the system. One study proposed involving pharmacists in the process. The study conducted by Arnold Zermansky and colleagues shown that pharmacists who conducted clinical medication review, i.e. reviewed medicine prescriptions and gave consultations to patients, improved the quality and control of their treatment [13].

Anna Bergkvist and colleagues in their study investigated whether an integrated medicine management (IMM) service, that was developed and implemented in Northern Ireland and involved pharmaceutical care at admission, during the hospital stay and at discharge, led to more appropriate drug use in elderly patients [14]. The results showed that there was a significant

decrease in the number of inappropriate drug use among those patients, whose drug treatment was monitored by the pharmacist.

Evidence from another study supported medication reconciliation interventions that included screening for inappropriate medications and adverse drug interactions, verification of prescribed medications [15].

Multiple studies [16] demonstrated that pharmacists' monitoring and educational services resulted in better compliance among patients. Another finding was that private face-to-face counseling that included both oral communication and written information was the most effective form of patient counseling.

Thijs Vinks and colleagues [17] conducted a study in the Netherlands to investigate how community pharmacists involvement would affect drug-related problems (DRP) in the elderly. They found out that elderly patients who used six or more different drugs were at high risk of potential DRPs. The authors proposed that pharmacists' interventions could identify potential DRPs, evaluate and prevent them, which would help to decrease the number of DRP cases.

7. Solution Space Research

A social network map was used to further understand the solution space. Our solution space now expanded to include not only the elderly end user but also their care givers, family members, household members, physicians, pharmacists, and logistical support people. Then, we took to the field to interview stakeholders.

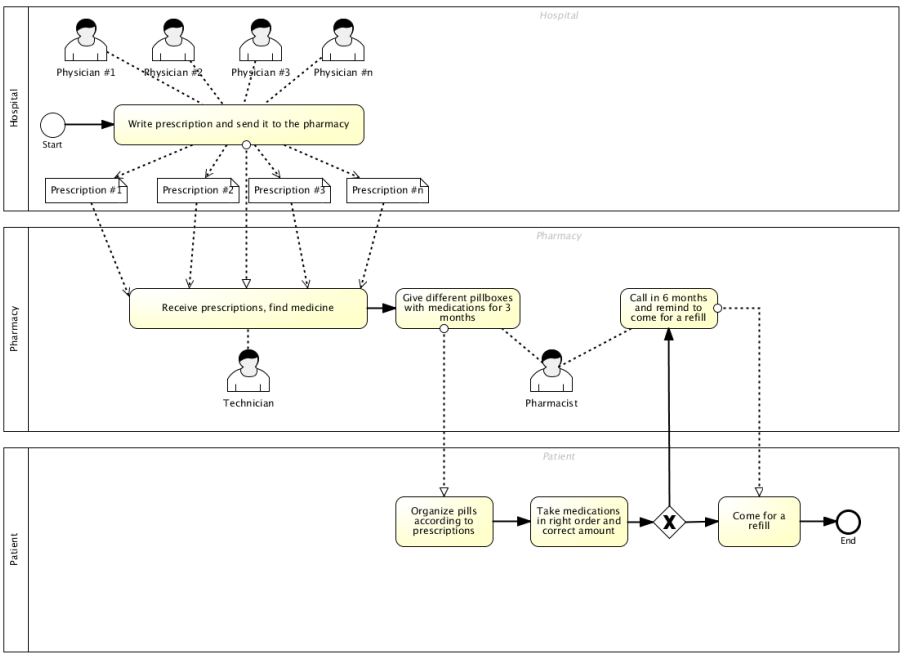

Figure 5. Medicine Management. The Current Process.

The Team determined that we needed to interview a pharmacist and family members who supported at least one of our participants. One care-giver was selected to provide us with insights in the needs of the users. A Pharmacist, who works for Kaiser, was approached by a team member and agreed to be interviewed.

We again performed a certain amount of design before completing the interviews. We wanted to focus our questions on systems and easing the use of medicine management for elderly when they were in a diagnostically unstable situation.

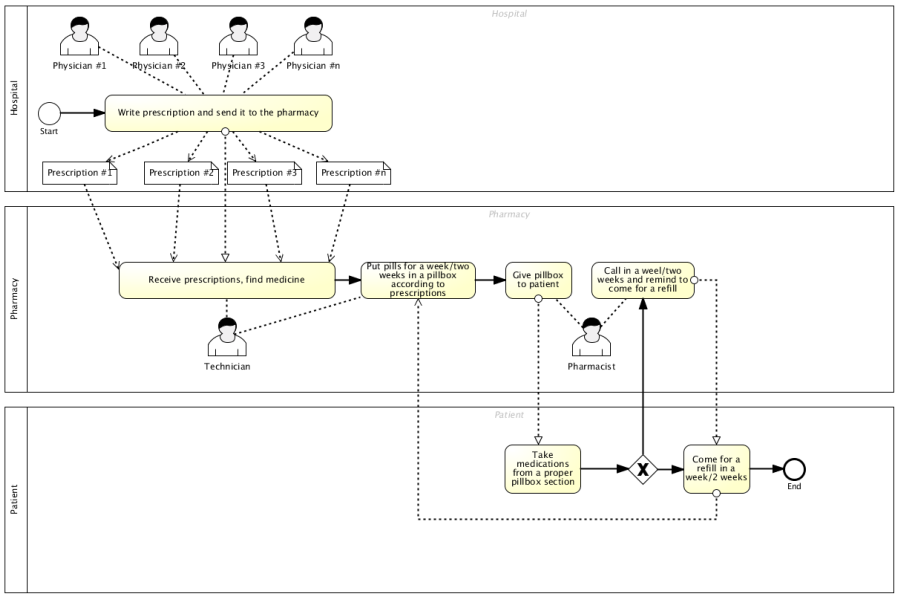

Figure 6. Medicine Management. The Proposed Process

Validation of the first prototypes: Pharmacist Interview

Our team held a phone interview with a Pharmacist, it involved an explanation of our project, and the interview was conducted in a question and answer session. It was important for us to explain our perspective of the target problem and our approach to identifying any possible resolutions. It is important to remember that at this point the team had developed with various possible solutions and was trying to find the right approach to improve the existing system. Our objective was to identify a gap in the existing system where we could provide a value added service or product while keeping the existing participants intact.

Below is a summary of the conversation:

Team: Do you have experience in delivering medicines for the elderly?
Pharmacist: Yes. I primarily deal with elderly patients. In fact we are a team of 5 in my Kaiser site who specifically focus on managing and delivering medicines for the elderly community.

Team: What are the different ways medicines are provided to the elderly from the pharmacies?
Pharmacist: There are several options elderly people can get their medicines. Since most medicines are prescribed to them on a regular interval basis like, monthly or quarterly etc; they can either come and collect their medicines from the pharmacy on a regular basis or we also have the option where if the elderly

are unable to visit the pharmacy then, we have primary care where there is a nurse or caregiver assigned who administer the medicines personally to the elderly. This is an additional service that can be chosen as part of Medicare by the patients.

Team: What are some of the issues or inconsistencies that you see in taking these medicines in the elderly people?
Pharmacist: One of the biggest aspects of concert is that, the elderly are not very regular in coming to the pharmacy to refill their medicines. We have had experiences where the patient has to refill their medicines every 3 months but they did not visit us for over 6 months period from the last refill. Sometimes they even forget to take the medicines or just refuse to take them. We try to contact these patients and have a personal counseling session were one of the pharmacist speaks to them to explain how important it is to take these medications in time and to ask them if they need any kind of assistance in the process like home delivery, reminders and personal care.

Team: Do you think it is feasible to have these elderly patients renew their medicines every once a week instead of once a month?
Pharmacist: Currently the patients do prefer to have their medicines refilled once a month or once in 3 months. This way they do not have to visit the pharmacy often but it is definitely possible to have a weekly refill process. But is there a specific reason you would like to introduce this into the process?
Team: Yes absolutely.

So our project is attempting to come up with a possible solution to solve the medicine management process among the elderly people at home. Like you mentioned earlier, a lot of elderly people have multiple medicines prescribed to them by multiple physicians and this is very confusing to elderly patients. Some of these medicines also have different dosage variations and they come in separate bottles with tiny writings on them. This is both overwhelming and difficult to manage. Some elderly patients just forget to take them all together; forget about getting them refilled because the medicines never were consumed in the first place.
We came up with this idea where if all of the medicines that are prescribed to and elderly patient can be consolidated to weekly dosages that can be organized by the pharmacists into 7 daily containers this will help in managing one of our biggest issue of improper medicine delivery and regulate its usage.

Team: What do you think about this idea?

Pharmacist: This definitely sound like a good idea. This will mean that the patients have only maximum of 1 week's worth of medicines on hand at a time which would mean they can manage it better. Also I think if they forget to take it and if this includes some life threatening related medicines that are critical for them to take on a daily basis, it allows us to tack them quicker rather than waiting for over 3 months.

Team: Do you feel this will increase workload to the pharmacists or would need more pharmacists to do this as compared to the current situation?
Pharmacist: I honestly do not think so simply because we already do this. We just need to change the amount of medicines we handle at a time for each patient which is in fact a positive. We also would not have to stock these medicines in large quantities and worry about expirations dates when giving them for 3 months period since weekly refills will always keep them current. I would definitely support this idea and think it would be beneficial to the elderly patients overall.

Team: Thanks so much for your inputs. Would you like to add anything else?
Pharmacist: You are welcome. I think this is definitely a good approach to the problem. You are actually trying to resolve the issue from the end user perspective and this is very encouraging. Good luck with the project.

8. Value Proposition and Solution Space

After several iterations of ethnographic research and prototyping, we are presenting a systems level versus a product level solution. The solution is to have the pharmacy control and package the multiple medications and simply ship them or stage at will call a box with a weekly or bi-weekly supply. The value in this proposition for our end user is that it eliminates their fear of being wrong. They no longer have to worry about taking the wrong medicine or taking it on the right day. Their feeling of overwhelm is reduced because they have decreased decisions. Their frustration about not being able to read or understand the small print on the label is gone. They can read the larger instruction sheet. They don't have to worry about creating their own system because it was created for them.

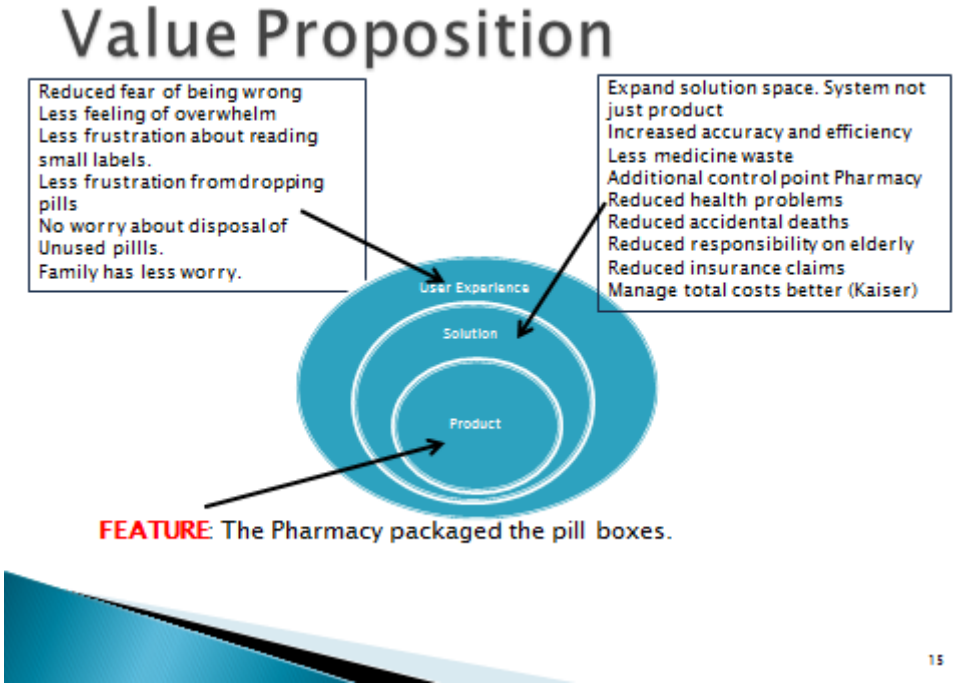

Figure 7. Value Proposition

There is also value for the solution providers. There is less waste. Insurance companies save money and the expired pill disposal problem is decreased. There will now be less pills making their way into the water systems. Because there is a reduction in the unused medications in the elderly patients home, there is less risk for accidental medication errors causing additional complications including death. Also, the total managed costs will go down which is seen as attractive according to the physician interview at one Kaiser site.

Our product will consist of a simple plastic holder, separated by seven colored compartments, one for each day of the week. Each daily compartment, will have two separate spaces, and will be label AM and PM. Each sub compartment will be able to hold the morning doses, and the night compartment the second daily dose.

Figure 8. Example of a Product

9. Conclusions

Through the 10 weeks we actually completed several design projects. The first one was cancelled and replaced by the second. It was interesting to see which concepts from the class we could apply directly and which we needed to tweak. In almost all cases, the concepts were solid but we made the processes and implementation our own. A key learning was to be flexible and encourage everyone to come up with ideas. It was a little hard to let go of the product solution because we thought we were on to something, but in the end the entire team thought we had a better solution and a good project. While the system change is not a technically challenging or sophisticated solution, we are happy with our results.

As we learned in our class, sometimes the more simple solutions are the most elegant.

10. Limitations and Future Research

Our team approached the project with the user in mind, as such; we did not consider the legal ramifications, or safety issues associated with medical devices. Government places rules and regulations on new medical devices entering the field. Usually, these rules are in place to make sure, the products to do not have any unintended consequences, and indeed the device is used for its intended purpose. On the legal side, whom would bear the legal responsibility if our device malfunctions, or by coupling multiple medicines together, they could produce a chemical reaction, and produce potential harmful side-effects. Our team did not consult any expert in the medical community, to gauge the additional screening needed to make sure the products would be safe indeed.
If this project were to be realized, we would need to understand, and solve all the medical, legal, and governmental issues, in order to have a viable product. We

would need advice from a legal, medical, and regulatory standpoint. Our product obviously is not viable when those additional hurdles are considered.

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