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Enhance Communication between Parents and Mature Children by Sharing Medication Information

Daisuke Asai[1,2,a)] Jarrod Orszulak[3] Richard Myrick[3] Chaiwoo Lee[3]
Lisa D'Ambrosio[3] Kathryn Godfrey[3] Joseph F. Coughlin[3] Olivier L. de Weck[4]

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Abstract: Aging in place is a sustainable strategy for aging societies all over the world, although there are still various issues to be resolved. One of those issues, the isolation of the elderly, is expected to be tackled by technology. We identify three concepts for designing systems to assist the elderly in communicating with their families: provide trigger for communication, provide control of communication, and effortless communication. We develop the e-Home system on the three concepts. e-Home is a communication system that includes home monitoring; it offers shared sticky notes and video-telephony for communication media while monitoring medication compliance. We conduct a two-month field study of four households, studying e-Home use and its impact on the subjects' communication habits. The results show enhanced communication in all households.

Keywords: aging in place, home monitoring, medication management, communication

1. Introduction

The population all over the world is rapidly aging. The percentage of the population aged 65 and over is predicted to become 19.3% in the U.S. by 2030 [7]. Given that infrastructure and nursing shortages are significant issues even now [8], this demographic imbalance poses one question; how can we support this trend at reasonable cost. One possible solution, called "aging in place," is the cost-containment strategy of encouraging the elderly to stay in their own home instead of moving into another place such as a nursing facility. "Aging in place" is also valuable in terms of mental health. One survey showed that what they fear most is not their death but the loss of independence [21]. However, "aging in place" is not still widely accepted because of various factors such as emergency and safety issues; new technologies are expected to resolve them [6].

Good social relationships, especially with one's family is said to be an important factor in raising the quality of life [16], and social relationships are strengthened by the amount of daily interaction [23]. However, "aging in place" reduces the opportunity to interact with others compared to a shared facility such as a nursing home or living with the family. As such, "aging in place" raise the difficulty of keeping social relationships with others. Recent progress in information communication technology makes it possible to tackle this issue. IP-based phone technologies such as Skype resolved the cost issue in that calling someone is no longer expensive. Furthermore, videophones provide us with the new communication experience of feeling as if you are facing the other person in the same place. This possibility has motivated many researchers and various efforts have been made to provide users with better communication experiences such as better video quality with limited network resources [4], or decreasing the delay [14], or making it more enjoyable by adding functions [12]. However, most of these works have focused on the communication act in progress and few have focused on the initial phase of communication.

Our research question is how to create communication, i.e., the initial phase of communication. We identify three strategies to support to communication establishment; providing a trigger for communication, support for establishing communication, and requiring less effort while communicating. We design and implement our communication system called e-Home based on these strategies.

e-Home consists of a pair of terminals installed in the parent's and children's homes. It offers two communication media, shared sticky notes by which users can share text information with the other side and videophones. In addition, the parent's e-Home terminal has the function of medication reminder, and his/her medication compliance information is shared with his/her family. In our field study, e-Home was installed in the homes of four pairs of participants.

We make three contributions in this study:

- We present three concepts for designing systems to enhance communication between parents and their mature families.
- We introduce e-Home as a system that is designed according to the three concepts. e-Home is a system that combines

[1] NTT Cyber Solutions Laboratories, Yokosuka, Kanagawa 239–0847, Japan
[2] Graduate School of System Design and Management, Keio University, Yokohama, Kanagawa 223–8526, Japan
[3] AgeLab, Massachusetts Institute of Technology, Cambridge, Massachusetts MA 02142, USA
[4] Engineering Systems Division, Massachusetts Institute of Technology, Cambridge, Massachusetts MA 02142, USA
[a)] asai.daisuke@lab.ntt.co.jp

communication with monitoring.

- We report our two-month field study with four pairs of households. We describe how they felt about e-Home and how e-Home affected them from the perspective of communication; finally, we discuss the three concepts.

2. Related Work

One major stream of related research is to support relationships between people living apart such as families, friends or couples by providing awareness of one side to the other. The Casablanca project yielded the Intentional Presence Lamp that indicates a user's presence to the other side [9]. Videochat systems are expected to play a key role in keeping relationships between families [1]. Some studies focused on the relationship between parents and their mature children. One example is the FamilyPlanter [17]. The FamilyPlanter is a pair of devices installed in the parent's and children's homes, each of which conveys presence information detected by the motion sensor through optical fibers in the other side. The FamilyPlanter takes more explicit attempts to communicate by encouraging the users to touch to the base of the unit, which results in a sound being emitted by the other side FamilyPlanter. They conducted a field trial with three pairs, parents and children, over a three-month period. They concluded that the unconscious presence cues and conscious touch signs improved emotional states such as familiarity or affinity, but there was no change in the usage of customary media. Another example is the Shared Family Calendars that facilitate the sharing of calendar information between multi-generational family members [20]. In their field study of three households, one junior subject noted that the shared calendar was not accessed often because they already knew pretty much what their parents were up to, and nothing of interest happened in the lives of the parents. Similar opinions were also observed in interviews of parents and grandparents [25]. Although most of these studies concluded that they succeeded to providing connectedness between subjects, none of them mentioned about their effect on communication or their ability to enhance communication. Their main shortcoming is, as symbolized by the junior subject's comment above, that the sharing of awareness is not interesting enough to stimulate further communication.

There are also other studies on supporting relationships by using monitoring technologies. A prominent example is the Digital Family Portrait, a picture frame designed to be placed in the child's home that displays information gathered from the sensors in the parent's home [18]. They conducted a field study with a 76-year-old woman and her son [22]. Although they found no evidence of a shift in connectedness based on the presence of the system, they gained the interesting insight that she felt "less lonely" because she knew he was watching out for her through their system. One recent example is the medication box called "SocialMedicationBox", which is designed to share the parent's medication compliance information with their children by Twitter [26]. Although both of them sought to improve the relationships between the generations, they considered only children as the communication initiator.

3. e-Home

We introduce the communication system called "e-Home;" it consists of a pair of terminals installed in the parent's and children's homes. e-Home introduces the shared sticky note and the videophone as communication media and a medication reminder function as a communication trigger.

3.1 Concept

The goal of e-Home is to support and encourage parents to keep good social relationships. While parents can have social relationships with their friends and acquaintances as well as their families, the relationships with their families is an important principal that raises the quality of life [16]. Furthermore, among the relationships with family members, the one between them and their children is notably close and strong because of the reciprocity built up through raising their children [2]. Based on these previous findings, their children are most likely to play a primary role in taking care of them. Therefore, we considered parents and their children as the primary target users of e-Home, although e-Home will also support other people. To design a system that satisfies our intent, we started by identifying three key concepts.

3.1.1 Provide Trigger for Communication

Effective triggers are important to encourage communication between parents and their children. Previous works failed to enhance communication even though they provided various kinds of triggers. Thus determining the most effective trigger is a critical factor in the success of e-Home. One important requirement is that the trigger must retain the users' attention. We considered two strategies to achieve this. The first one is to keep both parties interested by updating information that should alleviate boredom. Photo sharing is a typical example of this strategy [10]. The second strategy is to raise the importance of the information shared. The first strategy has one defect, especially for our case, in that it forces the parent to work hard at finding the topics of interest. This demand is not feasible. Therefore, we took the second strategy, and selected the parent's medication compliance information as the trigger. We expected that involving the children in the management of the parent's medication would keep the children's attention.

3.1.2 Provide Parent with Ability to Create Communication

Even as parents age, they want to maintain their role as the guardian of the family. Past work reveals the ambivalence parents have in the relationship with their children, describing that they are annoyed by the children's over protectiveness but appreciate the concern it expresses. They use a variety of strategies to deal with their ambivalent feelings, such as minimizing the help they receive, ignoring or resisting the children's attempts to control, and withholding information from children to maintain clear boundaries [24]. Given that our goal of e-Home is to use communication to enhance the relationships between parents and children, it's important for e-Home to provide control of communication equally to both parent and their children. Thus we differ from whereas most other researchers who provide the children with system over the system [5], [17], [26]. Providing parents with control over the communication enables them to initiate

interaction with their children or suppress the flow of their information to the children by themselves.

3.1.3 Require Less Effort to Use

Needless to say, establishing remote communication with others involves additional operations such as dialing for calling or typing for texting and thus is more cumbersome than talking face to face. These additional operations hinder the initiation of communication in the users' mind. One subject in the FamilyPlanter trial commented "*Even if I do not bother to make a telephone call, anytime I can feel the other party and it comforts me*" represents this feeling [17]. The subject felt the difficulty of initiating a phone call. Since our goal is to enhance actual communication rather than improving familiarity, minimizing the additional operations needed is an important strategy.

3.2 Implementation

Based on the three concepts above, we designed and developed e-Home system. e-Home system consists of a server and a pair of clients which are installed in the parent's and children's homes. Asus's desktop PCs (called "EeeTop") were used as the client terminals. Each PC has a touch screen display, which enables users to make all operations without mouse or keyboard actions. Both clients also run Information Globe, which indicates the parent's status. The parent's client also runs Medication Table, which automatically monitors the parent's usage of medication. **Figure 1** shows an overview of the parent's client. **Figure 2** shows the main screen of an e-Home terminal; across the bottom of the screen there are three icons to initiate local note, shared note, and videophone, which enable users to initiate each function very easily. Created sticky notes and the videophone screen are shown in the remaining area of the screen, both of which are movable. Users can move them to any area in the screen desired.

Fig. 1 Overview of e-Home client.

Fig. 2 Screen of e-Home terminal.

3.2.1 Videophone

Telephony including video telephony is the most familiar medium for communicating with remote people. However, telephony is more obtrusive than other communication media such as texting, the emotional barrier to initiating a phone call is relatively high. Users can be de-motivated by every step they need to do to initiate a call. Therefore, its important to decrease the number of those steps. Although phones are expected to be available in almost all homes, people don't always have them in their hands [15]. In other words, some steps such as going to pick the phone up are required to initiate call. Therefore, we implemented a videophone, called Meeting Plaza [13], in e-Home to decrease these steps. The only operation needed to initiate a call is to touch or click the "phone icon" on the e-Home screen.

3.2.2 Shared Sticky Notes

Although the videophone is the easiest medium to use, it has two shortcomings. One is its synchronous nature; it requires both parents and children to stay in front of their terminals. Given the difference in their daily schedule, caused by different lifestyles, it might be hard for them to hold video calls often [19]. The other shortcoming is its obtrusiveness [11]. Making a phone call forces the other side to take the phone call no matter the situation or how willing they are take the call, hinder the initiation of communication. To compensate these shortcomings of videophones, we added shared sticky notes as an asynchronous communication medium. They are a simple form of email that is easy to use and very less unobtrusive. Both parents and children can create, edit and remove sticky notes freely just as if they were actual sticky notes. Shared sticky notes are editable as well as movable in the screen. When a user clicks (includes screen touch) the shared sticky note icon, a blank sticky note appears on the screen. After the user enters the text desired and clicks the submission icon, the client sends the content to the server. Clicking the pencil icon of a sticky note (right upper corner) allows the content to be altered.

The server is connected with both clients via the Internt, and holds the list of sticky notes. The clients poll the server every ten seconds to catch or change the latest state according to the list of sticky notes that the clients have.

3.2.3 Monitoring Parents' Medication Compliance

As discussed above, we selected parent's medication compliance as the trigger for communication. To achieve this, we implemented our previously proposed medication management system. The system monitors the usage of registered medicines automatically and reminds users to take them and issuing alerts if the schedule is not followed. In this study, alerts are raised if the delay in taking a medicine exceeds one hour. Detailed technical description of the system is explained in Ref. [3].

Reminder messages are displayed as green sticky notes and warning messages as red sticky notes in both clients (Fig. 2). These notes automatically disappear when parents take designated medication.

In addition to sticky notes, we installed the status indicator called Information Globe; its color changes with the status of

medication compliance. In our case, red indicates some problem and green indicates full compliance.

4. Field Study

We expected that it would take considerable time for the new system to become familiar to both parents and children and for its real effect on their relationships to become apparent. Therefore, we conducted a long-term field study taking two months. We recruited four pairs of parents living alone and their children.

4.1 Protocol

Two different conditions were established to compare the effect of medication information as the trigger for communication:

- *Shared mode*: both sticky notes and the Infomation Globe of parent's medication status are shared with their children.
- *Local mode*: parent's medication status is not shared with their children.

Our two-month field study consisted of three periods; first three weeks, second three weeks, and last two weeks. Participants were assigned either shared mode or local mode in the first and second periods, and participants could select the mode in the last period. In this case, households #1 and #2 started with shared mode and households #3 and #4 started with local mode in the first period; they switched modes in the second period.

During the field study, we used several methods to capture information. The first one was a series of questionnaires. We asked participants to answer the questionnaires before the first period (pre-study questionnaire), between the first and second period (first interim questionnaire), between the second and last period (second interim questionnaire), and after the last period (post-study questionnaire). The second one was an in-depth interview with each participant in his/her home just after the end of last period; it was designed to extract qualitative information from the participants such as experiences, feelings, opinions, and perceptions. The third method was recording the data handled by the system, including the history of sticky notes and videophone usage (actual contents were not recorded).

e-Home terminals were installed in each participants home. Since we didn't designate the place for the terminals to be installed, the terminals were installed at the participant's request; sites included their kitchen and bedroom.

4.2 Participants

Four households that had a parent living alone some 40 km from his or her children were recruited to take part in the study. The extensive separation meant that the pairs may already be communicating via devices such as the computer or telephone, rather than taking face to face. In addition to the criteria above, the parents had to be over 60 years old, and taking at least one prescription medicine daily because we use medication compliance as the trigger.

4.2.1 Household#1

The 68 year old female has some difficulty in moving around outside her home. Her daughter is 50 years old and lives 56 km away. She worries about her mother because of her disabilities. They usually communicated once a week, mostly by phone, before the field study. Both the parent and the daughter use PCs for emailing and web browsing every day. e-Home terminals were installed in the dining room of the parent's home and in the living room of her daughter's home. The parent registered 1 medicine for 8am consumption and 3 medicines for 6pm consumption.

4.2.2 Household#2

The 65 year old male has no difficulty in daily life. His son is 31 years old and lives 56 km away. He doesn't worry about his father because his father manages by himself. They usually communicated once a week, mostly by email or phone, before the field study. Both the parent and his son use PCs for their jobs and have enough technical knowledge. e-Home terminals were installed in the working room of the parent's home (where he spends most of his time) and in the working room of his son's home. The parent registered 3 medicines for 12pm consumption.

4.2.3 Household#3

The 67 year old female has no difficulty in daily life. Her daughter is 40 years old and lives 46 km away. She doesn't worry about her mother because she thinks that her mother is very healthy and can manage by herself. They usually communicated once a week, mostly via email, before the field study. Both the parent and her daughter use PCs for email or web browsing. Parent has a technical background and has knowledge about PCs whereas her child doesn't. e-Home terminals were installed in the working room of the parent's home and in the private room of her daughter's home. The parent registered 1 medication for 8am consumption.

4.2.4 Household#4

The 76 year old female parent has no difficulty in daily life. Her son is 35 years old and lives 53 km away. He doesn't worry about her mother because he thinks that her mother can manage by herself. They usually communicated once a week, mostly by phone, before the field study. Moreover, the parent visited her son almost every weekend. The parent uses PC for email and web browsing whereas her son uses it for work. e-Home terminals were installed in the living room of the parent's home and in the play room of her son's home. The parent registered 3 medicines for 11am consumption and 1 medicine for 8pm consumption.

4.3 Result

Each subject's usage of sticky notes and the videophone was recorded including the time as well as the type of operation: creating, editing and deletion for sticky notes and calling and hanging up for the videophone. The fact that most of usages are followed by other usages implies participants had a series of interactions. Therefore, we grouped a contiguous sequence of usages (sticky notes or videophone or a mixture of both) into a cluster called an interaction sequence. **Figure 3** shows the daily numbers of interaction sequences. Each interaction sequence was counted separately according to the who made the first operation in the interaction sequence, in other words, who initiated communication.

When we looked at all interaction sequences, we found that they could be categorized into seven patterns as shown below. **Figure 4** shows the usages of each pattern.

- *Pattern I*: The parent or the child created a sticky note, and

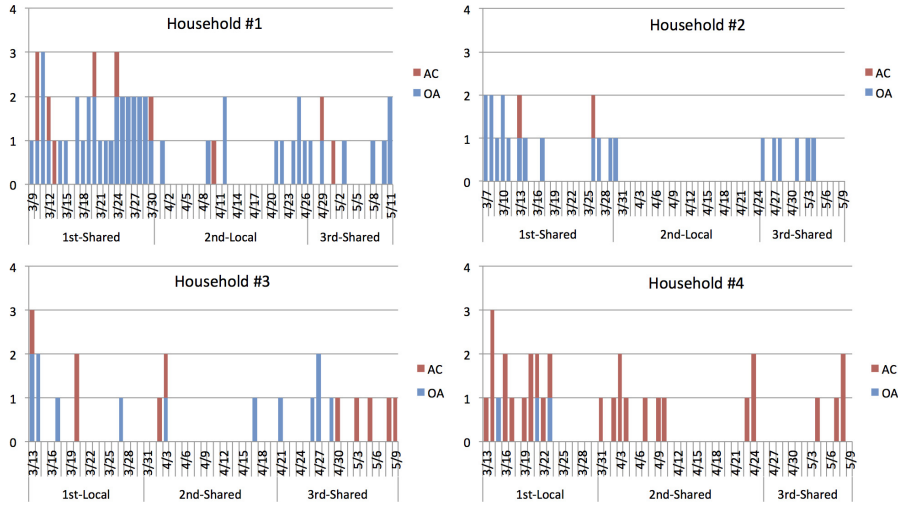

Fig. 3 Daily number of interaction sequences by parent (OA) and child (AC).

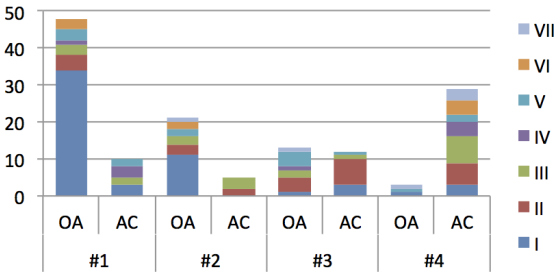

Fig. 4 Usage of each interaction sequence pattern by parent (OA) and child (AC).

then one of them removed it without updating.

- *Pattern II*: The parent or the child created a sticky note, and then one of them update it.
- *Pattern III*: The parent or the child created a sticky note, one of them update it, and finally they used the videophone.
- *Pattern IV*: The parent or the child made a videophone call, and the other accepted it (no prior sticky note interaction).
- *Pattern V*: The parent or the child made a videophone call videophone, but the other didn't accept it.
- *Pattern VI*: The parent or the child made a videophone call, the other didn't take it, and then a sticky note was created.
- *Pattern VII*: Pattern VI but the sticky note was noticed and a video chat was made.

Since the usage of existing communication media, phone and email, could not be captured automatically, the questionnaire asked each subject about their usage. **Figure 5** shows each subject's usage of existing communication media. Since we didn't record the contents of sticky note or videophone to preserve privacy and encourage participation, we didn't know what topics were discussed. Instead, we asked about the topics in the interview.

4.3.1 Household#1

Both the parent and the child used sticky notes for general communication such as "*Hi, how are you?*" Figure 4 shows that *Pattern I* was used often by the parent. A common reason was to let the child know that the medicine had been taken.

4.3.2 Household#2

Both the parent and the child used sticky notes for general conversation. However, both mentioned that "*It was too frustrating for me to use sticky notes. The design is awkward and does not encourage chatting.*" The parent also used sticky notes to let his child know that he would be away from home when the medicine was to be taken to reassure the child (*Pattern I*).

4.3.3 Household#3

Both the parent and the child used sticky notes for general conversation. It should be noted that the usage rate of sticky notes increased over time unlike the other households. Given that both the parent and the child updated sticky notes one after another, their communication was made via the same sticky note. The child said "*I used sticky notes to communicate with my mom because she replies quickly unlike email, my mom doesn't reply to email quickly.*"

4.3.4 Household#4

Three grandchildren as well as the parent and the child used sticky notes for general conversation. In most cases, the grandchildren initiated sticky note usage, and the parent replied to them. The grandchildren created sticky notes to remind to take medication when they saw the reminder or warning sticky note.

5. Discussion

Based on the field study results, we now explore the effect of e-Home on the communication between parents and children.

5.1 How Did the Parent's Medication Information Affect the Child?

When we designed e-Home, we hypothesized that the parent's medication information would motivate the child to communicate with the parent. Although Fig. 3 shows some difference between the interaction sequences in *shared mode* and those in *local mode*, in which the children except household#4 initiated interactions by themselves more often in *shared mode* than they did in *local mode*, the difference is not significant enough to validate the effect of sharing medication information.

In our field study, we saw two patterns related to our hypothesis. The first one is an explicit pattern that was observed in all households. The children initiated sticky note and/or videophone call when they saw a green or red sticky note on their termi-

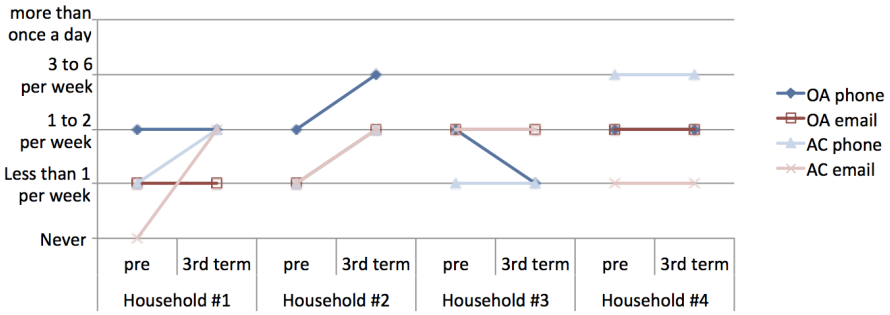

Fig. 5 Usage of existing media before field study and during third period by parent (OA) and child (AC).

Table 1 Number of interaction sequences initiated by children in shared mode.

particiant	number of interaction sequences	
	reminder and/or warning sticky note is displayed	no reminder nor warning sticky note is displayed
child of household#1	5	4
child of household#2	3	0
child of household#3	4	4
child of household#4	10	6

nals, which meant that the parent had not taken their medicine as scheduled.

Since the children were not always in front of the client, in other words, they were sometimes unaware of the sticky notes and Information Globe, assessing the linkage between the children's behavior of initiating interaction and the system's creating notification isn't reliable to validate our hypothesis. Instead, we assess whether the children were more likely to initiate interaction while the system is posting notification than they do while the system isn't posting notification. **Table 1** shows the number of interaction sequences that were initiated by the children under two conditions: when reminder and/or warning sticky notes were displayed in the clients of the children, and the other condition when no warning and reminder sticky note was displayed. The number of interaction sequences when reminder and warning sticky notes were displayed is larger than the number of those with such notes in all households except household#3, in which the numbers were equal. This result suggests that children were more likely to initiate interaction when reminder and warning sticky notes were displayed.

The child of household#1 describe her behavior, "*when I was getting alerts for her medication, if I didn't get one, I would start to get concerned. So I would always make sure that I Skyped (used videophone) her or sent her a note, like, 'What's up? Are you OK?' because she has so many medical issues. I always thought, oh my god, something must be wrong.*" The child of household#3 also mentioned, "*when I had that five (medication notes) in one day, I was like, what is going on? Yeah, and I was, like, nervous, like, what is happening? So I contacted her by the blue note and she didn't respond, so then I was, like worried, so then I went to the email or called her or whatever.*" Therefore, the worry or uncertainty about their parents' situation motivated the children to seek reassurance by sticky note or videophone as well as other communication media.

The other is an implicit pattern in which medication information acted as a theme for communication. In the post questionnaire, three of four children agreed that they are more likely to

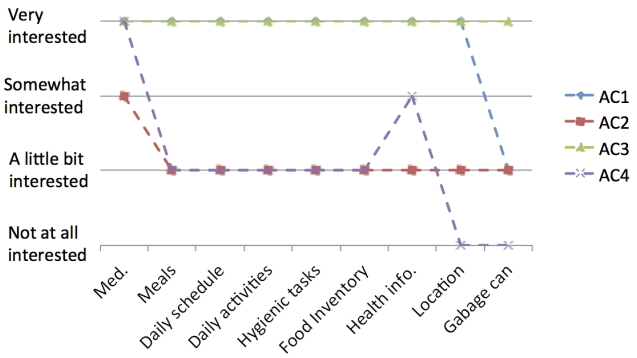

Fig. 6 Child (AC)'s interest in shared information.

talk about medication compliance than they used to be in their conversation. The child of household#4 said, "*I guess it has just become another item of stuff to talk about.*" We asked the children's interest in receiving parent's information after the field study and the result is shown in **Fig. 6**. One noticeable outcome is that all participants became interested in receiving medication information. Although their replies were possibly affected by our field study, this result implies that medication information is well-suited as a communication theme.

One question we had about medication information is how the children feel about sharing their parents' medication information. Given that they get more information than they used to, they might feel annoyed or overwhelmed, which would raise negative feelings about their relationship. In the post questionnaire, no child answered that such sharing had a negative effect on their relationship or become a source of tension or disagreement between them. Moreover, the child of household#1 asked their parent to select share mode, "*I told her that I wanted her to share. She was fine with that. I feel like if she didn't share, I probably wouldn't have been on it as much.*"

Another topic that is often raised with regard to these kinds of monitoring system is providing "peace of mind". Although we expected that our system would provide peace of mind to the children, only the child of household#1 agreed that using the sys-

tem yielded greater peace of mind. We have two reasons for this result. The first one is that the children, except the one of household#1, didn't previously worry about their parents seriously because they thought their parents were fine. Therefore, they didn't see any change in their minds over the course of this study. The other reason is that the information they got from our system wasn't enough for them to feel peace of mind. The child of household#2 said, "*now, if there was a time when, say, my father went three days without taking his medication, I'd be less concerned that he didn't take his medication, and more concerned that something happened to him.*" Based on this comment, a system that provides more critical information such as a fall or serious injury might provide peace of mind.

5.2 How Did Parents Feel about Sharing Their Medication Information with Their Children?

The parents also felt that sharing medication information acts as a theme or trigger for communication with their children. In the post questionnaire, three of four parents agreed that they are more likely to talk about medication compliance than they used to be. The parent of household#4 said, "*up until this point we really didn't talk about, you know, medication or how many I took, or – you know, why I needed a reminder. So there was lots of interesting conversations that happened because of it, yeah.*" The parent of household#2 said, "*because the thing is, it's giving you a basis to talk about other things. So if you're calling about the pills, you'll also start talking about something else. So I think it's just spurred general conversation.*"

When we designed e-Home system, we considered two negative feelings of the parents may have had with sharing medication information with their children. The first one is their hesitation in losing privacy. Since parents might hesitate to share private information such as medication even with their children, we projected that there would be some disagreement with their selection of mode, in which the parent would prefer the local mode whereas the child would prefer the share mode. However it turned out that all households selected share mode without any disagreement. The parent of household#3 said, "*if I'm talking to somebody, like one of my sister's husbands, then I wouldn't share a damn thing with them. But if it's somebody that's in your family, it's fine, unless they object.*" **Figure 7** shows the parents' willingness to share various types of information with their children, which we asked after the field study. All of the parents were very willing to share their medication compliance information whereas willingness to share other types of information was varied. Based on these results, as far as our participants are concerned, all the parents felt that is not a problem to share their medication information with their children.

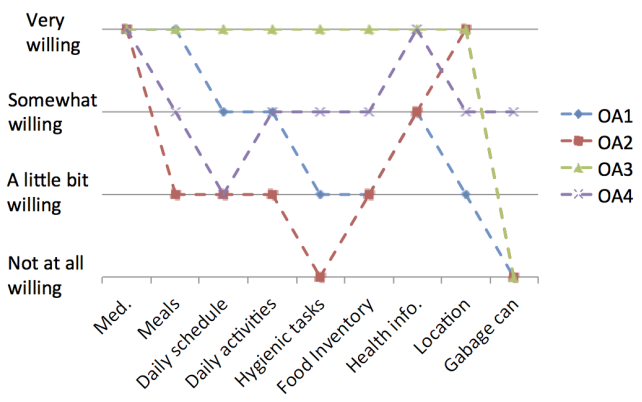

Fig. 7 Parent's willingness to share information.

The other negative feeling would be a hesitation to involve their children in their own matters, in other words, hesitation to burden their children. The parent of household#3 stated, "*so no, I think it's a good thing. I think that children, if they want to be involved and know.*" On the other hand, the child of household#3 mentioned about her mother, "*she doesn't always share all that stuff with me, so. Like, even with the medication, I wasn't really aware of medications that she was on prior to this.*" These dialogs imply that the parent are willing to share her medication information with her daughter, but doesn't want to force her daughter to do it. The parent of household#1 said, "*you know, I stay out of her life, you know, try anyway.*" These results show that some parents hesitate to involve their children too much in their life.

5.3 How Did Sticky Notes and Videophone Enhance Communication?

When we designed e-Home system, we expected that sticky notes would play two roles; asynchronous communication and less obtrusive communication. In period of the first role, asynchronous communication, all participants except the child of household#2 used sticky note as *Pattern I*. Among others, the amount of *Pattern I* by the parent of household#1 is quite a noticeable. She used sticky note in order to let her daughter know her taking medication. She explained about her behavior, "*well, I just thought she would know that I took them. I just wanted to make sure.*" Other purpose of *Pattern I* is memo, in other words, leaving general message. The child of household#1 said, "*I used the blue shared notes when I would leave her a quick message or something, like 'Happy Mother's Day' or something like that. Or, 'How was your day?' and stuff. 'Call me at 5:00'.*" On the other hands, sticky note was also used as a synchronous communication medium, *Pattern II* and part of *Pattern III*. The child of household#3 considers quickness of response as a merit of sticky note. She said, "*and she (the parent) doesn't respond as quickly to the emailing. So she doesn't get on her email as much as I do, but she seems to check that. So I'm more likely to reach her quicker, and she'll respond quicker on that,*" and the parent also said about shared sticky note, "*those were used quite a bit, actually. That was really nice, and it was a back and forth.*" Since we didn't design sticky note for synchronous usage, some participants felt hard to use sticky note. The parent of household#2 said, "*the blue notes (shared sticky notes) were great, except that if you're used to using any kind of instant messaging things whether it be AOL or Facebook and stuff, it was just very frustrating because it was slow or awkward and hard to use.*"

The other role was less obtrusive communication. Although it's difficult to confirm the effect statistically, some cases support this role. The child of household#3 initiated eight communication sessions using sticky notes (*Pattern II*) whereas she initiated only one session without them (*Pattern III*).

All households used the videophone although none of them had prior experience. The parent of household#3 said about the videophone, "*it was a nice way to see somebody in the family, in this particular case. In fact, I got to see my grandson, who I haven't seen in a long time because he's never home when I'm there. So it's really nice. It makes you feel like you're visiting physically, which I like.*" It's notable that all households except household#2 who already had Skype said that they want to keep using the videophone after this study. This implies that the videophone is an important communication medium for them.

Another topic we would like to mention is that sticky note and videophone Were used as adjuncts to existing media, i.e., phone and email, rather than replacements. Figure 5 shows the usages of all media before and during the field study. Although there are some exceptions, most households, saw no decrease in the usage of the phone and email.

6. Conclusion and Future Work

In this study, we design a communication system called e-Home to enhance relationships between parents and their adult children. e-Home has three primary functions, videophone and shared sticky note as communication media, and parent's medication compliance as a communication trigger. We conducted a two-month field study, in which e-Home terminals were installed in the parent's and children's homes of four households. Here are the key findings:

- Sharing parents' medication information with their children played two roles to enhance communication. One is as an alarm with regard to the parent's condition, which makes the children contact the parent in order to confirm their situation. The other is as a theme of communication for both parents and children. No negative effects such as the children feeling burdened by the parent's information or the parent's hesitation to disclose private information were observed in our study.
- Sticky notes was used as an asynchronous communication medium, in other words, memo for the partner as we designed. In addition to those roles, it was also used as a synchronous medium. The videophone was used by all subjects. Moreover, three of four households asked us to install Skype in order to keep using videophone after our study. Both sticky notes and videophone were not used as an alternative to customary communication media but media that is different from them.

To design e-Home, we identified three key concepts. Based on the result, we discuss on them for future implication of communication system for parents and their children.

- *Provide trigger for communication*: We confirmed that parents' medication information works to trigger communication in two ways: involving the children and providing a conversation theme for both parties. Another notable result is that both their children and parents preferred to share medication information as information rather than meals, daily schedule, or location tracking.
- *Provide ability to control communication*: Whereas similar systems in most previous works handed control to the children, we pointed out the importance of providing control for parents as well. In our study, we found that the parents were willing to initiate communication including sticky note and videophone equal to or more than their children, which supports our hypothesis of communication enhancement.
- *Require less effort to use*: We designed e-Home system so as to minimize users' steps to initiate sticky note and videophone usage. Although it's hard to verify this effect statistically in our study, one subject mentioned, "*I'm just too tired at night. Like, I get home after dinner and then I'm just too busy. It's just easier for me to just shoot her an email (shared sticky note) 'How's it going?' – than it is for me to boot up my computer, log onto my Yahoo account.*" Her comment shows that even such small steps like logging onto Yahoo hinders her communication with her parent. This dialog implies the importance of reducing overhead.

A clear limitation of our study is the small number of participants, which leads us to posit qualitative assessment rather than quantitative results. While we believe that our participants provided us with a lot of real facts to support our hypothesis, these facts can be generalized with many more participants, which we are planning to do in future work.

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Appendix

A.1 Questionnaire During Field Study

We tried to understand our participants through 4 questionnaires (pre-study, first interim, second interim, and post-study questionnaire) and depth interview after the field study.

A.1.1 Questionnaire

The questionnaires were designed from two perspectives: relationship with their communication partners, contact with their partners. The questions are shown below;

- Taking everything into consideration, how would you describe your relationship with your study partner? Option is: *not great*, *reasonable*, *good*, *very good*.
- How much conflict or tension would you say that there is in your relationship with your study partner? Option is: *not great*, *reasonable*, *good*, *very good*.
- Taking everything into consideration, how close would you say you are emotionally to your study partner? Option is: *not at all close*, *not too close*, *somewhat close*, *pretty close*, *very close*, *extremely close*, *don't know*.
- To what extent do you agree with the following statement: In my conversations with my study partner, we are more likely to talk about whether I am taking medications properly than we used to. Option is: *strongly disagree*, *somewhat disagree*, *neither agree nor disagree*, *somewhat agree*, *strongly agree*, *don't know*.
- What effect did sharing medication information with your study partner during the e-Home study have on your relationship with him/her? Option is: *had a positive effect on our relationship*, *had no effect on our relationship*, *had a negative effect on our relationship*, *don't know*.
- Did having access to your medication information during the e-Home study ever become a source of tension or disagreement between you and your study partner? Option is: *yes*, *no*, *don't know*.
- Since the last visit from the e-Home team, how often would you say you have seen your study partner face-to-face? Option is: *have not seen study partner since the last visit from the e-Home team*, *once or twice*, *3 to 6 times*, *6 times or more*, *don't know*.
- Since the last visit from the e-Home team, how often would you say that you talk to your study partner by telephone or cell phone (NOT including video chat services like Meeting Plaza, Skype or g-Chat)? Option is: *more than once a day*, *every day*, *3 to 6 times per week*, *1 to 2 times per week*, *less than once a week*, *don't know*.
- Since the last visit from the e-Home team, have you talked with your study partner using video chat services other than Meeting Plaza like Skype or g-Chat? Option is: *yes*, *no*, *don't know*.
- Since the last visit from the e-Home team, how often would you say that you send email to your study partner (NOT including using the blue share notes on the e-Home system)? Option is: *more than once a day*, *every day*, *3 to 6 times per week*, *1 to 2 times per week*, *less than once a week*, *don't know*.

A.1.2 Interview

In the interview after the field study, we asked them following key questions as follow;

- Tell me a little bit about your experiences with the e-Home system - what kinds of things did you like about the system, and what kinds of things didn't you like?
- During the study period, did you use the blue share notes or the yellow post notes?
- What did you like about the blue share notes? What did you not like?
- Did your use of these notes change over time - did you use them more or less often after the system was first installed? Why?
- Was it convenience? Easier to use another method to contact your study partner? Problems with the system?
- Did you use the videochat software, Meeting Plaza? What did you like or not like about this?
- Did your use of Meeting Plaza change over time - did you use it more or less often after the system was first installed? Why?
- Was it convenience? Easier to use another method to contact your study partner? Problems with the system?
- Which mode did you like better? Why?
- Which mode did you choose for the last two weeks of the study period? Why?
- How did you and your partner come to agree on that mode?
- Do you think that your communications with your study partner were different based on which mode you were in? Do you think that your communication with your study partner were better in one mode versus another?
- Did you feel better about being in one mode than another?
- Did one of the modes lead you to feel greater peace of mind or confidence about how your study partner was doing? Which one? Why?

- Do you think that taking part in the study had any effect on the relationship you have with your study partner? What kind of effect do you think it had - positive or negative?
- Do you feel like you communicated more with your study partner during the study than you did before the study? What has that been like? Do you think any changes in your relationship will keep up once the study finishes?
- Did you use the system to communicate with other people besides your study partner such as grandchildren, a partner's spouse, etc?

Daisuke Asai was born in 1981. He received his M.E. degree from the University of Tokyo in 2005. He is a Ph.D. candidate at Keio University. He has been working in NTT Corp. since 2005 and now is a research engineer at Cyber Solutions Laboratories. Since 2010 until 2011 he had been a visiting researcher of MIT AgeLab, US. He has been working in the research areas of human computer interaction, service design and user experience.

Jarrod Orszulak was born in 1985, he holds an M.S. in Electrical and Computer Engineering (2008) and a B.S. in Biomedical Engineering, both from the University of Rochester. From 2008 to 2011, he served as a Research Engineer at the MIT AgeLab, studying the role of technology in the home and in transportation for the world's rapidly aging population. Most recently he is employed as a Product Manager at FRABA Inc., part of an international group providing position sensors for industrial automation.

Richard Myrick retired in 2008 after more than 30 years of employment as an engineer and engineering manager with Hewlett Packard, Agilent Technologies, and Draeger Medical. His work was concentrated in Medical Equipment, and he and his teams were responsible for many new products, as well as several innovations in algorithms, data presentation, and networked capabilities. He also worked with and was responsible for engineering groups in Germany and Japan. He has a BSEE from MIT and an MSEE from Washington University in St. Louis, Missouri.

Chaiwoo Lee was born in 1985 in Seoul, Korea. She received her M.S. degree from Department of Industrial Engineering, Seoul National University in 2010. She is currently a Ph.D. candidate at Engineering Systems Division, MIT, and a research assistant at MIT AgeLab. She is partially supported by Samsung Scholarship. Her research areas include older users' interactions with technology, user-centered design and development, and product and service innovation.

Lisa D'Ambrosio is a Research Scientist at the MIT AgeLab. Her research focuses on questions about what an aging population will need to enhance their quality of life and to enable parents to live independently longer. Her work includes projects on parents' mobility, including a national study of older drivers' attitudes and behaviors around driving and research on helping families to address issues around driving and dementia. She is co-editor with Joseph F. Coughlin of the recently published Aging America and Transportation: Personal Choices and Public Policy (Springer, 2012). Her other research interests include decisions around housing choices and household technologies for an aging population, and work on financial planning. She teaches social science research methods for MIT's Engineering Systems Division graduate program. She earned her Ph.D. in political science from the University of Michigan, Ann Arbor, and her A.B. from Brown University. Prior to coming to the MIT AgeLab, she was a research analyst at the Volpe National Transportation Systems Center, USDOT.

Kathryn Godfrey was born and raised in the Boston area. She received her Bachelor's of Science in Psychology and Human Biology from the University of Toronto in 2008. She worked as a Research Associate at the MIT AgeLab and Massachusetts General Hospital from 2009 to 2011. She is now pursuing a Ph.D. at the San Diego State University and University of California, San Diego Joint Doctoral Program in Clinical Psychology. Her research interests are in behavioral medicine and computer-based interventions.

Joseph F. Coughlin is Director of the Massachusetts Institute of Technology AgeLab. His research focuses on consumer behavior, technology and well-being across the lifespan. He teaches in MIT's Engineering Systems Division. A Fellow of the Gerontological Society of America, Coughlin advises businesses and governments on aging and innovation worldwide. He is author of the online publication Disruptive Demographics and holds a B.A., A.M. and Ph.D. from the State University of New York at Oswego, Brown University and Boston University.

Olivier L. de Weck His research is in Systems Engineering. He focuses on complex man-made systems and how we can design them to maximize lifecycle value. Specific research results include methods such as Time-Expanded Decision Networks (TDN), the Delta-Design Structure Matrix (DSM) and the Technology Infusion Analysis (TIA) process that have been demonstrated on systems of real-world complexity in space exploration (NASA), oil and gas exploration (BP) as well as complex electro-mechanical products (e.g., Xerox, UTC). He is an Associate Fellow of AIAA, and serves as Associate Editor for the Journal of Spacecraft and Rockets and the Journal of Mechanical Design. He won the 2008 and 2010 best paper awards from the journal Systems Engineering and the 2010 Capers and Marion MacDonald Award for Excellence in Mentoring and Advising.