# University of Alberta

Usability of Medication Adherence Technologies among Older Adults

by

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## Abstract

This study examined the usability of medication adherence technologies (MATs) to improve medication adherence among older adults. A MATs survey and a product trial were used to understand the perspectives of health care providers and older adults. The survey was distributed to health care providers in Edmonton and surrounding areas. It received 210 responses with a 25% response rate and the results showed a low level of awareness of MATs. However, 94 percent of respondents felt MATs could be beneficial. A usability trial of a commercial MATs product was conducted with two older adults at the Glenrose Rehabilitation Hospital, Edmonton. It was tested in a home-like space over a two day period which brought out specific design limitations for use by older adults. It also highlighted the need for further research to understand design, cost and usability of MATs to enhance medication adherence among older adults with complex needs.

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# Introduction and Review of the Literature

## Canada's Aging Population

Healthy aging is defined by Health Canada (2002) as "a lifelong process of optimizing opportunities for improving and preserving health and physical, social and mental wellness, independence, quality of life and enhancing successful life-course transitions" (Foreward, para. 3). The concept of healthy aging is especially relevant as population projections estimate the proportion of older adults will exceed the proportion of children in this century (Statistics Canada, 2008). Older adults can be defined as individuals 65 years of age or older (Statistics Canada, 2007). Statistics Canada (2008) also reports that Canadians are living longer with a projected life expectancy of 81.9 and 86.0 years for Canadian males and females respectively by year 2031.

On a local level, statistics from the Government of Alberta (2011) indicate as of June 2009 there were over 385,000 older adults residing in the province with estimates that this number will grow to 505,800 by year 2016. In terms of financial costs, a background paper prepared for the Healthy Aging and Wellness Working Group (2006) reported that older adults accounted for only 13 percent of the Canadian population but required more than 44 percent of all provincial government health spending. This paper also reported that over 90 percent of older adults live independently in the community and the majority prefer to remain in their own homes.

With these population projections, the health care system's ability to support older adults will become increasingly more difficult in an environment constrained by available finances and workforce. It is anticipated that systematic changes in health care delivery, a new focus on disability prevention and the utilization of appropriate technologies will be required to handle the future increases in service demand.

**Medication Regimes**

When looking at the characteristics of the average older adult, one study found that 81 percent of older adults have at least one chronic condition with 33 percent of this group having three or more chronic conditions (Gilmour & Park, 2006). To treat these chronic conditions, a 2010 Canadian Institute for Health Information (CIHI) report found that older adults consumed more than 40 percent of the total amount of prescription drugs in Canada and yet represented only 13 percent of the total Canadian population. A majority of older adults were also prescribed multiple medications with 62 percent using five or more drugs and 21 percent using ten or more drugs (CIHI, 2010). An inverse relationship has also been found between the prescribed number of doses per day and medication adherence. A study by Claxton, Cramer and Pierce (2001) found that patients who were taking pills four times a day achieved a lower average adherence rate of 50 percent in comparison to their less-medicated counterparts whose adherence rate was 71 percent. In terms of long-term medication taking behaviours, medication adherence with chronic conditions has also been found to drop dramatically after the first six months of treatment (Osterberg & Blaschke, 2005).

Overall, the profile of the average older adult is an individual with at least one chronic condition who is on multiple medications. This places the majority of older adults at high risk for varying levels of medication non-adherence. The percentage of older adults successfully achieving healthy aging could potentially be improved if effective strategies can be found to increase medication adherence.

**Definition of Medication Adherence and Non-Adherence**

In general terms, the World Health Organization (2003) defines medication adherence as "the extent to which a person's behaviour taking medications, following a recommended diet and or executing life-style change corresponds with the agreed recommendations of a health care provider". Medication adherence levels for older

adults have been found to be as low as 42 percent to 64 percent with electronic monitoring considered to be the gold standard of measurement in comparison to pill counts and self-report (Hayes, Larimer, Adami, & Kaye, 2009; Setoguchi, Choudhry, Levin, Shrank, & Winkelmayer, 2010; Smith, Hankins, Hodson, & George, 2009).

The specific definition of medication adherence is the proportion of days an individual take the appropriate number of doses over a specified period of time (Claxton et al., 2001). Older adults with levels greater or equal to 80 percent are considered as adherent while older adults with levels less than 80 percent are considered non-adherent (van Onzenoort et al., 2010). Non-adherence episodes can include dose-taking errors (i.e., dose omissions, dose duplication) or dose-timing errors (i.e., failure to take medications past the pre-defined dosing interval) (Claxton et al., 2001).

Non-adherence can further be divided into two categories: intentional versus non-intentional. Intentional non-adherence is when an individual purposively decides to omit a certain medication. The decision to purposively omit a dosage could be due to lack of perceived benefit and limited knowledge regarding the purpose of the medication. Non-intentional non-adherence is when an individual intends to take the dosage but fails to complete the act due to issues such as confusion about when to take the medication, forgetfulness, inability to recognize environmental cues and changes in medication regime. Complete non-adherence is when an individual discontinues treatment altogether. Typical reasons cited by older adults for missing a dose include forgetfulness, other priorities, lack of information and intentional decisions to omit the dose (Osterberg & Blaschke, 2005).

**Factors Influencing Medication Adherence**

The task of taking medications falls under the category of instrumental activities of daily living (IADLs). IADLs are activities that enable older adults to live independently in the community. These activities include meal preparation, housework,

money management and most importantly, medication management. Inability to complete IADLs usually results in an older adult requiring formal support services (i.e., community care) or re-locating to supportive housing (i.e., assistive living). An activity analysis of medication management reveals the cognitive and physical requirements required to complete this IADL. For example, vision, hearing, memory and attention are required to identify environmental cues in a dosing schedule as well as to correctly identify and select the correct medication. Comprehension, literacy and memory are required to understand a medication's purpose as well as to identify an adverse drug interaction. Bilateral manual dexterity is required to open the pill bottle and adequate pinch strength, wrist range of motion and tremor free movement are required to bring the pill to the mouth. Finally, a normal swallow reflex is then required to properly ingest the pill. Several or all of these components of medication management can be compromised by physical and cognitive deterioration associated with age-related conditions.

Physical and cognitive deterioration can be caused by a combination of diagnoses such as arthritis and cognitive impairment. Arthritis is the most frequently reported chronic condition in Canadian older adults with over one reported million cases and can affect range of motion, muscle strength and finger dexterity (Statistics Canada, 2008). Sale, Gignac and Hawker (2006) also found that older adults with osteoarthritis had lower medication adherence rates for prescribed painkillers than their other prescribed medications due to perceptions and attitudes toward pain. Mild cognitive impairment can be described as an abnormal state of cognitive impairment which is the transitional state between normal aging and dementia diagnoses such as Alzheimer disease (Petersen, 2004). A cross-sectional study by Hayes et al. (2009) found that independently living older adults with mild cognitive impairment achieved a significantly lower medication adherence rate. This suggests that even mild cognitive impairment in older adults may have a detrimental impact on medication adherence. A cohort study by Petersen et al.

(1999) found that older adults with mild cognitive impairment had notable memory deficits but otherwise demonstrated comparable cognitive functions to the control group. Moderate cognitive impairment occurs when deficits begin to appear in other domains of cognition and often impair an older adult's ability to complete activities of daily living (Farlow, 2005). At this stage, formal dementia diagnoses can be determined.

Given the complexity of treatment regimens and various combinations of co-existing sensory, physical or cognitive limitations, it is not surprising that such a small percentage of older adults are able to follow their medication regime with 100 percent adherence. This greatly limits the ability to achieve optimal clinical outcomes for chronic diseases and places the older adult at greater risk for adverse drug events.

**Consequences of Non-Adherence to Medication**

From an individual perspective, non-adherence can produce sub-optimal clinical outcomes which leads to lowered quality of life and loss of independence. A study by Berry et al. (2010) found that older adults with low medication adherence rates were more likely to experience two or more falls in comparison to their counterparts who were characterized as having high adherence rates. Fall-related injuries can affect an older adult's ability to complete IADLs such as medication management and prompt the need for re-location to supportive housing. As noted earlier, the majority of older adults prefer to remain in their own homes.

Sub-optimal clinical outcomes can also result in increased family physician visits. Non-adherence makes it difficult for a physician to evaluate if the patient is non-responsive to a medication or if therapeutic dosages are not reached (Claxton et al., 2001). Both these situations prevent the physician's ability to provide optimal care.

As a society, the financial cost of medication non-adherence is high. In 2000, the cost related to drug-related morbidity in older adults was estimated to be $11 billion in Canada (Flanagan, MacKinnon, & Hanlon, 2002). Adverse drug events secondary to

medication non-adherence have been found to occur four to seven times more frequently in older adults and result in an increased need for medical care and hospitalizations (De Geus-Wenceslau, 1998).

Fortunately, adverse drug events leading to hospital admissions can be preventable in one third of the cases of hospitalization if non-adherence is addressed (McDonnell & Jacobs, 2002). The challenge now rests with identifying effective strategies to improve medication adherence that are suitable for older adults. When human resources are limited, technology such as electronic reminders and remote monitoring may be able to assist.

**Common Medication Aids**

Currently, the most commonly available aids for medication adherence are dosettes or blister packs. A dosette consists of a plastic tray with several compartments and individual lids. They are usually organized by dosage time and day of the week (Figure 1.1). For example, all of a person's 09:00 AM pills are stored in the "Morn" compartment for each day of the week and they would progressively work from the top compartment "Morn" down to the "Bed" compartment for each day. As the older adult or caregiver is responsible for loading the dosette themselves, the main limitation of a dosette is the risk of the medications being loaded or taken incorrectly. Dosettes are also available for purchase at most pharmacies and usually cost less than $20.00.

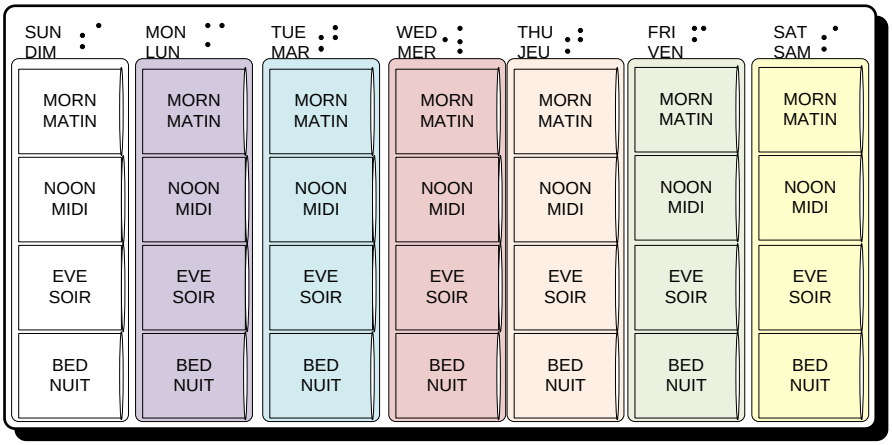



*Figure 1.1.* Example illustration of a dosette. Illustration created by author, based on the "*Super Pill Box"* by PharmaSystems Inc, Ontario, Canada, December 2011.

Blister packs are disposable trays with several foil-sealed compartments (Figure 1.2). Similar to a dosette, they are organized by dosage time and days of the week. The morning to night compartment pattern is also similar to the dosette but typically requires the older adult to work left to right for each day instead of top to bottom. Blister packs typically hold a week's worth of medications. They differ from a dosette as they are loaded and sealed by a pharmacist. There is usually a small fee charged by the pharmacy for this service. The main limitation of blister packs is the difficulty for those with

limited dexterity to punch the pills out of the foil compartments. It requires manual dexterity and strength in both hands to decompress the plastic bubble at the front of the blister pack which will push the pills out of the foil backing. Older adults with visual impairment may also have difficulty detecting if pills are stuck in the plastic bubble. Pills may also be dropped if the blister pack is not held over a table or container to catch the pills. In addition, a blister pack can be used only once and the older adult needs to receive a new replacement sheet each week.

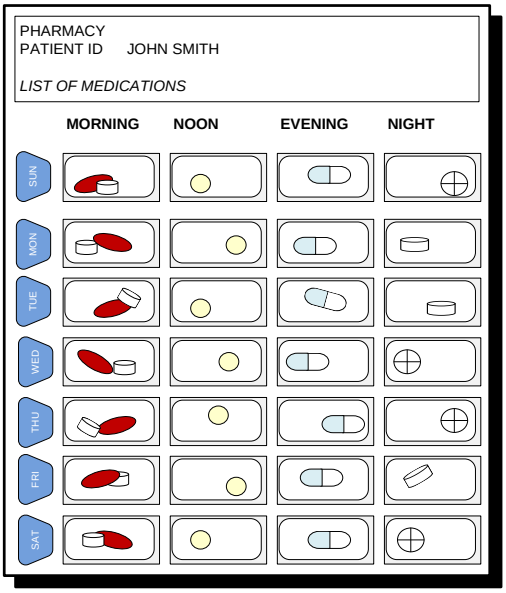



*Figure 1.2.* Example illustration of blister packaging. Illustration created by author, based on "*blister packs"* by London Drugs, British Columbia, Canada, December 2011.

Neither aid has any electronic reminder or remote monitoring abilities. Visual inspection of the dosette or blister pack by a caregiver or health care professional to complete a pill count is required. It is the only method to potentially assess an individual's ability to follow their medication regime using blister packaging or dosettes and does not provide detailed information regarding when the medications were taken.

**Medication Adherence Technologies (MATs)**

MATs are a new category of adherence products which have an electronic component. Advances in the integration of data processing, electronics and wireless communication have increased the number of MATs entering the market at a more affordable price with greater portability. These include relatively low tech and affordable standalone products (i.e., simple MATs), which can range from $50-100, to complex and expensive health management systems (i.e., advanced MATs) which include medication organization, caregiver notification and tracking options. Advanced MATs cost several hundreds of dollars to purchase plus regular monitoring fees (Figure 2.1).

The interest in MATs is highlighted in a 2010 U.S. survey conducted by the National Alliance for Caregiving (2011) who polled 1,000 technology-using caregivers on which technologies they believed would be helpful for supporting caregivers or providing care to their loved ones. This survey found seven out of ten caregivers helped with medication management while half also arranged for formal caregiving services to assist with this IADL. Out of twelve possible technologies, medication support systems (i.e., MATs) were rated by the caregivers as one of the top three technologies with the greatest potential to lessen the challenges of caregiving (Figure 1.3). These caregivers expected potential technologies to save them time, ease caregiving, increase safety of the care recipient, increase effectiveness and reduce their stress. From an informal caregiver perspective, technologies such as MATs have high expectations to fill. This raises the question as to whether health care providers have the same expected benefits in this technology.

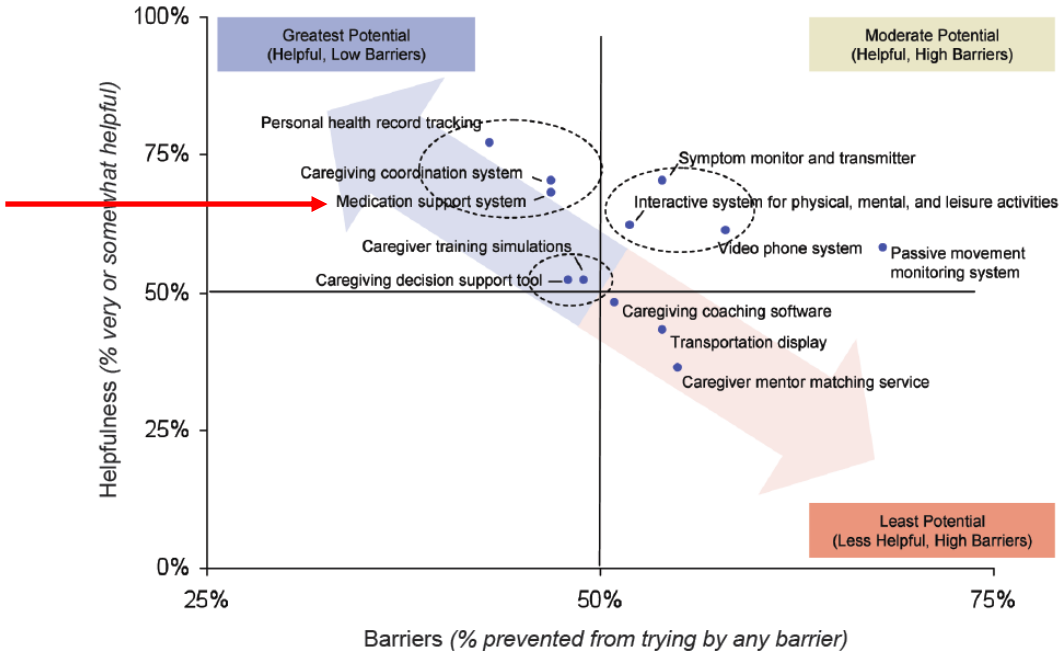



*Figure 1.3.* The 12 technologies evaluated in the survey are plotted into four quadrants with medication support systems being identified as one of the technologies with the "Greatest Potential". Adapted from: "*e-Connected Family Caregiver: Bringing Caregiving into the 21st Century,*" by the National Alliance for Caregiving, Bethedesa, MD, January 2011, p.3.

**Benefits of MATs**

The main benefit of MATs is the ability to collect precise information on the timing of when medications are taken in comparison to the more traditional methods of pill counts, patient self-reports and pharmacy prescription refill patterns (Claxton et al., 2001; Farmer, 1999; Parker et al., 2007). MATs provide electronic reminders and incorporate the use of microprocessors to record medication compartment openings and provide real-time data over a pre-determined length of time. Each compartment opening is time stamped. Advanced MATs have the additional feature of regularly uploading data to a central database either via phone or internet.

Advanced MATs also have the ability to provide immediate caregiver notifications if the pill-taking data stray beyond pre-defined parameters (i.e., therapeutic windows in which a medication should be taken). Long term data can be viewed in

graphical format with frequency statistics using a password protected website. By reviewing the data over an extended period of time, caregivers or health care providers can identify possible patterns in missed or incorrect doses. This objective data could enable early identification and early remediation of medication non-adherence. For example, if the data indicates missed 08:00 AM dosages for a one month period, the health care provider could use this dosing history to discuss potential causes with the older adult (i.e., cognitive decline, unwanted side effects, too early in the morning, intentional behaviour). Together they could investigate alternative methods such as simplifying the medication regimen or changing the dosage time to better suit the older adult's needs or daily routines. MATs may have the ability to provide information to assist with decision making and improve medication adherence beyond what a non-electronic aid could provide.

**Limitations of MATs**

The largest limitation with MATs is the assumption that each compartment opening implies that a user has proceeded to follow through with taking out the correct number of pills and proceeding to swallow the correct pills. Although electronic, it is still an indirect method of measurement and cannot distinguish between an intentional and non-intentional compartment opening (i.e., all compartment openings are counted in the medication adherence statistics). A systematic review by Wetzels, Nelemans, Schouten, and Prins (2004) found that electronic monitoring can potentially overestimate or underestimate adherence if the user opens the MATs multiple times in a day out of curiosity or to double-check the number of pills in a container. Therefore, caution still needs to be taken when interpreting the data from MATs in these scenarios.

Very few studies currently exist on the usability of MATs as an assistive aid in the average daily routine of an older adult. The majority of the studies used silent electronic products, such as the Medication Event Monitoring System (MEMS,

AARDEX Ltd., Zug, Switzerland), which only has monitoring capabilities (i.e., no alert function) to compile drug dosing histories and is mainly utilized to assess compliance in clinical drug trials (Charpentier, Fleury, Dubroca, Vaur, & Clerson, 2005). Products such as MEMS do not have the added benefit of providing electronic reminders or caregiver notifications and they do not aim to alter an individual's medication taking behaviour. Electronic products like MEMS were aimed for clinical research, used as a measurement tool and not assessed for usability as an assistive aid for older adults. These studies were also limited to one single type of medicine (i.e., one hypertensive drug) versus tracking a complex medication regime typically prescribed to an older adult (Parker et al., 2007; Wetzels, Nelemans, Schouten, van Wijk, & Prins, 2006; Zeller, Schroeder, & Peters, 2007).

One of the few studies which used community-dwelling older adults was a case series of twelve participants where an advanced MAT product was found to reduce the frequency of missed doses, reduce hospitalization rates, emergency room visits and decrease the number of medications prescribed (Buckwalter, Wakefield, Hanna, & Lehmann, 2004). In addition, beta results from a 2009 study found that an advanced MAT product measured an average adherence rate of 86 percent among 50 participants for a three month period (Vitality Inc., 2010). Overall, the available preliminary results is promising, demonstrates the potentials benefits MATs may be able to offer to the older adult population and supports the need for further research.

**Technology Acceptance Model (TAM)**

Although MATs are available commercially, it is not known whether these products are accepted or used within an older adult's daily routine. A 2005 U.S. telephone survey of 4955 older adults found that only 2 percent of those surveyed used some type of electronic alarm to assist them with their medication regimes and more than half relied on simple pillboxes (Metlay et al., 2005).

A theoretical model can help explain factors that contribute to the adoption or abandonment of technological inventions. The technology acceptance model (TAM) is one of the most commonly applied theories for explaining and predicting user acceptance of a wide range of technologies within varying contexts (Yousafzai, Foxall, & Pallister, 2007). This model suggests a user's internal beliefs affect his or her behavioural intention to use a product and will either facilitate or hinder actual system use (Figure 1.4). Therefore, technology acceptance of a user group should be relatively predictable if we understand the indirect and direct factors which influence behavioural intention. Recent studies provide evidence that the TAM can be a good predictor of behavioural intent to accept technology in health care (Holden & Karsh, 2010; Melas et al., 2011; Melas, Zampetakis, Dimopoulou, & Moustakis, 2011; Yarbrough & Smith, 2007).

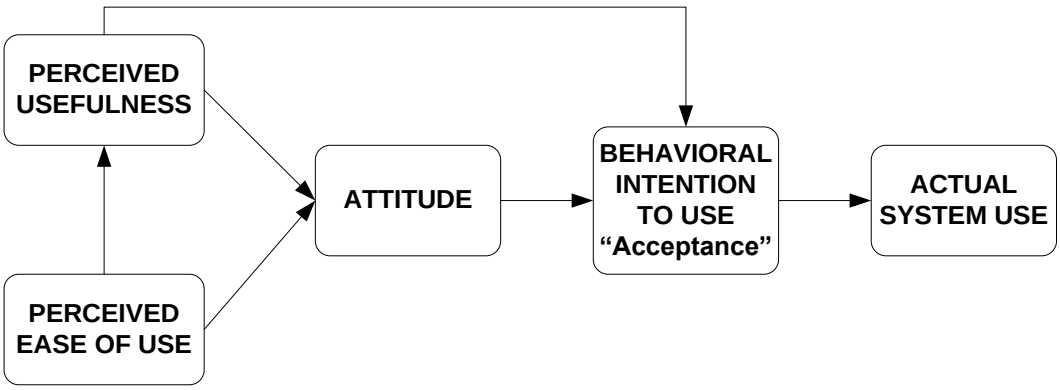



*Figure 1.4*. The Technology Acceptance Model. The arrows indicate the relationships between a user's internal beliefs, attitudes and the effects each factor plays towards generating actual system use. Adapted from "The Technology Acceptance Model: its past and its future in healthcare" by R.J. Holden and B.T. Karsh, 2010, *Journal of Biomedical Informatics, 43,1,* p.161.

As described by Holden and Karsh (2010), prior to actual system use there are four variables which precede this action: perceived usefulness, perceived ease of use, attitude and behavioural intention to use. The TAM suggests that the technology's perceived usefulness and perceived ease of use are the most important factors to facilitating actual system use. Perceived usefulness can be related to either outcomes or

processes which are improved by the technology to make tasks easier or increase quality of care. Perceived usefulness has an independent effect on behavioural intention. This means that even though a user may have a negative attitude about a technology, if the technology has a high level of perceived usefulness, the user will still use the technology. Perceived eased of use can be defined as being easy to use, requiring low mental effort or easy to get the system to do what one wants. Perceived ease of use has an effect on both perceived usefulness and attitude. Perceived usefulness and perceived ease of use both contribute to a user's attitude and subsequent behavioural intention to use. Actual system use is when the user incorporates the new technology into his or her practice or daily routine. A large component of actual system use relies on the usability of a product and can be measured through a process known as usability testing. The International Organization for Standardization (ISO) defines product usability as "the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use" (ISO, 1998).

**Usability Testing**

The central focus of usability testing is the needs of the user. Usability testing is a systematic process which evaluates the ease with which users can use a product to achieve the intended goal (i.e. perceived ease of use). This process includes gathering information from a variety of indirect and direct sources which can include: questionnaires, interviews, focus groups and observing live interactions between the user and product (Sandars & Lafferty, 2010). As described by Rubin and Chisnell (2008), usability testing involves participants who are representative samples of the target population and focuses on understanding how the targeted user group uses a product. An ideal design is a product which does not force a user's patterns of behaviour to change to use the product itself. Use of the product should be intuitive while meeting the objectives

it was designed for. Usability testing can be conducted at different points in the product development cycle.

The process of innovation is the common product development cycle which most technologies need to undergo when attempting to enter a health care environment (Figure 1.5) (Varkey, Horne, & Bennet, 2008).

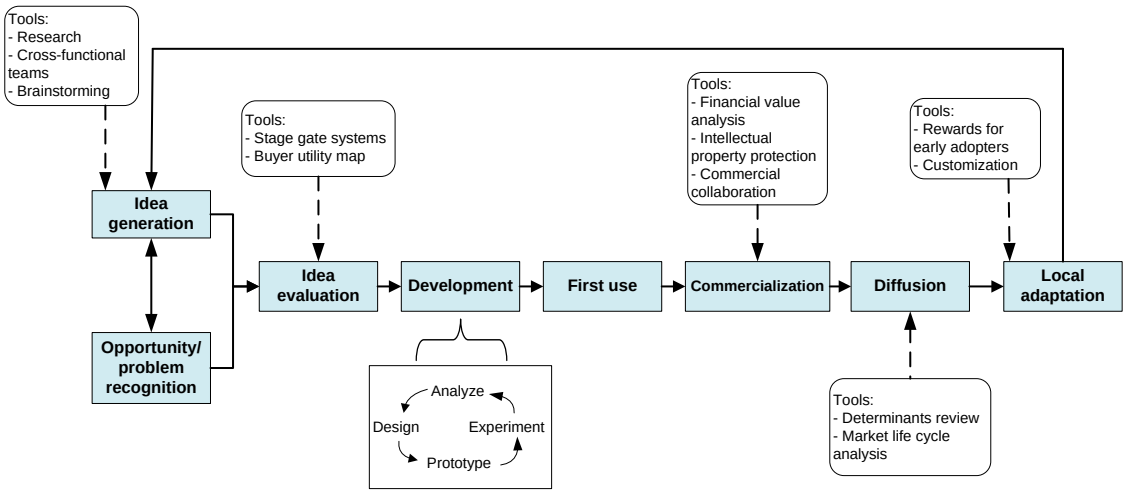



*Figure 1.5*. The process of innovation. Medication adherence technologies are currently in the diffusion stage with local adaptation being relatively low. Adapted from: Varkey, P., Horne, A., and Bennett, K.E. (2008) from "Innovation in Health Care: A Primer". *American Journal of Medical Quality, 23,* p. 384.

MATs are currently at the diffusion stage as they are commercially available. Completing usability testing at the diffusion stage can provide the most accurate appraisals as it involves actual users, true environments and real-life scenarios which cannot be re-created in a lab environment (Rubin & Chisnell, 2008). Data collected in this manner has significant value and can identify a product's strengths, weaknesses and offer suggestions for future innovations (Varkey et al., 2008). It can also identify characteristics of potential users who would adopt this innovation (Fleuren, Wiefferink, & Paulussen, 2004). Information gained can also be applied to the TAM to predict if a technology will be widely accepted by the user.

Currently, MATs are rarely being recommended by health care providers or used by older adults. This raises the question of why this branch of technologies has not progressed into local adaptation. Few studies currently exist on usability testing of MATs products.

**Rationale for the Study**

Proper medication adherence influences the overall health of our older adults and is a widespread challenge. Older adults are the most medicated people in the entire life cycle of human development but, as mentioned, can have medication adherence rates below 50 percent. If properly designed and matched to the individualized user, MATs may provide the right level of assistance, be a useful tool for health care providers and provide older adults or caregivers insight into an older adult's own dosing history. Most importantly, MATs may be able to enhance or prolong an older adult's ability to maintain acceptable medication adherence rates and enable older adults to remain at home in their communities.

Currently there is limited research investigating the relationships between older adults and health care providers with MATs. There is also little information on the usability of currently available MATs products with the older adult population.

**Purpose of the Study**

The purpose of this study was to determine the usability of MATs through a survey and a trial. The study examined the factors associated with health care providers' perceived likelihood of recommending MAT products and the usability of a commercially available MAT as experienced by older adults in a simulated home environment prior to discharge from a rehabilitation hospital.

**Specific Objectives**

1. To determine the current level of awareness of MATs among older adult's care providers and other factors associated with their perceived likelihood of recommending MATs to their patients.

2. To describe the usability of one commercially available MAT product. Usability was examined using the data collected from the medication adherence rate, observations and participant exit interviews of two older adult participants.

**Assumptions**

A local environmental scan of Edmonton's health care equipment stores and community pharmacies was conducted by the investigator to determine the current availability of medication adherence technologies in Edmonton, Alberta. Using the local yellow pages, the investigator systematically called listed pharmacies and healthcare specialty supply stores to query if MATs were available for purchase. In total, fifty stores were contacted by the investigator and five healthcare specialty supply stores indicated over the phone that they carried a MAT product. A subsequent site visit was then completed to identify the product brand, price and features (Appendix A).

Overall, five simple MATs products (i.e., electronic devices that provided alerts but did not remotely track dosage taking history) were available for over the counter purchase and the investigator was unable to locate advanced MATs available for local purchase. Given the limited availability of MATs products, it was anticipated that most survey respondents would have minimal exposure to these products. It was also anticipated that the older adults involved in the trial would not have previous exposure to such a product and no previous experiences in using MATs.

# Chapter 2

## Methods

As part of usability testing, different types of data collection were used to meet the study objectives. This section is organized into two parts and will describe the separate methods used for the survey and product trial respectively. Operational definitions are provided in Appendix B.

### Objective #1: Survey

The first objective of the study was to determine health care providers' current level of awareness of MATs products through the use of a survey.

### Research Design

The research design used a web-based (electronic) survey, cross-sectional approach and convenience sampling. Hardcopies of the survey were also provided to participants if requested.

### Justification of Research Design

Without any previous studies available, a cross-sectional approach was chosen as a practical method to complete the initial collection of local health care providers' perceptions of MATs products.

### Justification of Web-Based Survey Design

A web-based survey was chosen due to the minimal cost and burden on respondents than for face-to-face interviews or telephone surveys. A web-based survey can be defined as a series of web pages stored on a server and accessed via an electronic link (Dillman, Smyth, & Christian, 2009; Klein & Smith, 2002). Due to the variability in the respondents' practice locations, an electronic method enabled the study to poll a larger sample size. Those who received the advertisement via email were taken directly to the survey using the hypertext link. Higher convenience of survey access has been found to increase response rates (Dillman et al., 2009) .

**Sample Size Calculation**

The response rate for our electronic survey was estimated prospectively. One of the main challenges with an internet-based survey was developing a sampling frame. Due to the multiple disciplines and locations of practice, a sample size of all of the health care providers included in the survey could not be calculated. The inability to access physician and pharmacy email lists also prevented direct electronic access to these health care providers. Given that a 30-60 percent response rate was considered adequate for questionnaires, with additional consideration that electronic questionnaires may generate an 11 percent lower than average response rates, a 20 percent response rate was considered to be a successful participation rate in this study (Lozar Manfreda, Bosnjak, Berzelak, Haas, & Vehovar, 2008; Portney & Watkins, 2009).

**Inclusion Criteria**

Our target sample included health care providers in three different groups: (a) primary care physicians, (b) Community Care case managers and (c) community pharmacists. For geographical distribution, health care providers practicing in Edmonton and surrounding areas were selected.

**Exclusion Criteria**

Specialists and health care providers working in acute care centers were excluded from the survey.

**Distribution**

Direct email addresses could not be obtained from the College of Physicians and Surgeons of Alberta or the College of Alberta Pharmacists. Instead, various communication tools in both electronic and print format were used to reach these respondents. As indicated by Klein and Smith (2002), this multiple-contact strategy would increase response rates and the following strategies were completed:

*Community Care case managers*

- The hypertext link was distributed via email by the Director of Community Care to their 157 case managers with one reminder email.

*Community pharmacists*

- The survey was advertised in the College of Pharmacists electronic newsletter with the hypertext link.
- The survey poster was mailed out to 300 pharmacies in Edmonton and surrounding areas using mailing addresses obtained from the Alberta College of Pharmacist website (https://pharmacists.ab.ca). The Alberta College of Pharmacists governs, registers and licenses pharmacists and pharmacies in Alberta.

*Family physicians*

- The survey was advertised electronically in the Alberta Health Services (AHS) Medical Director's newsletter, Alberta Medical Association's electronic newsletter MDScope and AHS Edmonton Zone News print edition.
- The survey poster was mailed out to 368 physicians listed in all of the primary care networks in Edmonton and surrounding areas.

The total number of confirmed electronic and hard copy mail outs of the poster was used as the denominator to calculate response rate (n=825).

**Methods to Increase Response Rates**

As suggested by Edwards et al. (2009), several strategies such as incentives and advertising features were used to increase response rate for the survey. The poster included an image of a MAT product, the survey link, entry deadline, investigator's contact information (Appendix C). It also had both logos from the university and health authority to indicate sponsorship. The envelope was post-marked with the return address

of the Specialized Geriatrics Department, Glenrose Rehabilitation Hospital and the address labels were printed.

As token financial incentives have been found to increase response rates, a prize incentive was also listed on the poster (Dillman et al., 2009). This enabled participants to enter their email addresses at the end of the survey for a prize lottery. Their email addresses were entered into a separate database to ensure anonymity.

**Procedures**

**Development of the Survey Questionnaire**

A 2010 literature search by the Canadian Agency of Drugs and Technology in Health (2010) revealed no previous questionnaires existed. A 17-item survey was developed based on feedback from the research team and the objectives of this study (Appendix D). To increase response rates, all survey questions were designed in an easy-to-answer format and the length of survey completion time was aimed at five minutes (Dillman, Sinclair, & Clark, 1993). The survey questions were in a 5-point Likert scale or closed question formats. All closed questions included a set of response categories and one "other" free-text response. This allowed respondents to define their own category if their response did not fit the categories provided. The survey was divided into five domains:

1. Respondent demographics
2. Current strategies for identifying medication non-adherence
3. Current strategies for improving medication non-adherence
4. Perception of MATs in comparison to non-electronic medication aids
5. Perceived barriers of MATs and suggested strategies to remove these barriers

For survey format, demographics were listed at the beginning to provide the health care providers with a few practice questions using the electronic survey. To ensure clarity, pictures of dosettes, blister packaging, simple MATs and advanced MATs

products were provided. An additional free text box was also offered at the end of the survey to capture any additional respondent feedback not covered in the 17 questions.

The survey instrument was developed and built by the investigator using an online survey tool (www.fluidsurveys.com). To ensure data security, this online survey tool was Canadian-based with its servers located in Canada.

In April 2011, the survey was pilot-tested for face validity by a panel of ten health care providers: two specialist, two family physicians, four community care coordinators and two pharmacists. These health care providers were a representative sample of the target group and represented the various clinical perspectives. Responses from these ten participants were not included in the final data set. Feedback was obtained using an evaluation sheet which included questions about clarity, comfort, wording, length, technical difficulties and applicability (Appendix E). The questions were then revised and incorporated their feedback.

**Code Book**

A code book for data entry and analyses was developed to accompany the questionnaire. Responses to close-ended questions were coded for descriptive statistics and non-parametric statistical analyses. For example, encountered rates of adherence were coded as never (0), half of the time (1), majority of the time (2) and all of the time (3). Responses to open-ended questions were reviewed by the investigator and then coded into reoccurring descriptive themes which were documented in the code book.

**Schedule of distribution**

On May 1st 2011, the survey was officially launched and the Community Care director distributed the survey email to case managers. Pharmacy and MD Scope advertisements occurred in electronic and print format the following week. Three hundred poster hardcopies were mailed out to the pharmacies in mid-May 2011. An additional 368 poster hardcopies were mailed out to physicians in mid-June 2011 in an

effort to increase response rates. A reminder email from the Community Care director was also sent out to case managers in July 2011. The hardcopy of the AHS Edmonton Communication newsletter which was supposed to be mailed out to all AHS employees was not completed due to the Canada Post mail strike but was made available at all AHS sites in July 2011.

**Hardcopies of the questionnaires**

Hardcopies of the survey were offered to minimize sampling bias (i.e., enabled those without internet access an equal opportunity to complete the survey) (Klein & Smith, 2002). The investigator's contact information was listed on all the hard copy advertisements, the posters and consent page of the electronic survey to allow potential participants to request a hard copy of the survey. Two individuals requested a hardcopy; one by email and one by phone. Both respondents faxed in their results and these were entered by the investigator into the survey's database.

**Data Inclusion**

The official survey close date was July 31$^{st}$ 2011 but the electronic survey link remained active until August 31$^{st}$ 2011 to allow for late entries.

**Statistical Analysis**

Results were exported from the online survey tool into a Microsoft Office Excel spreadsheet which was then exported into statistical analysis software, SPSS Statistics 19. Descriptive statistics, such as frequencies, were completed on the demographic categories, product familiarity and technology beliefs. To test for associations between two variables, Chi-Square Test was run for categorical variables and Kruskall Wallis Test for continuous variables. If significant associations were found with the Chi-Square Test, a Cramer's V post-hoc test was also completed. The alpha level of significance was set at $p \leq 0.05$.

**Ethical Considerations**

This study obtained ethical approval from the University of Alberta Health Research Ethics Board (HREB), Panel B in April 2011. In addition to the consent form being listed on the first page of the survey, the investigator followed HREB recommended prize regulations (Appendices F & G).

When the survey closed, the prize draw was completed by the investigator in the presence of a witness. The winners were notified via email and the prizes distributed by the investigator. The names of the winners were not published or disclosed outside of the research team.

**Objective #2: Product Trial**

The second objective of this study was to determine older adults' perceptions of the use and design of one commercially available MAT product. Perceptions were described using data collected from the MATs product, research team observations and participant exit interviews.

**Research Design**

Initially, a randomized control trial (RCT) with a sample size of 12 participants was proposed as a control group would have also enabled comparisons on the effectiveness of electronic reminders. The proposed process flows, sample size calculation and protocols for the RCT are provided in Appendix H.

However, due to challenges in participant recruitment and, therefore, the inability to reach the calculated sample size, an RCT could not be completed. Alternatively, a case study approach was used. Instead of using a control group, all participants in the product trial received the audible and visual electronic alerts.

**Justification of Research Design**

Purposive sampling was used to identify potential participants who met the inclusion criteria. Presenting the data in case study format was still beneficial since very little research in MATs usability exists.

**Participant Inclusion/Exclusion Criteria**

Participants were sampled from in-patients units at the Glenrose Rehabilitation Hospital, Edmonton Alberta, Canada.

Participant inclusion criteria were as follows:

- In-patients aged 65 years and over
- Medically frail but were in stable medical condition and nearing discharge
- Community dwelling

- Mild to moderate cognitive impairment (recent Folstein Mini-Mental State Examination score $\geq 20$) (Molloy, 1999)
- Preference given to patients without psychosocial support or those resistant to recommendations for Community Care services

Participant exclusion criteria were as follows:

- Patients who were physically incapable of managing their medications (i.e., unable to manipulate/open the unit's compartment lids or buttons secondary to hemi-paresis, severe arthritis, upper extremity amputee etc.)
- Patients who had significant visual impairments
- Non-English speaking patients
- Patients who required modified diet restrictions due to feeding/swallowing impairments
- Patients who required injectable medications (i.e., insulin)

**Participant Recruitment**

Active participant recruitment occurred from June 2011 to October 2011. Two presentations to the physician group were completed. The research nurse and investigator also distributed poster advertisements on the in-patient units and attended team rounds. In August 2010, challenges in participant recruitment prompted the research nurse and investigator to complete regular chart reviews to identify potential eligible participants.

**Code Book and Training**

A code book was developed to record the number of in-patients approached, their characteristics and responses to the MATs product.

A two hour training session was provided by the MATS product vendor on February 14th 2011 via teleconference and was attended by the research nurse, investigator and computing sciences graduate student. A programming manual was also

developed by the investigator. Using the manual, the investigator provided training to the four in-patient pharmacists on May 10th 2011.

**MATs Product**

The "off the shelf" MAT product was selected in agreement by the members of the research team. This particular brand and model was selected due to its availability in Canada, compatible connection methods, Canadian server location, low-cost per unit ($124.00) and remote monitoring capabilities (Medsignals, LIFETECHniques, San Antonio, TX). An illustration of this MATs product and specific product features are summarized in Figure 2.1 and Table 2.1.

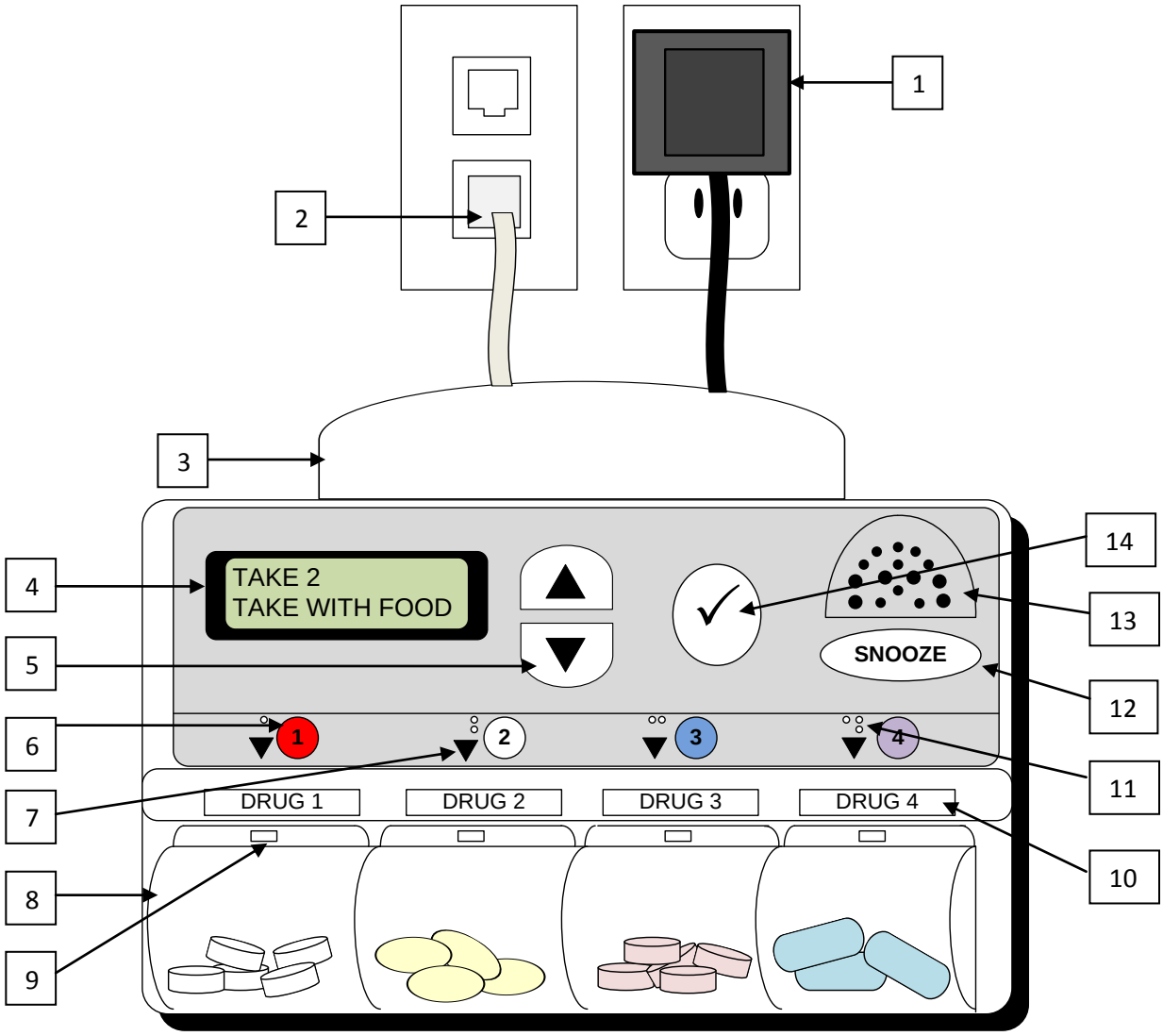



*Figure 2.1.* Illustration of the MAT used in the product trial. Illustration created by author based on the "*Medsignals*" electronic pillbox by LIFETECHnique, Texas, United States, December 2011.

Table 2.1.

*MATs Product Features*

| FEATURE | DESCRIPTION |
|---|---|
| 1. Power source | 120VAC 60 HZ output AC Adapter connected to the docking cradle. |
| | Backup power: Battery will enable product to remain active when off the cradle for portability. Battery lifespan depends on frequency of alerts. |
| 2. Connectivity | Requires analog phone line. Will not work on digital phone lines. When the product is on the docking cradle, It will dial a toll-free number to connect to a server for data uploads/downloads. |
| 3. Docking cradle | Has a RJ-11 jack to enable two-way communication. It will recharge the battery and upload/download data to the unit on a pre-set schedule. Has two analog phone ports and one ac adapter port. |
| 4. LCD screen | 1 ½" (l) x ½" (w). Visual and verbal prompts available in English and Spanish. |
| 5. Up/Down arrow keys | Enable manual programming of the unit. |
| 6. Bin buttons | If pressed, will display the pill consumption history for the last 24 hours. |
| 7. Flashing light alert | Red flashing light will blink at dose time. |
| 8. Plastic lids | FDA approved plastic, UV-restricting lids. Each bin can hold thirty two 325 mg pills. |
| 9. Plastic tab | Located at the top of each bin, the plastic lid must be clicked into the plastic tab to be fully closed. |
| 10. Bin labels | One adhesive label required per bin. Sheets with medication names, common conditions and blank labels provided. |
| 11. Braille | Braille indicating bin number is located above each bin for tactile identification. |
| 12. Snooze button | If pressed once: delays alerts by 30 minutes. If pressed twice: silences alarm until next dose. |
| 13. Speaker | Audio beeps and verbal alerts are emitted from the speaker. Off, low and high volume settings available. |
| 14. Checkmark button | Enables option selection during manual programming. |

The four main components of this product were pill organization, programming, data transfers and alerts. Each component is described below:

1. Pill organization

The overall concept was to organize pills by medication type and to store up to a month's worth of supply in the unit. For example, Bin #1 stored 14 Aspirin pills, Bin #2 stored 14 Calcium pills, Bin #3 stored 14 Celexa pills and Bin #4 stored 14 Novasc pills. If each medication was taken once a day, the unit would need to be re-filled every two

weeks. Each time the plastic lid on the bin was opened, the time and date of the opening was recorded in the unit's microprocessor. Comparing the time-stamped bin openings to the programmed alert times were considered the outcome measure for medication adherence. Three days worth of medication were loaded by the pharmacist into the MATs unit for each trial to accommodate for the one day of bedside training and additional two days in the trial.

2. Programming

There were two methods for programming the unit: manual or online. Using the manual method, the investigator could access the programming menu directly on the unit's LCD screen using the check mark and up/down arrows (Figure 2.1, features 5 & 14) to enter the times, quantity and frequency each pill should be taken from each bin (e.g., take one pill from Bin #1 at 09:00 AM). Special pill-taking instructions to accompany the medication alert (e.g., "*Take with food*") could also be programmed manually.

The online programming method was the preferred method of programming. It required computer and internet access. After purchasing and registering the unit with the MAT's company, the investigator used an assigned username and password to gain access to the company's website. In addition to the same features in manual programming (i.e., dose times, pill quantity, frequency, special pill-taking instructions etc.), the investigator was able to program therapeutic windows in which the medication should be taken (e.g., 30 minutes ± from the alert time). The therapeutic windows were determined by pharmacy for each medication. The online website also enabled the investigator to register for email alerts if the bin opening did not occur within this therapeutic window. The website also calculated medication adherence statistics and graphed this data into charts to illustrate pill-taking behaviours. To download the

programmed medication regimen from the website to the unit, the unit was placed on the docking cradle (Figure 2.1, feature #3) and plugged into an analog phone line.

3. Data transfers

The ability to upload information from the unit to the online website required a monthly subscription fee. There were three tiers of subscription which determined if the upload occurred daily, weekly or immediately. This study signed up for the top tier of notifications to complete immediate uploads of data. To upload information from the unit to the website, the unit needed to be placed on the cradle and plugged into an analog phone line. Using the analog phone line connection, the unit dialled a toll-free number to connect to a host server. It then uploaded the time-stamped data and downloaded program updates. Once this transmission was completed, it would disconnect the call.

4. Alerts

At each programmed dosage time, the unit emitted an audible beep from the speaker and the light next to the corresponding bin flashed red. Once the plastic lid on the bin was opened, an automated voice relayed the pill taking instructions (i.e., "*Take one pill, take with food"*) and these instructions appeared on the LCD screen. The older adult was then expected to remove the instructed amount of medication and close the bin lid.

**Procedures**

**Consent**

Once identified as meeting the inclusion criteria, determined as medically stable and nearing discharge home, a potential patient volunteer was invited by the investigator to participate in the study. The investigator provided the patient with the study information letter and returned in 1-2 days (Appendix I). This allowed the patient time to read the letter, formulate questions and participate without feeling pressured to participate as part of their medical care.

**Baseline Testing**

Once the investigator obtained written consent, participants underwent a baseline screen by the research nurse which included two validated instruments to measure levels of function: the Katz Activities of Daily Living Index (Katz, Downs, Cash, & Grotz, 1970) and the Lawton Instrumental Activities of Daily Living (Lawton & Brody, 1969) to gather information regarding the participant's current level of function. Additional information was collected from the medical chart and previously completed assessments by the rehabilitation team. The combination of validated instruments and data collection provided baseline participant characteristics to detect potential trends and enable comparisons with participants in future studies.

**Research Location**

The product trial was conducted in the Independent Living Suite (ILS) at the Glenrose Rehabilitation Hospital. The ILS was a 802 sq ft. space designed to represent a home-like setting in which health care providers can simulate a variety of discharge scenarios for their patients (Appendix J). The ILS was equipped with a fully-stocked kitchen, standard bathroom, bedroom and living room. Patients are able to stay in the ILS for multiple days, including nights, and normally are left to manage their activities of daily living independently.

For safety measures, the ILS was equipped with three call bells, a Lifeline pendant/base unit and the Nursing Unit 3A was located 15 feet from the front door of the suite. The on-duty nurses completed a visual inspection at shift change and responded to any emergencies. The investigator also completed periodic checks one to two times per day to complete the pill counts and respond to any participant concerns.

**Loading the Unit**

Once a participant was identified and written consent obtained, his or her pharmacist loaded three day's worth of the current medication regimen into the MATs

units. The investigator and the pharmacist then programmed the unit on the online website. The pharmacist determined the therapeutic window for when each drug should be taken (i.e., plus or minus 30 minutes) and any special instructions for each medication (i.e., "*Take with food"*). The medication regimen was then uploaded to the unit using the cradle and an analog phone line. Settings were double-checked by both the investigator and pharmacist for accuracy by pressing each of the bin buttons.

**Participant training**

On Day One, product training was provided by the investigator or the research nurse to the participant. The participant was then left to independently use the product at bedside (i.e., their hospital room) to provide a 24 hour practice period and opportunity for questions or additional training prior to entering the ILS.

**Data Collection**

Basic demographic data was collected from the participant's medical records. This included age, gender, marital status, primary diagnosis, reason for admission and location of residence.

Participants were asked to spend two days and one night in the ILS in an attempt to create natural medication taking behaviours in a home-like environment. The ILS created typical extraneous distractions (i.e., noise from the television, distractions with cooking, being in a different room from the medications etc.) which created the typical competing auditory, visual and cognitive challenges to following a daily medication regimen. With the exception of the investigator pill-count checks and nursing safety checks, the participant was left alone and observed remotely by the investigator using the sensor and MATs data. This unmonitored method of usability testing served the purpose to reduce the potential influence of the investigator's presence on the participant's behaviour in using the MATs product (Barnum, 2011).

In the morning of Day Two, the investigator would porter the participant to the ILS suite. An ILS orientation was provided by the investigator to increase participant familiarity and comfort (see Appendix K). Data collection for medication adherence started when the investigator left the suite. The participant was then left alone in the ILS to simulate a home-like environment which included sleeping in the ILS. A participant check for a visual pill count was completed twice per day by the investigator to verify that proper doses of medications were taken and to confirm product reporting accuracy.

Before the participant exited the ILS at the end of Day Three, a semi-structured exit interview was completed by the investigator for a retrospective review (Appendix L). This reduced subject desirability bias since the participant's medical team would not be present. The participant was then returned back to his or her home unit for the remainder of the hospitalization.

A report was generated within a twenty four hour period which listed the participant's medication regimen, calculated adherence rate, baseline test scores and comments (Appendix M). Additional data was collected using motion sensors and were included in the participant activity report. These results are beyond the scope of this study and will not be discussed. The report was then distributed electronically to the medical team and a hard copy placed in the patient's chart. The members of the medical team were then asked to complete a Likert-style questionnaire to assess if the information from the MAT product assisted with discharge planning (Appendix N).

**Data analysis**

The data was collected during the participant's stay in the ILS and was analyzed daily to recognize the timeliness of the participant's medication-taking activity and observed behaviours with using the product. Descriptive statistics and data were collected from the participant exit interviews and the medical team's questionnaires to identify potential positive and negative features of the MATs product itself. Observations

taken by the investigator, research nurse and pharmacist were also recorded in the code book.

**Ethical Considerations**

This study obtained ethical approval from the University of Alberta Health Research Ethics Board (HREB), Panel B in January 2011. The requirements for informed consent as outlined by HREB were listed in the participant consent form and study information letter (Appendix H).

# Chapter 3

## Results

The results from each objective are organized and reported in separate sections in Chapter 3. Collectively, they form the results of the usability study.

### Objective #1: Survey

#### Response rate

A total of 217 responses were received (215 electronic and 2 hardcopies). Of the 217 received surveys, 210 responses were fully completed and seven surveys were incomplete. Upon further analysis one survey was left blank and the remaining six were abandoned halfway through the survey. The seven incomplete survey responses were excluded from the data analysis.

To calculate response rate, the investigator divided the total number of completed surveys (n=210) by the total number of confirmed distributions (n=825) for an overall response rate of 25.5 percent. It was greater than the anticipated 20 percent. The average completion time for the survey, as recorded on the online survey tool, was 2.3 minutes which suggested that the survey was easy to complete and not time consuming.

Although higher than expected, the survey response rate was affected by our inability to reach family physicians and pharmacists directly by electronic means and the Canada Post strike which delayed the delivery of the mailed posters by approximately three weeks. In addition, the survey was open from May 1$^{st}$ to August 31$^{st}$ 2011 where staff absences due to summer holidays may have also affected the survey response rate.

#### Data integrity

With the exception of two surveys which were manually entered, the rest of the responses were entered electronically by the respondents. These responses were then directly transferred electronically into the statistical analysis software. The code book and

coding of variables were reviewed and verified by the investigator to ensure proper coding and interpretation was completed.

**Survey Results**

As discussed in the Methods section, the 17-item survey was divided into five domains. The results from the survey are organized and presented according to this format.

**Respondent Demographics (Domain #1)**

Demographic data of the respondents was collected in questions 1-4 of the survey (Tables 3.1 to 3.4). The findings indicated the majority of the respondents were nurses, had 15 or more years of experience, worked in Community Care services and were based in an urban center.

Table 3.1.

*Respondents' Profession Type*

| **Profession (n=210)** | Frequency | Percent (%) |
|---|---|---|
| Nurse | 76 | 36.2 |
| Pharmacist | 52 | 24.8 |
| Physician primary care | 36 | 17.1 |
| Occupational therapist | 26 | 12.4 |
| Social worker | 15 | 7.1 |
| Physical therapist | 2 | 1.0 |
| Other | 3 | 1.4 |

Table 3.2.

*Respondents' Level of Experience*

| Years of Practice (n=210) | Frequency | Percent (%) |
|---|---|---|
| 0 to 5 years | 32 | 15.2 |
| 6 to 10 years | 52 | 24.8 |
| 11 to 15 years | 42 | 20.0 |
| 15+ years | 84 | 40.0 |

Table 3.3.

*Respondents' Practice Setting*

| Practice Center (n=210) | Frequency | Percent (%) |
|---|---|---|
| Community care services | 133 | 63.3 |
| Private pharmacy | 38 | 18.1 |
| Medical clinic | 33 | 15.7 |
| Facility | 6 | 2.9 |

Table 3.4.

*Respondents' Geographic Location*

| Location of Practice (n=210) | Frequency | Percent (%) |
|---|---|---|
| Urban center | 173 | 82.4 |
| Rural center | 37 | 17.6 |

**Current Strategies for Identifying Medication Non-Adherence (Domain #2)**

Respondents were asked to rate the frequency they encountered medication adherence issues with older adults which included five choices that ranged from never (0%) to all of the time (100%) (Table 3.5). Over 50 percent of the respondents selected "half of the time" and no respondent selected the "never" or "all of the time" options. This suggests that issues with medication adherence with older adult patients are a commonly encountered occurrence for most health care providers.

Table 3.5.

*Reported Frequency of Encountered Medication Adherence Issues*

| Frequency of encountered non-adherence (n=210) | Frequency | Percent (%) |
|---|---|---|
| A few times (25%) | 52 | 24.8 |
| About ½ of the time (50%) | 121 | 57.6 |
| Much of the time (75%) | 37 | 17.6 |

The investigator further collapsed the seven profession groups into three groups: physicians, pharmacists and community care health care providers (which included occupational therapists, physical therapists, nurses, social work and "other" categories). A two way contingency analysis was conducted to determine if there was relationship between rate of encountered non-adherence and type of profession. All three groups indicated that they mainly encountered non-adherence "half of the time" (Table 3.6) but the chi-square test indicated that the distribution was not statistically different ($x^2 = 2.82$, df=4, p=0.06). Therefore, not one professional group is more likely to report a higher level of encountered non-adherence in providing care to older adults.

Table 3.6.

*Reported Occurrence of Medication Non-adherence and Profession Type*

| | Occurrence of Medication Non-adherence | | | |
|---|---|---|---|---|
| Profession Type | A few times | About ½ of the time | Much of the time | Total |
| Physicians | 8 | 24 | 4 | 36 |
| Community Care* | 28 | 70 | 23 | 121 |
| Pharmacists | 16 | 27 | 10 | 53 |
| Total | 52 | 121 | 37 | 210 |

*Community Care included: occupational therapists, physical therapists, nurses, social workers and "other" professionals.

Respondents were asked to indicate their current practice methods for identifying medication adherence issues and common issues cited by their older adult patients. Each question included a text box for respondents to include additional comments or if the choices provided did not cover all of their opinions. These comments were analzyed for themes and coded to identify frequency of these themes.

The majority of respondents in all three profession groups relied on patient self-report or caregiver self-report to identify issues with medication adherence (Table 3.7). The main descriptive theme indicated in the 43 text responses was that visual inspection of the patient's bottles or blister packs was another commonly used method to detect medication non-adherence. Factors such as scattered pills, missed or remaining doses in the blister pack or incorrect medications would cue the health care provider that issues with medication adherence existed.

Table 3.7.

*Current Methods Used by Health Care Providers to Identify Medication Adherence Issues*

| | Profession Group | | | |
|---|---|---|---|---|
| Current methods | Physicians | Community Care* | Pharmacists | Total |
| Patient self-report | 35 | 111 | 42 | 188 |
| Caregiver self-report | 34 | 113 | 39 | 186 |
| Irregular pharmacy refill patterns | 18 | 41 | 51 | 110 |
| Increase in ER visits or hospitalizations | 17 | 52 | 10 | 79 |
| Adverse drug reactions | 25 | 32 | 16 | 73 |
| Recent patient lab work | 20 | 21 | 8 | 49 |
| Other | 4 | 38 | 1 | 43 |
| Total | 153 | 408 | 167 | 728 |

* Community Care included: occupational therapists, physical therapists, nurses, social workers and "other" professionals.

The majority of respondents in all three profession groups reported the most frequent reason cited by patients to affect medication adherence was cognitive decline (Table 3.8). This coincides with patient self-report being one of the most frequent methods of assessing medication adherence issues. Older adults, when asked by their health care provider, cite that cognitive decline affects their ability to follow their medication regimen. Physicians and pharmacists cited complex medication regimens as the second most frequent patient-reported reason for medication non-adherence. Community care professionals cited limited patient knowledge as the second most frequent patient-reported regimens and also cited physical limitations with packaging as their third most frequent reason.

Table 3.8.

*Patient-Reported Reasons Which Affect Medication Adherence*

| | Profession Group | | | |
|---|---|---|---|---|
| Patient-Reported Reasons | Physicians | Community Care* | Pharmacists | Total |
| Cognitive decline | 35 | 117 | 49 | 201 |
| Complex Medication Regimens | 34 | 88 | 49 | 171 |
| Limited patient knowledge | 25 | 96 | 42 | 163 |
| Adverse side effects | 31 | 58 | 32 | 121 |
| Financial | 11 | 62 | 27 | 100 |
| Personal beliefs | 23 | 60 | 16 | 99 |
| Physical limitations with packaging | 5 | 70 | 21 | 96 |
| Limited caregiver awareness | 8 | 44 | 12 | 64 |
| Other | 3 | 5 | 2 | 10 |
| Total | 175 | 600 | 250 | 1025 |

*Community Care included: occupational therapists, physical therapists, nurses, social workers and “other” professionals.

**Current Strategies for Improving Medication Non-Adherence (Domain #3)**

To improve non-adherence, the respondents indicated that they most commonly recommend blister packaging as an assistive aid (Table 3.9). Use of a dosette and simplifying their medication regimen were the second and third most common strategies reported. The use of electronic MATs products was the least commonly cited strategy by the respondents with only two percent. The main theme in the free text comments indicated that most respondents will also refer to Community Care services for the medication assistance program to be used in conjunction with blister packaging.

Table 3.9.

*Current Strategies Used by Health Care Providers to Address Medication Adherence Issues*

| | Profession Group | | | |
|---|---|---|---|---|
| Current Strategies | Physicians | Community Care* | Pharmacists | Total |
| Blister packaging | 36 | 120 | 52 | 208 |
| Dosette | 29 | 66 | 39 | 134 |
| Simplify medication regimen | 28 | 65 | 38 | 131 |
| Inform the caregiver | 22 | 64 | 27 | 113 |
| Referral to community care services | 28 | 56 | 22 | 106 |
| Individualized patient counselling | 15 | 37 | 36 | 88 |
| MATs products | 2 | 8 | 3 | 13 |
| Other | 2 | 24 | 3 | 29 |
| Total | 162 | 440 | 220 | 822 |

*Community Care included: occupational therapists, physical therapists, nurses, social workers and "other" professionals.

**Current Level of Perception of MATs in Comparison to Non-Electronic Aids (Domain #4)**

Respondents were then provided with an image of a dosette, blister package, simple MATs and advanced MATs. These images were accompanied with a short description of common features associated with each product and respondents were asked to indicate using a "Yes" or "No" question if they were familiar with each product (Table 3.10). Over 99 percent of the respondents were familiar with dosettes and blister packaging. Less than 12 percent reported awareness of simple MATs and almost all respondents were unfamiliar with advanced MATs.

Table 3.10.

*Familiarity of Different Medication Adherence Products*

| Product | Familiarity | Frequency | Percent (%) |
|---|---|---|---|
| Dosette (n=210) | | | |
| | no | 2 | 1.0 |
| | yes | 208 | 99.0 |
| Blister packaging (n=210) | | | |
| | no | 1 | .5 |
| | yes | 209 | 99.5 |
| Simple MATS (n=210) | | | |
| | no | 185 | 88.1 |
| | yes | 25 | 11.9 |
| Advanced MATS (n=210) | | | |
| | no | 207 | 98.6 |
| | yes | 3 | 1.4 |

**Association between years of practice and familiarity with Simple MATs**

The majority of respondents, regardless of level of experience, were not familiar with simple MATs (Table 3.11). Those with fifteen or more years of practice had the highest percentage at 18 percent. A two way contingency analysis was conducted to determine if there was a relationship between reported years of practice and respondent's familiarity with simple MATs. A Chi-Square test indicated no significant association between years of experience and familiarity with simple medication adherence products ($x^2$=5.68, df=2, p=0.06).

Table 3.11.

*Association between Years of Practice and Familiarity with Simple MATs*

| | Familiarity with Simple MATs | | |
|---|---|---|---|
| Years of Practice | No | Yes | Total |
| 0 to 5 years | 31 | 1 | 32 |
| 6 to 15 years | 85 | 9 | 94 |
| 15+ years | 69 | 15 | 84 |
| Total | 185 | 25 | 210 |

**Association between years of practice and familiarity with Advanced MATs**

Similar to simple MATs, the majority of respondents were not familiar with advanced MATs (Table 3.12). A two way contingency analysis could not be conducted since 50 percent of the cells had an expected count less than 5. However, given that 99 percent of the respondents responded in the "no" category, it is reasonably safe to infer that there is no association between years of practice and familiarity with advanced MATs.

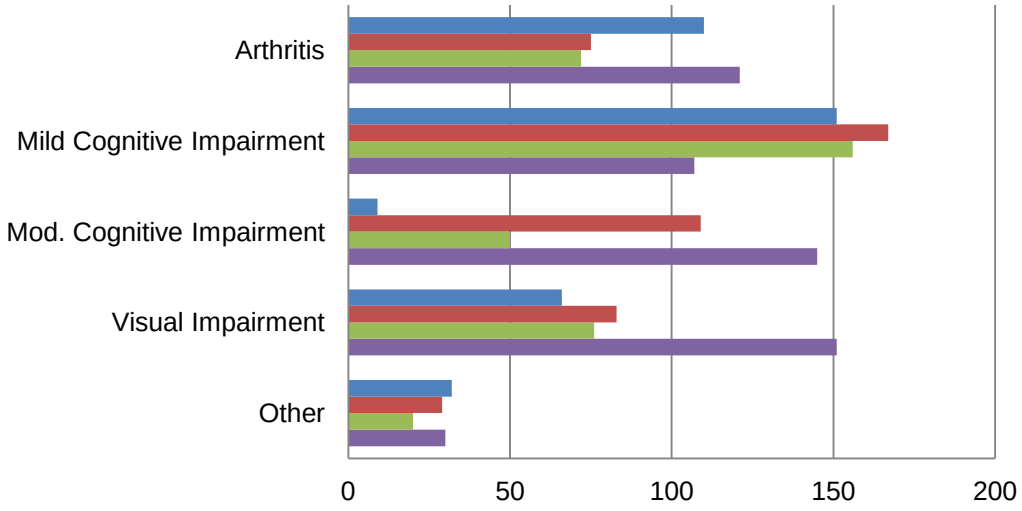
Table 3.12.

*Association between Years of Practice and Familiarity with Advanced MATs*

| | Familiarity with Advanced MATs | | |
|---|---|---|---|
| Years of Practice | No | Yes | Total |
| 0 to 5 years | 32 | 0 | 32 |
| 6 to 15 years | 93 | 1 | 94 |
| 15+ years | 82 | 2 | 84 |
| Total | 207 | 3 | 210 |

**Matching medication adherence products to different groups of older adult characteristics**

Each image of a product was accompanied by a "select all that apply" follow-up question to ask which group of older adults they believed were the most appropriate for each product. The four impairment categories were divided into: visual impairment, mild cognitive impairment, moderate cognitive impairment and arthritis. An additional free text comments box was also offered to capture any characteristics not offered in the four choices. Respondents could select more than one category if they felt the product could benefit multiple characteristics in older adults. The respondents' choices are illustrated in Figure 3.1.




| | Other | Visual Impairment | Mod. Cognitive Impairment | Mild Cognitive Impairment | Arthritis |
|---|---|---|---|---|---|
| Dosette | 32 | 66 | 9 | 151 | 110 |
| Blisterpack | 29 | 83 | 109 | 167 | 75 |
| Simple MAT | 20 | 76 | 50 | 156 | 72 |
| Advanced MAT | 30 | 151 | 145 | 107 | 121 |

*Figure 3.1.* Matching medication adherence products to different groups of older adult characteristics

Descriptive analysis was completed on the free text comments and major themes were identified in the "Other" response category as described below:

**Dosettes**

Dosettes were mainly selected for older adults with mild cognitive impairment and arthritis. The most prevalent descriptive theme in the "Other" option was that respondents felt that dosettes were not recommended for older adults or that dosettes would be appropriate only for older adults without any of the four impairments listed. Comments included:

- "*Older adults who are non-arthritic, non-cognitively impaired and with good eye sight are best with dosettes"*
- *"We do not recommend dosettes due to the high potential of spillage. If dropped, the entire content of the dosette could be spilled"*
- *"None of these clients (unless they have medication assistance from a caregiver or health care aide). A dosette is not appropriate for any of these clients"*

**Blister packaging**

Blister packs were mainly selected for older adults with mild cognitive impairment and moderate cognitive impairment. Arthritis was selected the least for blister packs and matched the most prevalent descriptive theme in the "Other" option which identified physical challenges with opening or accessing the foil compartments. Comments included:

- *"I do run into people who don't have the dexterity to use either blister packs or dosettes but they're easier than bottles"*
- *"Clients with arthritis can use something to open the foil but it could dangerous to use a sharp object"*

- *"[Difficult] for them to punch [pills] out and especially if they have a half a pill with lots of other pills it gets struck really easy in the plastic and it is easily missed by the client or even the health care aides. They really have to double check the packet. Some seniors really have trouble with pushing out the meds in blister packs"*

**Simple MATs**

Simple MATs were mainly selected for older adults with mild cognitive impairment. The most prevalent descriptive themes in the "Other" option were the uncertainty of which older adult characteristics' would benefit from this product or that the caregiver needed to be available to monitor this product. An additional theme indicated that some respondents felt simple MATs were not appropriate for older adults. Comments included:

- *"Older adult would need to be keen with technology"*
- *"I'm aware of the existence of these products but have rarely encountered them with clients"*
- *"Need to not be afraid of using electronics. Need to be able to access these if battery dies"*
- *"Sounds complicated and intimidating for elderly, cognitively impaired and arthritic clients"*

**Advanced MATs**

Advanced MATs were evenly selected in all four categories: visual, moderate cognitive impairment, arthritis and mild cognitive impairment. The most prevalent themes in the "Other" option included concerns regarding costs and affordability, themes suggesting alternative groups outside of older adults and the suggestion that advanced MATs weren't appropriate for older adults. Comments included:

- *"Assisted living facilities where medications are dispensed by personal care attendants"*
- *"Rich people"*
- *"I do not think this is appropriate, it the older adult requires this level of monitoring and care, a personal assessment of care would be warranted, as the case is often more complex and requires more intervention such as homecare, designated assistive living etc."*

**Investigating associations between respondent demographics and current perception of MATs**

Five questions on the survey asked respondents to rate their comfort, beliefs and awareness of MATs using a 5-point Likert scale which ranged from "Strongly disagree" to "Strongly agree" (Appendix D, q13). The investigator then collapsed the five groups into three groups: "disagree", "neutral" and "agree". Non-parametric statistical analyses were then completed to determine if significant associations existed between the respondent's demographic characteristics and current perception of MATs.

**Respondent's overall technology comfort by profession**

The majority of respondents agreed that overall they are comfortable with technology (Table 3.13). A Kruskal-Wallis Test was conducted to explore the impact of profession on the comfort of technology. It did not reveal a statistically significant difference in overall comfort with technology levels across the three different professional groups ($x^2$=1.96, df=2, p=0.38).

Table 3.13.

*Overall Comfort with Technology by Profession*

| | Overall, I am comfortable with technology | | | |
|---|---|---|---|---|
| Profession Group | Disagree | Neutral | Agree | Total |
| Physicians | 3 | 3 | 30 | 36 |
| Community Care* | 6 | 19 | 96 | 121 |
| Pharmacists | 10 | 4 | 39 | 53 |
| Total | 19 | 26 | 165 | 210 |

*Community Care included: occupational therapists, physical therapists, nurses, social workers and "other" professionals.

**Respondent's comfort with technology and years of experience**

Overall comfort with technology was then compared with years of practice (Table 3.14). A Kruskal-Wallis Test was conducted to explore the impact of years of experience on the comfort of technology. It did not reveal a statistically significant difference in overall comfort with technology levels across the three categories of years of practice ($x^2$=0.87, df=3, p=0.83).

Table 3.14.

*Overall Comfort with Technology and Years of Practice*

| | Overall, I am comfortable with technology | | | |
|---|---|---|---|---|
| Years of Practice | Disagree | Neutral | Agree | Total |
| 0-5 years | 3 | 5 | 24 | 32 |
| 6-15 years | 9 | 7 | 78 | 94 |
| 15+ years | 7 | 14 | 63 | 84 |
| Total | 19 | 26 | 165 | 210 |

**Respondent's level of MATs awareness by profession**

More than half of the respondents disagreed that they are aware of the current MATs available (Table 3.15). A Kruskal-Wallis Test revealed a statistically significant difference in awareness of medication adherence technologies across the three different professional groups ($x^2$= 9.01, df=2, p=0.01).

The physician group recorded a lower median score (Md=1.36) than the other two professional groups, which recorded median values of 2.00. Physicians were more likely to disagree that they are aware of the current MATs available.

Table 3.15.

*Current Level of MATs Awareness by Profession*

| | I am aware of the current MATs available | | | |
|---|---|---|---|---|
| Profession Group | Disagree | Neutral | Agree | Total |
| Physicians | 28 | 3 | 5 | 36 |
| Community Care | 80 | 16 | 25 | 121 |
| Pharmacists | 27 | 4 | 22 | 53 |
| Total | 135 | 23 | 52 | 210 |

*Community Care included: occupational therapists, physical therapists, nurses, social workers and "other" professionals.

**Respondent's personal beliefs that MATs are a useful tool by profession**

More than half of the respondents agreed that they believe MATs are a useful tool (Table 3.16). A Kruskal-Wallis Test did not reveal a statistically significant difference in the distribution across the three different professional groups ($x^2$=3.81, df=2, p=0.15).

Table 3.16.

*Personal Beliefs on MATs Usefulness by Profession*

| | I believe MATs are a useful tool | | | |
|---|---|---|---|---|
| Profession Group | Disagree | Neutral | Agree | Total |
| Physicians | 3 | 3 | 30 | 36 |
| Community Care | 5 | 21 | 95 | 121 |
| Pharmacists | 0 | 5 | 48 | 53 |
| Total | 8 | 29 | 173 | 210 |

*Community Care included: occupational therapists, physical therapists, nurses, social workers and "other" professionals.

**Respondents who regularly recommend MATs by profession**

More than half of the respondents disagreed that they regularly recommend MATs as part of their clinical practice (Table 3.16). A Kruskal-Wallis Test did not reveal a statistically significant difference with those who regularly recommend MATs across the three different professional groups ($x^2$=0.53, df=2, p=0.77).

Table 3.17.

*MATs Recommendations by Profession*

| | I regularly recommend MATs | | | |
|---|---|---|---|---|
| Profession Group | Disagree | Neutral | Agree | Total |
| Physicians | 28 | 3 | 5 | 36 |
| Community Care | 93 | 23 | 5 | 121 |
| Pharmacists | 38 | 12 | 3 | 53 |
| Total | 159 | 38 | 13 | 210 |

*Community Care included: occupational therapists, physical therapists, nurses, social workers and "other" professionals.

**Respondent's practice location and awareness of local availability**

More than half of the respondents disagreed that they are aware of where MATs are available locally (Table 3.18). A Kruskal-Wallis Test did not reveal a statistically significant difference between profession groups and respondents' awareness of local availability ($x^2$=0.30, df=2, p=0.22).

The investigator also compared if the respondent's location of practice may be associated with level of awareness. The majority of respondents in both urban and rural settings disagreed that they were aware of where to purchase MATs locally (Table 3.19). A Kruskal-Wallis Test did not reveal a statistically significant difference between urban or rural practice locations and respondents' awareness of local availability ($x^2$=0.47, df=1, p=0.50).

Table 3.18.

*Awareness of MATs Local Availability by Profession*

| | I am aware of MATs available in my surrounding areas | | | |
|---|---|---|---|---|
| Profession Group | Disagree | Neutral | Agree | Total |
| Physicians | 33 | 1 | 2 | 36 |
| Community Care | 95 | 14 | 12 | 121 |
| Pharmacists | 42 | 8 | 3 | 53 |
| Total | 170 | 23 | 17 | 210 |

*Community Care included: occupational therapists, physical therapists, nurses, social workers and "other" professionals.

Table 3.19.

*Location of Practice and Awareness of MATs Local Availability*

| Practice Setting | | I am aware of MATs available in my surrounding areas | | | Total |
|---|---|---|---|---|---|
| | | Disagree | Neutral | Agree | |
| Urban Center | | 141 | 18 | 14 | 173 |
| Rural Center | | 29 | 5 | 3 | 37 |
| | Total | 170 | 23 | 17 | 210 |

**Important Factors towards Selecting MATs (Domain #5)**

Respondents were asked to indicate which factors are important towards selecting MATs. Seven choices were presented in addition to a free text "other box". Respondents could select more than one choice in this question (Figure 3.2).

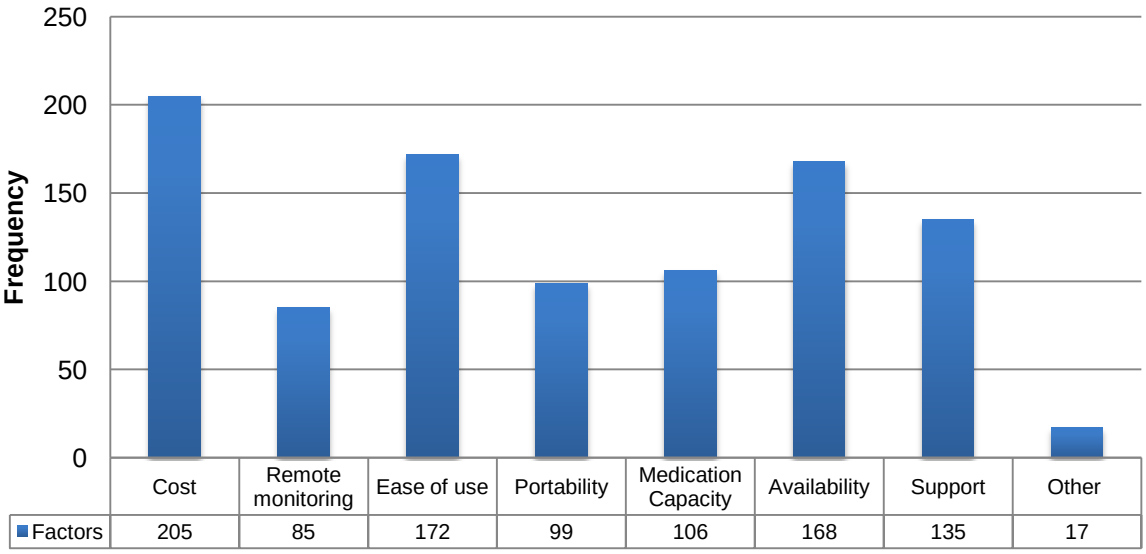



Figure 3.2. Important factors towards selecting MATs

Overall, the respondents indicated that cost, ease of use and availability were the three most important factors they consider in MATs selection. The most prevalent descriptive themes in the "Other" option included: availability of training, product reliability and subsidized funding availability. Selected comments:

- *"Back-up energy supply in event of power outages or inadvertent power supply being unplugged by client"*
- *"Reliability - i.e., what happens when power fails or who loads the device? What if pill gets clogged?"*
- *"Training and support for staff involved in filling and monitoring these devices....additional staffing is increase cost to pharmacy, most are not interested in increase cost or staffing"*
- *"Ease of reloading as medications are always changing"*
- *"Subsidized funding for these devices"*

**Suggested strategies to increase their comfort and knowledge of MATs**

Respondents were asked to indicate which strategies would increase their comfort and knowledge in incorporating MATs into clinical practice. Five choices were presented in addition to a free text "other box" (Figure 3.3). Respondents could select more than one response to this question.

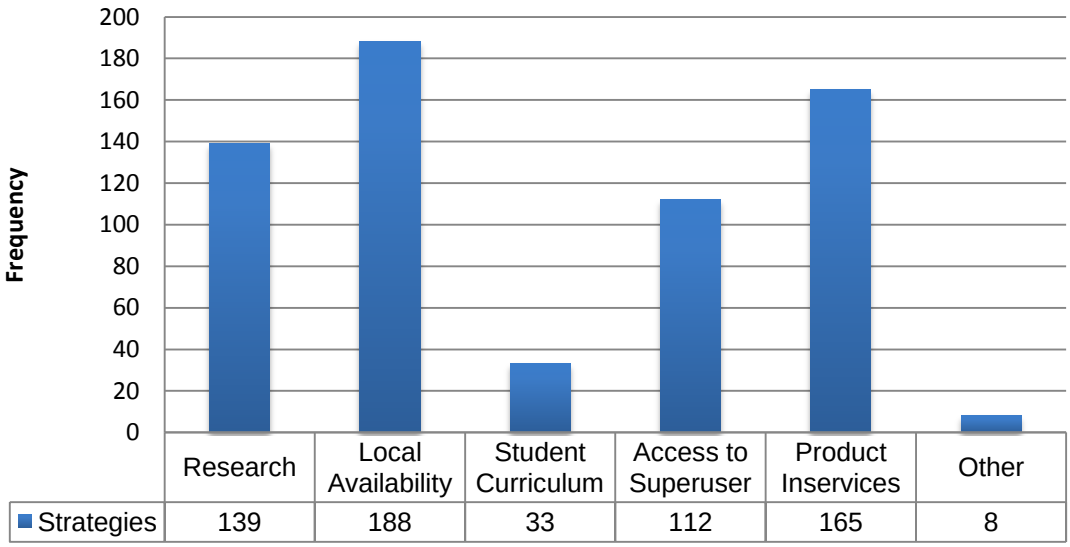



Figure 3.3. Suggested Strategies to Increase Health Care Providers' Comfort and Knowledge with MATS

The respondents indicated that increased knowledge of local availability, product in-services and research to support the use of MATs were the top three recommended strategies to improve their comfort and knowledge of MATs. The most prevalent descriptive themes in the "Other" option included strategies which increased personal knowledge, incentives for patient use such as subsidized funding and formal education such as professional education credits. Comments included:

- *"Overall, I would be very interested to learn more and therefore perhaps recommend these medication technologies to appropriate clients"*
- *"I like seeing and "playing" with the technologies so I have a better understanding of them"*

- *"Incentives for clients to use them. [A] four times daily medication assistance [service] to a client in their own home will cost Home Care a minimum of $60 per day. If we put a fraction of that into electronic medication technology, it's a win-win for the system and clients"*
- *"[Provide] Continuing Medication Education credits for MATs training courses"*

**Profession type and increased inclination to recommend MATs**

A follow-up question asked respondents if they would be more inclined to recommend MATs if their suggested strategies were implemented and over 90 percent agreed (Table 3.20). A Kruskal-Wallis Test did not reveal a statistically significant difference between profession groups and respondents' receptivity to recommend MATs ($x^2$=2.12, df=2, p=0.35).

Table 3.20.

*Inclination to Recommend MATs by Profession*

| | If strategies were available, I'd be more inclined to recommend MATs | | |
|---|---|---|---|
| Profession Group | No | Yes | Total |
| Physicians | 3 | 33 | 36 |
| Community Care | 5 | 116 | 121 |
| Pharmacists | 5 | 48 | 53 |
| Total | 13 | 197 | 210 |

*Community Care included: occupational therapists, physical therapists, nurses, social workers and "other" professionals.

This concludes the findings from the survey. The next section of the Results chapter will present results for the second objective of the study: the usability of a commercially available MATs product and older adults' perceptions of this technology.

**Objective #2: Product Trial**

The second objective of this study was to determine older adults' perceptions on the use and design of one commercially available MAT product. Usability results were based on data collected from the medication adherence rate, observations and participant exit interviews.

**Sample Size**

Active participant recruitment ran from June 2011 to October 2011 and we were unable to reach the targeted sample size required for a randomized control trial (n=12). Difficulties in participant recruitment were due to the following factors:

- There was limited health care provider knowledge in the potential uses of MATs. For many health care providers, our presentations appeared to be their initial exposure to MATs products.
- The main subjective feedback received from health care providers upon initial inspection of the product was the limitation in bin capacity. With each unit only having four bins, the product could not accommodate most older adults' medication regimen. They stated on several occasions that their patients typically had eight or more types of medication in their regimen.
- This method of pill organization did not meet their expectations of what they anticipated a MATs product would require in meeting an older adult's needs. Although health care providers were informed that there is the ability to use multiple units to increase pill capacity, this did not increase interest in participant referrals.
- Health care providers also frequently queried how the product could track other types of medications such as injectable medication, inhalers, creams, powders and "prn" medications (i.e., "take when needed").

- One health care provider mentioned that the cost of the product (e.g., $124 CAD plus monthly monitoring fee) was prohibitive to their older adult patients and did not see the clinical value in trialing a product that their patients could not afford upon discharge.

In total, 12 potential volunteer participants were identified and approached by the investigator or research nurse during the recruitment period. Nine of these potential participants declined participation. Reasons cited included: lack of interest in trialing the technology (n=6), unwillingness to accommodate another change in bed location (n=1) and being overwhelmed with their current hospitalization (n=2). One additional potential participant initially consented but later withdrew due to concerns raised by her rehabilitation team that she was not appropriate due to a reoccurrence of hip pain. The team was also concerned about the product's ability to handle this patient's 16 medications.

Two volunteer participants consented and proceeded to participate in the full two day trial. Although a randomized control trial was not possible, their results will be reported in a case study format to provide information on usability and older adults' perspectives on their experience using the MATs product for a two day trial period.

**Participant #1**

**Background**

Participant #1 was an 82 year old female who had been living independently in an older adults' apartment. A widow since 2005, she had been independent with her IADLs and required periodic assistance from her son who resided nearby. In June 2011, she experienced a fall in her parking lot and was taken to the local Emergency Department with complaints of right knee pain and a left frontal hematoma. She was subsequently admitted into acute care for further investigation. Prior to this admission, her records indicate that she has had seven separate Emergency Room visits recorded in the past five years for various medical issues such as back pain, vertigo and general weakness. Her past medical history indicated that she has osteoarthritis, osteoporosis, hypertension, anxiety, anemia, degenerative disc disease, chronic obstructive pulmonary disease and left hip replacement. She also wore glasses and used a dosette at home for her medications. Prior to her fall, she was ambulating with a cane. She was able to recollect the specific fall, indicating that she was backing up from the dumpster and lost her balance.

Cognitive test scores were 28/30 on the Mini-Mental State Examination (MMSE) and 21/30 on the Montreal Cognitive Assessment (MOCA). A score of 23 or lower in the MMSE is indicative of cognitive impairment (Molloy, 1999). Normative data for the MOCA indicate a score of 27.4 to be the normal control score and those with mild cognitive impairment typically score 22.1 (Nasreddine et al., 2005). Participant #1's scores suggested the presence of a mild cognitive impairment which documented staff observations also support.

The KATZ Index of Independence in Activities of Daily Living score was 6/6 and The Lawton Instrumental Activities of Daily Living Scale was 7/8 indicating that the patient was independent with almost all of her activities of daily living.

**Treatment goals**

A geriatrician consultation suggested that Participant #1 was deconditioned and at high risk for re-occurring falls. She was a good candidate for rehabilitation and was subsequently transferred to a tertiary rehab inpatient unit. The rehabilitation team's goals were to:

- Improve lower extremity strength, gait and balance
- Fit the patient with a right knee brace to improve stability
- Transition the patient to using a four wheeled walker instead of a cane to help with balance and decrease risk of falls

**Timeline**

A two day trial in the ILS was arranged four weeks post-rehab. When the participant entered the ILS on July 30th 2011, her rehabilitation team reported she had reached her treatment goals and was nearing discharge home. She was now independent with transfers, had greater lower extremity strength, higher endurance and was ambulating well with her four wheeled walker.

**Medication regimen**

At the time of the trial, Participant #1 was prescribed eight medications and two inhalers. Since each MAT unit had four bins, two units were required. The units were loaded by her pharmacist who also determined the therapeutic windows and special pill taking instructions (i.e., "*Take with food").* The two inhalers were not tracked for adherence. The medication regimen, purpose of each drug, time of the electronic alerts, therapeutic window and patient's performance percentage are listed in Table 3.21. These settings were programmed by the investigator using the online website. The length of time required to load and program the two units was 60 minutes. The docking cradle and units was set-up on the ILS kitchen counter.

Table 3.21

*Participant #1's Medication Regimen*

| Medication Name | **Purpose*** | **Electronic Alerts Programmed** | **Therapeutic Window** | **% Pills Taken Within Window** |
|---|---|---|---|---|
| Hydrochlorothiazide | High blood pressure | 9:00AM | ± 1 hour | 100 |
| Vitamin D | Assists with calcium absorption | 9:00AM | ± 1 hour | 100 |
| Altace | High blood pressure | 9:00AM | ± 1 hour | 100 |
| Pantoprazole | Gastroesophageal reflux disease | 9:00AM | ± 30 minutes | 100 |
| Multivitamin | Supplementary vitamins | 9:00AM | ± 1 hour | 100 |
| Celebrex | Osteoarthritis | 9:00AM & 6:00PM | ± 30 minutes | 100 |
| Calcium | Increase bone density | 9:00AM & 6:00PM | ± 30 minutes | 100 |
| Tylenol | Pain relief | 9:00AM, 12:00PM, 6:00PM & 9:00 PM | ± 1 hour | 100 |

*The general purpose of the medications was obtained from Medline Plus, Retrieved November 12, 2011, from http://www.nlm.nih.gov/medlineplus/druginfo/meds/a682882.html

**MAT product performance**

Based on the data uploaded from the medication adherence product, the participant was able to achieve 100 percent medication adherence with the eight medications. Pill counts at the end of each day verified accuracy. The participant's average response time to taking the pill (i.e., opening the bin compartment) after the electronic alert activated was one minute.

**Investigator's observations**

During the scheduled patient checks, the investigator made the following observations:

- The participant was observed to have difficulty removing pills from each bin. She was observed opening the bin and being unable to use a tip-to-tip pinch to grasp pills. Alternatively, using one hand she tipped over the unit to empty that bin and

its contents into her opposite palm to grasp one pill. The participant then re-loaded the pills back into the bin. The participant did notice the dropped pill five minutes later and self-corrected by re-loading the dropped pill back into the bin. She was observed dropping a pill during re-loading on two occasions.

- As seven of the eight medications had a 09:00 AM dosage time, seven red electronic lights (Figure 2.1, feature #7) flashed at 09:00 AM. The participant appeared anxious to take all the pills quickly due to the perceived pressure from the multiple flashing lights.
- Participant #1 became familiar with the positional orientation of the units on the counter (i.e., Unit A was in the left quadrant and Unit B in the right quadrant). When the units were re-arranged (i.e., Unit B in the left quadrant and Unit A in the right quadrant), she became momentarily confused.

**Rehabilitation Team Feedback**

Two completed team evaluations were received from the participant's care coordinator and physical therapist. On a 5-point Likert scale, both respondents agreed that the information received from the MATs was useful. One comment was provided:

- *"(The report) complimented what we were seeing on the unit and gave the patient greater awareness"*

**Participant exit interview**

During the exit interview, Participant #1 stated she had difficulty hearing the audible voice alert from the units and reiterated that she found it difficult to open. She commented that the voice alert was not clear and it was difficult to interpret the instructions which advised the participant how many pills to take with special pill taking instructions. In terms of possibly using this specific product at home, she stated that she "*didn't really like the product...it was annoying...you couldn't make me use it at home...I prefer to use my current system but I could see how this would be helpful for someone*

*who has memory problems".* Participant #1 also commented that she would not pay to use this product or for monthly monitoring and it would not make her feel more independent or safer at home.

**Post-completion of the trial**

The participant was discharged four days after the trial and returned back to home in a seniors' apartment. Recommendations included a referral to Community Care services for the Medication Assistance Program. This program utilizes a Community Care services nurse who coordinates blister packaging and on-going monitoring of an older adult's medication regimen. A licensed health care aide is also authorized to complete daily home visits, which can range from once to multiple times per day, to dispense the medications from the blister package.

**Participant #2**

**Background**

Participant #2 was an 84 year old male who had been living alone in his bungalow style home. Separated from his spouse for over five years, Participant #2 had been mostly independent with his IADLs. Tasks such as meal preparation were repetitive and basic as this participant's main meals consisted of microwavable macaroni and cheese, cottage cheese, yogurt and cooked meat. His four children resided in Edmonton and his oldest son checked on him weekly. Prior to this hospitalization he was actively driving and ambulating independently with a cane for distance.

In August 2011, he experienced a sudden episode of lower extremity weakness and sustained a fall while doing yard work. He was found by his neighbour and taken to the local Emergency Department where he was admitted into acute care for further investigation. His past medical history indicated that he has spinal stenosis, previous compression fractures, osteoarthritis, hypertension, chronic renal failure, diastolic dysfunction, aortic stenosis, peripheral vascular disease, prostate cancer, ischemic heart disease and gout. His last recorded Emergency Department visit was in 2007 for an allergic reaction. He wore glasses for reading and would take his pills directly from their bottles at home.

Cognitive test scores were 26/30 on the MMSE and 52/114 on the Behavioural Neurology Assessment-short form test scores. Although Participant #2 scored above the normative MMSE score for cognitive impairment, the Behavioural Neurology Assessment-short form was a more in-depth test and the score was significantly below the 82/114 score cut-off for dementia (Darvesh, Leach, Black, Kaplan, & Freedman, 2005). This suggests the participant had mild cognitive impairment and was possibly advancing towards moderate cognitive impairment.

The KATZ Index of Independence in Activities of Daily Living score was 4/6 with points lost on bathing and continence. The Lawton Instrumental Activities of Daily Living Scale score was 7/8 with one point lost on food preparation. Participant #2 had greater difficulties completing IADLs than Participant #1.

**Treatment goals**

A geriatrician consultation suggested that Participant #2 benefited from additional rehabilitation to facilitate his return home. He was transferred to a tertiary rehab inpatient unit on September 12th 2011.

The rehabilitation team's goals were to:

- Improve lower extremity strength, gait and balance
- Transition the patient to using a four wheeled walker instead of a cane to help with balance and decrease risk of falls

**Timeline**

A two day trial in the ILS was arranged 18 days after intensive rehabilitation. When Participant #2 entered the ILS on September 29th 2011, his rehabilitation team reported that he was independent with ambulating with a four wheeled walker, had improved lower extremity strength and was nearing discharge home. Discharge was planned five days after the trial was completed.

**Medication regimen**

At the time of the trial, Participant #2 was prescribed nine medications and one pre-packaged medicated powder. As each unit had four bins, three MATs units were required. The units were loaded by his pharmacist who also determined the therapeutic windows and special pill taking instructions. The pre-packaged medicated powder was not tracked for adherence. The medication regimen, purpose of each drug, time of the electronic alerts, therapeutic windows and patient's performance percentages are listed in

Table 3.22. The length of time required to load and program the three units was 60 minutes. The docking cradle and units was set-up on the ILS kitchen counter.

Table 3.22

*Participant #2's Medication Regimen*

| Medication Name | Purpose* | Electronic Alerts Programmed | Therapeutic Window | % Pills Taken Within Window |
|---|---|---|---|---|
| Norvasc | High blood pressure and angina | 9:00 AM | ± 30 minutes | 100 |
| Atacand | High blood pressure | 9:00 AM | ± 30 minutes | 100 |
| Bisoprolol Fumarate | High blood pressure | 9:00 AM | ± 30 minutes | 100 |
| Calcium | Increase bone density | 9:00 AM & 6:00 PM | ± 30 minutes | 100 |
| ASA | Pain relief | 9:00 AM | ± 30 minutes | 100 |
| Flomax | Enlarged prostate | 9:00 AM | ± 30 minutes | 100 |
| Prednisone | Anti-inflammatory | 9:00 AM | ± 30 minutes | 100 |
| Senokot | Stimulant laxative | 9:00 PM | ± 30 minutes | 0 |
| Vitamin D | Assists with calcium absorption | 9:00 AM | ± 30 minutes | 100 |

*The general purpose of the medications was obtained from Medline Plus, Retrieved November 12, 2011, from http://www.nlm.nih.gov/medlineplus/druginfo/meds/a682882.html

**Medication adherence product performance**

Based on the data uploaded from the MAT product, the participant was able to achieve 90 percent medication adherence with the nine medications. As it is greater than our predefined cut off of 80 percent, this was considered as being adherent. The missed pill, Senokot, was recorded on the MATs as being taken once at 7:19 AM on Day Two instead of the prescribed 9:00 PM time on Day One. Pill counts at the end of each day verified accuracy. The participant's average response time to taking the pill (i.e., opening the bin compartment) after the electronic alert activated was 11 minutes.

**Investigator's observations**

During the scheduled patient checks, the investigator made the following observations:

- Similar to the previous participant, Participant #2 was observed tipping over the unit to unload the pills into the palm of his hand on three occasions. Participant #2 did not drop any of the pills when re-loading extra pills back into their respective bins.
- Participant #2 did not fully close the plastic bins on the medication bins using the plastic tab locking mechanism at the top of the bin (Figure 2.1, feature #9).
- The adhesive on two of the medication label stickers was failing and the stickers were peeling off (Figure 2.1, feature #10).
- The three units occupied considerable space on the kitchen counter as three cradles, three power adapters, three power cords and three phone cords were required.
- Participant #2 could not hear the audible alert when the television was turned on. Inability to hear the audible alerts may account for the recorded 11 minute average response time to opening the pill bins.
- One of the bin buttons was difficult to push due to a sticky food substance which may have been spilled on the unit.
- Programming the three units using the online website was complicated. Because there was only one analog phone line, each unit had to be docked on the cradle one at a time. This method was time consuming and could be prone to programming errors if completed by an informal caregiver or if frequent medication changes were made.

**Team feedback**

Two completed team evaluations were submitted from the participant's care coordinator and pharmacist. On a 5-point Likert scale one respondent "agreed" and the other respondent "strongly agreed" that the information received from the MATs product was useful. One comment was provided:

- "*It would be beneficial if the product could be programmed to beep (for some of the time) to assess whether the patient required cueing to actually use the medication box. As has been discussed with the team, the medication product is not optimal for persons with several medications to take at each time. A product closer in design to current "dosettes" and medication boxes commercially available in which all meds for one time could be in the same slot would be better. This would be easier for the patient and also indicate more clearly if the correct number of tablets had been taken at the particular time"*

**Patient exit interview**

During the exit interview, Participant #2 stated that the main difficulty with the product was reading the LCD screen (Figure 2.1, feature #4) and hearing the audible instructions. He did not indicate any additional issues with operating the product. When asked about the missed dose, Participant #2 was unaware that he missed the 9:00 PM dose of Senokot and was unable to recall why he took the dose the following day. He commented that *"overall it is a good machine and I would use it at home...you would need people who would want to use this machine...the technology is helpful to save the nurses work*". Participant #2 also commented that he would pay to use this product to a maximum of $10 per month but stated that if the government paid for it that it *"would be good*". He agreed that using a MATs product could help him feel more independent and safer at home.

**Post-completion of the trial**

The patient was discharged twelve days after the trial with the same nine medications and pre-packaged medicated powder. A family conference was held and recommendations included joining a day program for socialization and exercise, having his children provide more support at home, recommendation to pursue Telecare (the emergency alert pendent) and assistive bathing equipment. Based on the discharge notes, as this participant had adequate informal supports at home, the recommendation for Community Care services was not indicated at the time of discharge.

# Chapter Four

## Discussion

The proportion of older adults in Canada is rising and the majority of these individuals are prescribed multiple medications to treat complex health conditions. Many struggle with maintaining optimal medication adherence as prescribed by their family physicians and very few are able to achieve 100 percent medication adherence. Research in improving medication adherence continues to be important since medication management is an instrumental activity of daily living contributes to healthy aging and helps maintain independence in the community.

The consequence of poor medication adherence creates long-term consequences such as loss of independence, increased hospitalizations and shorter life expectancies. Medication non-adherence affects the quality of life for our older adults and their ability to remain in their own homes. This challenge, coupled with statistical predictions of a growing older adult population in Canada, has put pressure on health care providers to identify new strategies to aid in the improvement of medication adherence. The ubiquitous nature of technology makes it a logical step to investigate if there are potential uses with older adults and medication adherence.

The purpose of this study was to extend the research on MATs. There were two objectives for this study. The first objective was to determine the current level of awareness of MATs among an older adult's care providers which included their family physician, local pharmacist and Community Care case manager. The second objective was to determine older adults' perceptions on the usability and design of one commercially available MATs product.

As mentioned in the literature review, an activity analysis identified the various functional, cognitive and environmental factors which may influence the operation and acceptance of MATs. As there is very limited previous research in MATs with older

adults; the intent of this study was exploratory and to create baseline knowledge to help guide future research in this area.

**Meaningful Gap in Knowledge**

The overall results from the survey indicated that the health care providers polled experience issues with medication adherence with their older adult patients 50 percent or more of the time and equally in all of the disciplines. Utilizing patient self-report as the most common method of identifying medication non-adherence and having patients cite cognitive decline as the most frequent issue also coincides with the standard interview type patient assessments conducted by health care providers. The additional method of visually inspecting a patient's medication within his or her home to identify missed dosages or scattered pills corresponds with the strong response rate from Community Care case managers who regularly complete home visits.

This does bring forward the question of how non-adherence issues are identified in the segment of older adults who intentionally choose not to disclose these issues with their health care provider or who are not receiving Community Care services, especially older adults who reside alone and do not have informal caregivers.

Almost all of the respondents were familiar with blister packaging and were relying on this as their current strategy to address medication adherence issues. This corresponds to the high response rates of Community Care case managers who require blister packaging to authorize their Medication Assistance Program services. Pharmacists also list blister packaging as the most commonly used method as it's a service offered by most pharmacies and naturally their most favoured method.

Although the most prevalent, the design of blister packaging also has its challenges and, as found in the survey responses, respondents identified that older adults with arthritis or other physical impairments have difficulty pushing the pills through the foil backing. The survey responses suggested that an alternative strategy is needed for

older adults who have issues managing blister packaging and do not have formal or informal caregivers to monitor.

Overall, the survey responses demonstrated a low level of awareness of MATs among family physicians, Community Care case managers and pharmacists in Edmonton and surrounding areas. This suggests that MATs products are currently aids just emerging in the market and are very rarely recommended to older adults by their health care providers. The older adults that do use these products likely purchased the products on their own or the initiative was brought forward by an informal caregiver.

In general, the investigator was unable to find any statistically significant associations when the respondents' demographics such as years of practice, profession category and overall comfort with technology were compared to the reported level of MATs awareness or personal beliefs regarding MATs. Other than identifying a statistical association with physicians having the lowest perceived level of familiarity of MATs, no other statistically significant feature was identified in our respondents' demographics that indicated a particular group or characteristic that had a comparatively greater or less likelihood of utilizing MATs. Although health care providers with 15 or more years of experience had the highest level of awareness of MATs, this proportion was only at 18 percent. This confirms the low level of clinical exposure to such technologies in the respondents' health care practices. Overall, it can be inferred that all respondents polled in this survey had a low level of awareness in the availability of MATs.

The current level of unfamiliarity and caution in using MATs by health care providers could also be attributed to the growing need for evidence-based practices. Health care providers appear to be more inclined to use labour-intensive but predictable strategies. This is demonstrated by their high preference for using blister packaging and utilizing medication assistance programs. The findings from this study indicated that although MATs are innovative, further research is required to provide health care

providers with sufficient evidence to change their current practices. Further research is also required to improve designs of currently available technologies.

Using the technology acceptance model to explain the health care providers' perspective, we can see how the respondents' themes of uncertainty reflect a low level of perceived ease of use with MATs. For descriptive purposes, the investigator used a low, moderate or high ranking system for all of the TAM variables except for attitude. Attitude was ranked as either positive or negative. Most respondents currently cannot foresee how a MAT product could be incorporated into their current health care services. They are unaware of the capabilities of MATs and how to integrate this technology to improve the quality of care. The reoccurring themes in the respondents' descriptive comments were based on uncertainty in product features, reliability and potential uses. Their comments also suggest an "all or none" perspective; respondents perceived that the introduction of technology removed the human factors currently involved in medication management (i.e., removed the need for Community Care services) or raised questions about what would happen if the product fails.

It is likely that if handed a MATs product, most health care providers would find it challenging to describe or demonstrate the use of the MATs to an older adult. In contrast, it is likely that if asked to explain a dosette or blister pack, health care providers would be able to describe these aids without much effort or discomfort. The commercial product that was used in the trial was only accompanied by an instruction manual and the vendor's helpline phone number. The additional training session provided by the vendor was requested by the research team for an additional cost and was not offered as a regular accompanying resource to informal caregivers or health care providers. Instead, informal caregivers and health care providers were expected to teach themselves how to load and program this product. There were no formal educational strategies (i.e., in-person training) available to users to increase their perceived ease of use.

Overall, although 82 percent of the respondents indicated they felt MATs were a useful tool, which suggested that although perceived usefulness, attitude and behavioural intention to use is positive, the low level of perceived ease of use (i.e., level of local availability 8%, awareness of MATs 25%) is the current barrier to actual system use (Figure 4.1). This is consistent with the fact that only six percent of these respondents regularly recommend MATs products to their older adult patients. These barriers could explain why health care providers have not adopted using this technology.

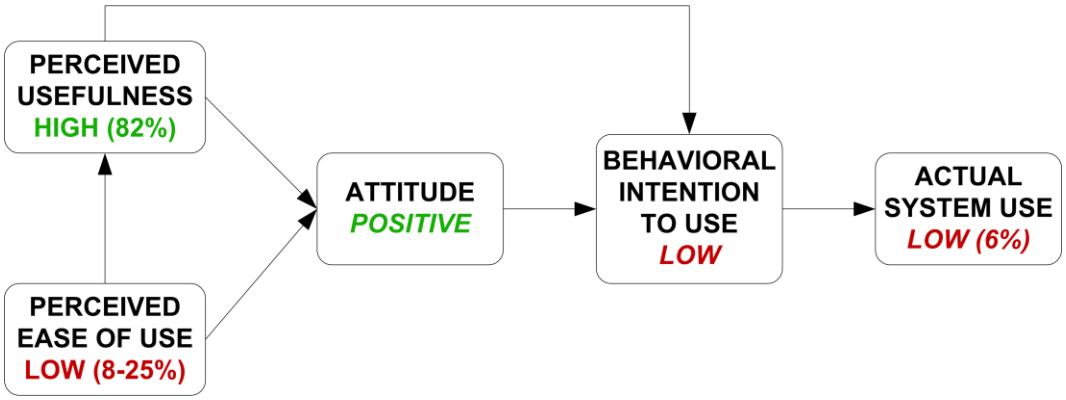



*Figure 4.1*. Applying the technology acceptance model to explain health care providers and their current usage of MATs. Although the majority of health care providers in this survey felt MATs are beneficial, their lack of knowledge of potential MATs applications and how to use this technology prevents them from actively recommend MATs usage with their older adult patients. Adapted from "The Technology Acceptance Model: its past and its future in healthcare" by R.J. Holden and B.T. Karsh, 2010, *Journal of Biomedical Informatics, 43,1,* p.161.

When asked for possible strategies to improve awareness and ease of use, the health care providers indicated their top three choices would be increased knowledge in local availability, access to product in-services and increased research to support the use of MATs. If these strategies were available, over 90 percent indicated they would be more inclined to recommending MATs to their older adult patients. This high level of receptivity is positive and demonstrates that the main barriers are the limited local availability, lack of education, and evidence-based information on MATs.

From an older adults' perspective, the two participants involved in the product trial achieved similar adherence rates but had different experiences in using the technology. When the TAM is applied, the predictive ability of actual system use differs. As illustrated in Figure 4.2, Participant #1 had a low level of perceived ease of use as she repetitively stated that this technology was harder to operate than her dosette, was observed having difficulty opening the pill bins and stated that she preferred to return to using her dosette when discharged home. For perceived usefulness, this participant had limited insight into her own cognitive deficits, was deterred by the cost and did not believe that this technology would be useful for her. Perceived usefulness could be rated as low, attitude could be rated as negative and behavioural intention to use as low. If the TAM was applied, the likelihood of this participant actively using MATs upon discharge could be predicted to be low.

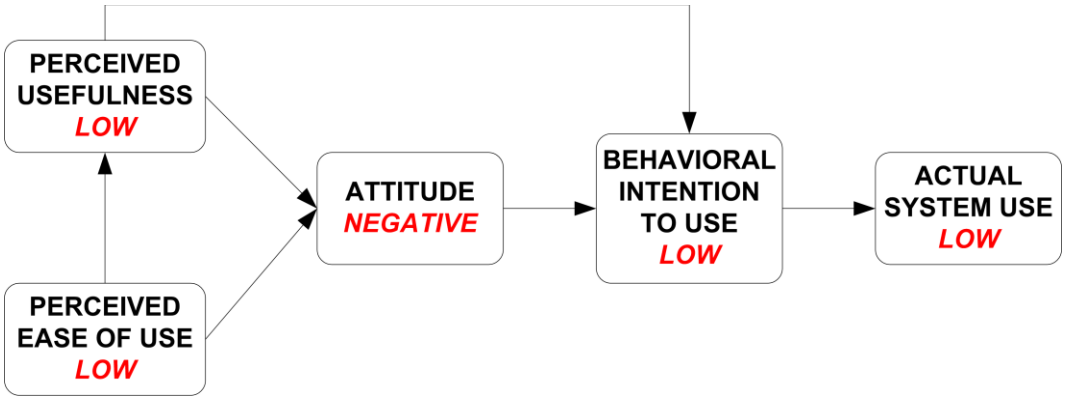



*Figure 4.2*. Applying the technology acceptance model to Participant #1's experience with the medication adherence technology. Adapted from "The Technology Acceptance Model: its past and its future in healthcare" by R.J. Holden and B.T. Karsh, 2010, *Journal of Biomedical Informatics, 43,1,* p.161.

Alternatively as illustrated in Figure 4.3, Participant #2 stated he had fewer issues with operating the MATs product and therefore had a moderate level of perceived ease of use. He was not bothered or disoriented with using three units. Although he stated he had difficulties with reading the LCD screen and hearing the audible alerts during the exit interview, Participant #2 did not state any other difficulties with the MATs product during the actual trial and could be given a moderate rating of perceived ease of use. Participant #2 could also see the potential uses in this technology, felt the technology helped increase his feelings of safety and independence and was not deterred by the cost. Perceived usefulness could be ranked as moderate. As positive comments were recorded during the exit interview, his attitude and behavioural intention to use could be respectively ranked as positive and moderate respectively. As Participant #2 had a higher level of perceived usefulness and perceived ease of use than Participant #1, it is possible that Participant #2 would have been receptive to using the MATs product upon discharge home. However, due to the short trial period, there is not enough information to infer how long Participant #2 would continue using the product at home.

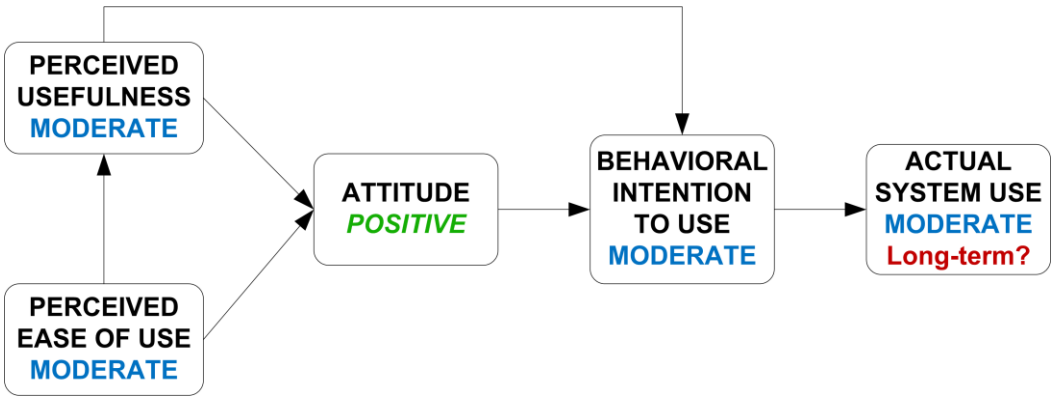



*Figure 4.3*. Applying the technology acceptance model to Participant #2's experience with the medication adherence technology. Adapted from "The Technology Acceptance Model: its past and its future in healthcare" by R.J. Holden and B.T. Karsh, 2010, *Journal of Biomedical Informatics, 43,1,* p.161.

**Understanding the complexity of older adults**

As reported in the literature review, these case studies highlighted the general complexity of older adults. We learned that considerations specific to the older adult population need to be taken into account when assessing the usability of a MATs product. The importance of handling a large medication regimen is highlighted in both case studies which had 8 to 9 medication types in pill form per participant. In addition, both participants were on additional medications which were not in a pill-format (i.e., inhalers and powders) or without set dosage times (i.e., prn or "take as needed" medications) and these could not be managed by the MATs product. This brings forward the question of how to manage these alternative forms of medications which are equally important for optimal health.

Although both of the participants were high functioning and community dwelling older adults, the cognitive test scores suggested the presence of mild cognitive impairment and possibly moderate cognitive impairment for Participant #2. However, both participants were able to learn the basic concepts of using the MATs product with one 30 minute training session and one day of practice prior to entering the Independent Living Suite (ILS). Once in the ILS, both participants were able to achieve high rates of adherence with the MATs product. This suggested that older adults with mild cognitive impairment continue to have the capacity to learn and adapt to this type of technology.

The findings from the case studies also highlighted varying combinations of visual, fine-motor and auditory impairments which can affect an older adult's ability to use MATs. An ideal MATs design would need to either be able to address these combinations or possibly have specific designs designated for extreme impairments in each area (e.g., a hearing aid compatible design, a low vision design) to meet the complex needs of older adults. Additional research is also required to identify which older adults may respond more favourably to the use of MATs and to determine optimal timing for

introducing this technology when faced with progressive cognitive and physical impairments. Developing an ideal older adult profile may assist health care providers with identifying older adults who would benefit from MATs and exclude those who should receive more traditional methods of medication assistance.

**Importance of product design**

Similar to the survey results, the product trial reinforced the current knowledge gaps in the uses of MATs but also reinforced the importance of product design to improve perceived ease of use and perceived usefulness. Although the product trial was able to recruit only two participants, Nielsen (1993) suggests that small samples sizes of five to six participants are usually adequate to identify 95 percent of usability problems with a product. Therefore, a sample size of two participants could still identify a significant amount of usability problems.

Design features which were found to have significant impact on participant performance or health care provider usability can be divided into five categories: medication organization, alerts, bin access, connectivity and programming. These issues are identified below with suggested design improvements for increased usability with the older adult population.

**Medication organization**

During participant recruitment, health care providers were quick to identify that the product's four bin design was unable to accommodate their typical older adult's medication regimen and therefore was not useful for their patients. This observation was commonly seen although the investigator indicated that multiple units could be used to accommodate larger medication regimens. However health care providers would indicate that on a practical level, the purchase of multiple units at $124 each would make this product unaffordable.

The one medication type per bin design also relied on the older adult to correctly select the prescribed number of pills out of each bin (i.e., "*Take 2 pills out of bin #1"*). As the product relied only on bin openings to track adherence, it cannot identify if too many or too few pills were taken in one sitting. By including the extra step of expecting the user to be able to follow the verbal prompts and complete the correct action of removing the prescribed pills, this design was difficult for older adults with cognitive impairment and placed them at risk for over or under dosing. In addition, older adults familiar with the dosette or blister packaging method of organization would have additional difficulty adjusting to this new method of pill organization.

As an alternative, a more suitable MAT product should pre-sort medications based on dosage times instead of medication types. This removes the cognitive task of requiring the older adult to accurately recall the number of pills which are needed at each dosage time and can accommodate larger medication regimens. This also removes the need for lengthy verbal audio instructions, visual print instructions on the LCD screen and individual medication labels. For example, the older adult would only need to be reminded to take all pills in the "AM slot" and does not require the older adult to be able to identify the medication type, # of pills needed or open multiple slots at one time. It would also enable this product to meet the needs of older adults who have low English literacy, visual or hearing impairments. Although this design would be larger in size and less portable, its increased capacity to hold a larger variety of pills and a week's worth of medications could improve perceived ease of use. An additional option of being able to weigh each compartment pre and post dosage may also identify if pills were left behind in each compartment.

In addition, by following the dosage time organization, it would increase its resemblance to a blister package or dosette. As indicated by the survey results, 99 percent of the service provider respondents were familiar with the organization style of

blister packages or dosettes and the majority of respondents recommend blister packaging to their older adult patients. By transferring this familiar design to a MATs product it may also have a higher likelihood of facilitating health care providers' and older adult perceived ease of use.

**Alerts**

The electronic alerts on this MATs product came in four methods: a flashing light above each bin, written instructions across the LCD screen, an audible beep and verbal instructions. The flashing light was found to cue both participants in correctly opening the correct bins and suggested that this visual cue was effective. Both participants reported they had difficulties reading the 1" x ½" LCD screen which suggested that a larger display with increased font and color contrast was required to increase readability. The participants also reported the MATs verbal instructions were muffled and difficult to hear on the loudest volume setting from the speaker. This suggested that this type of alert likely wasn't effective and was difficult to follow. Participant #2 was observed having issues hearing the audible beep, especially when in an alternate room. This brings up the possibilities of incorporating a smaller, wearable alert (i.e., bracelet or necklace) that could communicate wirelessly with the home base unit to ensure the older adult receives the alert regardless of room location (i.e., via vibration or audio) and would be cued to travel to the home base MATs unit. It may also be useful to ensure the audible alerts are compatible with hearing aid frequencies.

**Bin access**

Accessing the pills in the medication bins was also seen as a significant barrier for both participants. The 1" diameter of the pill bins prevented both participants from removing pills from the product without tipping the product over. This was not the intended use of the product and placed the older adult at significant risk for increasing medication taking errors. In addition, by re-loading dropped pills, this also affected the

accuracy of the remote monitoring data as additional bin openings were reported as an over dosage when, in reality, the older adult was self-correcting, or replacing a dropped pill.

The actual size and design of each dosage bin should be large enough to allow for more than two fingers to access the pills (i.e., the thumb, index and middle finger to access the pill using a three point pinch or finger sweep). Alternatively, a design with individual cups which could be removed from the product and poured into the palm of the hand could also be effective.

**Connectivity**

The product's cradle required access to an analog phone line and the location of the analog phone jack dictated the location of where the MATs product would be placed (i.e., kitchen counter). There were also limited analog phone jacks available within the hospital and the cradle was not compatible with digital phone lines. This highlighted the importance of having the right type of connectivity in addition to being limited by the location of the phone jack. The unit also had to be properly docked on the cradle for connectivity and charging of the battery. If an older adult were to forget to return the unit back onto the cradle for a prolonged period of time (i.e., multiple days), potential "missed dose" information could not be retrieved until the unit is later returned on the dock. This also raises the concern of unit power failures. Depending on the number of programmed alerts required, the battery back-up system was found to only last 4-5 days before losing power. The caregiver would receive an email alert that the unit has not reported data but if they were subscribed on a monthly upload data plan this information would not be received in a timely manner.

With the advancing digitisation of television and telecommunications, older adults may discover after purchasing similar products that they are unable to establish connectivity if they do not have an analog phone line. A MAT product which has

wireless capabilities would eliminate the need for specific connectivity requirements. This would also enable the unit to be set-up in the older adult's desired location instead of being limited to analog phone jack locations. It could also enable older adults to continue using the MATs if they re-locate to different housing or travel for extended periods of time.

**Programming**

To fully utilize the programming capabilities, the MATs product used in the trial required an active internet line, updated web browser (i.e., Internet Explorer 8.0 or higher) and computer to access the online website. For both participants, it required the investigator and pharmacist approximately 60 minutes to load and program the multiple units since each bin had to be separately programmed with the medication name, dosage, alert times, therapeutic windows and special pill taking instructions. Once programmed, the investigator needed to ensure each bin was properly labelled with the adhesive identification label (Figure 2.1, feature #10) prior to docking each unit onto the cradle to download the data. This process had to be repeated for each additional unit required. The final step required the investigator to verify that the settings were downloaded correctly by pressing the bin buttons (Figure 2.1, feature #6) on each unit. On two instances, the data did not download correctly and the investigator had to contact the vendor's helpline for assistance.

The pharmacist and investigator found these steps time-consuming and increasingly complicated if multiple units were used since the online website had separate accounts for each unit which were identifiable by serial numbers only (i.e., Unit A was identified by account #80030123, Unit B was account #90040124 etc.). These steps would likely be even more difficult for informal caregivers to complete as they only have the instruction manual to reference versus the training which the investigator received directly from the vendor. This potentially increases the chances of programming errors

and subsequent medication taking errors; especially if older adults had medication regimens which changed frequently.

One previously mentioned improvement would be to change the medication organization to dosage time instead of medication type. This would eliminate the need to manually program medication types individually and would eliminate the various online programming pages. Wireless capabilities would eliminate the need for a cradle. By eliminating a cradle and using a power source directly attached to the product, this could decrease the risk of power failures although it would eliminate portability. It could also be useful to explore alternatives to remove the additional step of manually loading medications and programming by incorporating existing available technologies such as bar codes and scanners. For example, a pharmacist could pre-load and seal trays which are compatible with a MATs product (i.e., similar to their blister packaging methods), print out a personalized barcode with the medication regimen and affix it to the tray, the caregiver could pick up the tray, return home, scan the barcode using the scanner built into the MATs product and load the tray in the product. Once scanned, the dosage data would be automatically uploaded into the product which reduces the possibility of loading and programming errors.

Overall, the findings from the product trial suggest this commercial product's design is not an appropriate match for older adults on complex medication regimens. This particular product would have difficulty gaining technology acceptance and successful long-term use from both the health care provider and older adult perspectives. This study found that additional usability testing is needed with alternative "off the shelf" products to find a better fit. Additional testing could assist in determining if a design currently exists to meet the needs of older adults or if the current products are not suitable for this population. If that is the case, then it would guide research back to product development and to re-start the process of innovation. Durability of the product, the

ability to withstand drops or liquid spills and battery life should also be considered to understand the dependability of the product.

**Using an Integrated Systems Approach versus a Stand-Alone Product**

Surprisingly, 82.4 percent of the survey respondents believed that MATs are a useful tool with 93.8 percent indicating an increased likelihood of recommending MATs if strategies such as increased local availability and product in-services were made available. Holden and Karsh (2010) conducted a systematic review of studies who have applied the TAM with healthcare technologies and found significant relationships in all of the studies reviewed between behavioural intention and perceived usefulness. The high percentages in perceived MATs usefulness are promising and indicative that health care providers' overall beliefs are receptive to MATs usage. Health care providers can see the potential of this technology but currently do not know how to use this technology and believe it could be too complicated to use (i.e., low perceived ease of use). This supports the need for future research in the area of MATs to identify how we can increase perceived ease of use to influence attitude and behavioural intention.

Since cost, ease of use and availability were identified as important factors towards selecting a MATs it could be also beneficial to consider involving key stakeholders and policy makers to develop an integrated program to support the use of MATs instead of viewing this technology as a stand-alone product. A good example of an integrated product in healthcare is The TeleCare® Support System (TeleCare®, Edmonton AB). This is a remote monitoring safety alert pendant which has gained widespread acceptance. It is frequently recommended by health care providers and used by older adults. The system consists of a base unit which connects to an analog phone line and can communicate with a one-button pendant necklace. By pressing the pendant, the base unit will activate a call to a 24 hour call center. Live personnel can speak with the older adult via the base unit to triage the situation and determine if additional

interventions, such as activating emergency medical services, is required. What makes this system unique is the involvement of multiple stakeholders who fulfill different roles to support this technology within an older adult's home.

At the beginning of the process is the identification of potential users. This is completed by Community Care services that identify older adults who have potential safety risks (i.e., cognitive impairment, risk of falls, limited social supports). These health care providers describe TeleCare® and recommend its use as part of the treatment plan. By discussing the various features and uses of TeleCare®, the health care providers are assisting with increasing the level of perceived usefulness with the older adult. The health care providers also direct the older adult to the Good Samaritan Society which is a nationally accredited social services organization who offers the Telecare program. This removes the additional step of sourcing product availability. Once in contact with the Good Samaritan Society, the steps of product delivery, installation and product education are provided by this organization to increase the level of perceived ease of use. The Good Samaritan Society is also responsible for staffing a 24 hour emergency response call center which responds to the activated alerts. These activated alerts could also be programmed to notify the older adult's caregiver of reoccurring patterns or potentially high risk issues such as reoccurring falls. The Good Samaritan Society also retains ownership of the TeleCare® system and is responsible for replacing faulty or damaged equipment. This reduces the risk of equipment failure and lapses in service. The cost of renting the system and monthly monitoring fee is then subsidized by a separate governmental program known as the Special Needs Assistance for Seniors (Government of Alberta, Edmonton AB). The Good Samaritan Society or Community Care services can assist the older adult in completing the application paperwork for this funding. By addressing the barriers of limited local availability, high cost and lack of provider

support, the TeleCare® product has achieved successful and long-term technology adoption.

We are suggesting that MATs should follow a similar model that consists of shared partnerships between stakeholders and clearly defined roles. A hypothetical integrated system for MATs explaining these roles is highlighted in Figure 4.5. It could help increase health care providers' confidence and promote MATs usage with older adults.

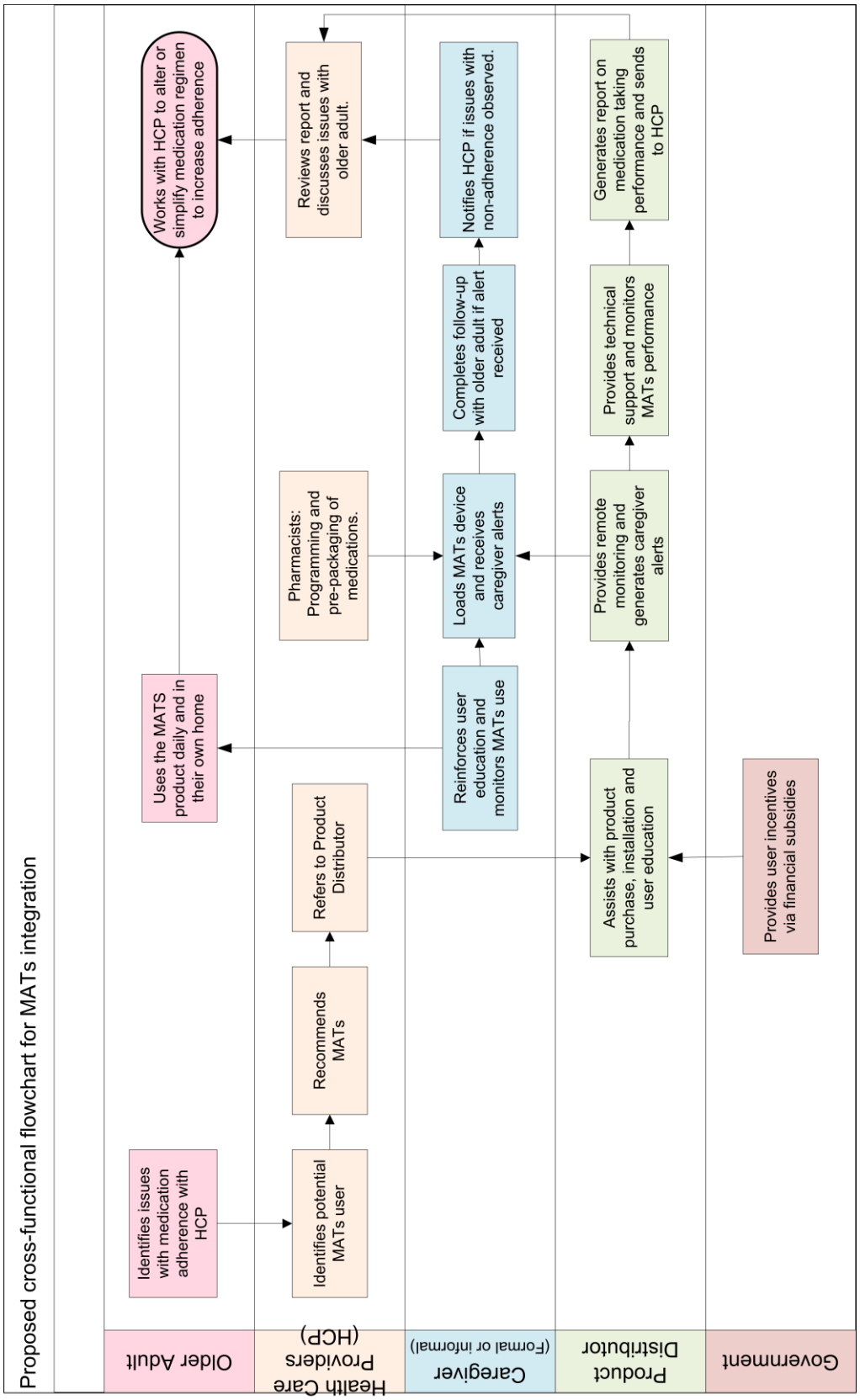



Figure 4.2. Proposed cross-functional flowchart for MATs integration. This illustrates the need for involvement and defined roles from multiple stakeholders to support this technology within the health care system. The bands represent each stakeholder and the shapes represent the proposed steps that each stakeholder would be responsible for.

This integrated system first relies on the health care provider and older adult identifying medication adherence issues. Similar to TeleCare®, the healthcare provider can recommend the MATs product and direct the older adult to a product distributor. Having an organization such as the Good Samaritan Society acting as the product distributor would increase ease of access to the product selection and purchase. This would also ensure consistency in the type of technology selected to prevent older adults or informal caregivers from mistakenly purchasing a MATs product that does not meet their needs. Subsidized funding through a governmental organization such as Special Needs Assistance for Seniors also enables equal access to older adults regardless of income and addresses the health care providers' concerns regarding cost. The usage of MATs could potentially improve the efficiency of Community Care services to provide care to a larger number of older adults without increasing the number of healthcare personnel. For example, instead of requiring a health care aide to complete multiple home visits in a day for medication reminders, they could potentially reduce this visit to once at the end of each day or once per week to check on the technology, load the product and provide positive reinforcement for MATs usage. The integrated approach should also develop a feedback system for health care providers to receive and review the medication adherence data. The objective data collected from MATs can be used in conjunction with patient self-report to alter or change existing care plans. The view of MATs as an integrated program versus a stand-alone product could provide clarity in how this technology could fit within the current provision of health care services and promote technology adoption among health care providers.

## Limitations

Although the survey provided initial insight regarding health care providers' perceptions of MATs, it did not include all care providers involved in maintaining the health and well-being of community dwelling older adults. Formal and informal care providers, such as nurse practitioners, health care aids and family, were not included in the survey sample. Although the 25 percent response rate is considered favourable, there are no past surveys to compare the response rates and these should be considerations when interpreting the data.

As the catchment area was limited to Edmonton, AB and surrounding areas, external validity is limited as it may not be a representative sample. There may be limited ability to generalize the survey results to rural areas or to assume a normal distribution. To address this, a larger survey which could encompass health care providers in the entire province would be necessary. Gaining direct email access to all health care providers and conducting the survey at a different time of year could also have increased response rate. The survey responses may also be subject to a non-response bias; respondents might have been motivated to participant in the survey if they were particularly supportive or critical of MATs and the data may have only captured the extreme opinions.

The product trial was unable to attract the required number of participants to conduct a randomized control trial and as already discussed in the previous chapter, this was potentially due to the design of the MATs product and low technology acceptance from both health care providers and older adults. The ability to generalize the results from the two case studies is limited. These two patients may have also been more inclined to trialing technology than the typical older adult. The high compliance rates achieved during the product trial may be due to the participant being informed about the purpose of the monitoring and this awareness may have resulted in higher than normal

compliance (i.e., hyper vigilance). A longer trial period in the ILS, or even in a older adult's own home immediately after discharge, could have provided a larger amount of data and observations that are more representative of product adoption and effectiveness.

## Implications for Future Research

Future studies focused on usability testing of current commercial products and analyses of each product's design with consideration for the older adults' needs are warranted. To help guide and narrow the product selection, preliminary focus groups with older adults and health care providers would assist researchers in identifying potential products for usability testing.

It is possible that results from the focus groups may suggest that a suitable product currently exists but is unavailable in Canada or that an ideal product does not exist and the introduction of MATs on the commercial marketplace for older adults is premature. This would guide a return back to developing a design which meets all the usability and ease of use requirements for actual system use with older adults.

Due to the short time period of the product trials, it is currently not known if compliance rates can be maintained over a prolonged period of time or if the older adults would naturally display a tapering off effect once the awareness of being monitored is decreased. Although we used a simulated environment within a rehabilitation hospital, we cannot assume these findings apply to an older adult's home in the community. It is suggested to target future trials directly in older adults' homes for a longer period of time to capture long-term medication behaviours and to evaluate if electronic alerts can maintain long-term adherence rates. A suggested time period is six months as Benner et al. (2002) found medication adherence to drop from 79 percent in the first three months to 56 percent in six months for older adults during their first year of prescribed statin therapy. It would also be helpful to determine if MATs could be used in alternate levels of housing (i.e., assisted living) to help promote independence and decrease specific aspects of formal caregiver assistance which could be supplemented by technology and remote monitoring.

Our usability trial also measured how a novice or beginner used the product, not a user who has been using the product for a longer period of time. A larger data set over an extended period of time may also address if electronic alerts are as effective when cognitive decline progresses and if there are potential patterns which can be seen in the remote monitoring data.

Further investigations regarding the specific types of learning strategies that would be required to increase health care provider comfort in MATs usage is also recommended. Additional information is also required to assist in the development of specific, contextualized and actionable strategies to increase MATs knowledge. It would also be important to learn if having access to the remote monitoring data (i.e., objective data on medication taking behaviours) would enhance a health care provider's treatment plan or possibly reduce the number of adverse medication taking events related to medication adherence issues.

## Conclusion

The findings from the survey part of this study suggest that medication non-adherence with older adults is a common issue identified by community based health care providers. These providers currently have a limited awareness of MATs, likely due to the limited availability, but they were receptive to gaining an increased understanding about this technology. To increase clinical acceptance, the respondents suggested offering strategies such as access to information on technology availability, product in-services and evidence-based research on the use of MATs. The product trial identified usability issues in one commercially available MATs product and highlighted the importance of design features for ease of use and technology acceptance among older adults. Due to the complexity of medication management and the multiple stakeholders involved, an integrated approach may be required to incorporate and support the on-going use of MATs.

To conclude, usability testing involving a survey of 210 health care providers and product testing with two older adults showed that there is a gap between perceived usefulness and perceived ease of use. Additional usability testing on MATs designs to identify which MATs best serve older adults and a systems approach is recommended to support actual system use of MATs.

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# APPENDICES

# Appendix A: MATs Environmental Scan

**MATs Environmental Scan**

An environmental scan was completed in October 2010 to determine the current availability of medication adherence technologies in Edmonton, Alberta. Using the local yellow pages, the investigator systematically called listed pharmacies and healthcare specialty supply stores to query if MATs were available for purchase (n=50).

In total, five healthcare specialty supply stores indicated that they carry a MAT. A subsequent site visit was then completed to identify the product brand, price and features. All five products are listed below. It is important to note that all five products are considered "Simple MATs" in that they only provide electronic reminders and do not have remote monitoring capabilities (i.e., they cannot track the user's ability to follow the pre-programmed medication regimen nor alert caregivers if dosages are missed).

Advanced MATs were not found available for local purchase in this environmental scan. Additional products were available to purchase online but are not listed in the below scan as only products readily and locally available were considered.

| PRODUCT | DESCRIPTION | |
|---|---|---|
| Medi-Mate Pill Box Timer  | Company: | Apothecary Products |
| | Website: | www.apothecaryrpoducts.com |
| | Price: | $59.95 CAN |
| | Product Dimensions: | 4"H x 6 1/4"W x 1 1/4"D |
| | Patient alert mechanism: | Audio (e.g., beeping alarm) |
| | Patient alert description: | The outside of the case displays the current time and features a timer that can set for 2X, 3X or 4X dosage reminders per day. |
| | Pill Capacity: | 3 compartments |
| | Dispensing mechanism: | Pill tray slides out to display all three compartments. |
| | Power source: | Battery-powered |
| | Remote monitoring capabilities: | No |
| | Caregiver alert capabilities: | No |
| | Availability: | Healthcare Solutions 5405 99 Street, Edmonton AB ph: 780-434-3131 |

| | | |
|---|---|---|
| EZ Dose Remind and Time 7 Day Pill Reminder<br>  | Company: | Apothecary Products |
| | Website: | www.apothecaryrpoducts.com |
| | Price: | $14.95 CAN |
| | Product Dimensions: | 7" x 1 1/2" X 3/4" |
| | Patient alert mechanism: | Audio (e.g., beeping alarm), Visual (e.g., flashing light) |
| | Patient alert description: | The attached timer will beep and the small red light will flash until the button on the timer is pressed. |
| | Pill Capacity: | 7 compartments |
| | Dispensing mechanism: | Standard dosette flip top |
| | Power source: | Battery-powered |
| | Remote monitoring capabilities: | No |
| | Caregiver alert capabilities: | No |
| | Availability: | Healthcare and Rehab Specialities 10611 Kingsway, Edmonton AB ph: 780-424-6094 |
| VitaCarry Advanced with Timer<br>  | Company: | PharmaSystems |
| | Website: | www.pharmasystems.com |
| | Price: | $29.99 CAN |
| | Product Dimensions: | Not specified |
| | Patient alert mechanism: | Audio (e.g., beeping alarm), Visual (e.g., flashing light), Tactile (e.g., vibration) |
| | Patient alert description: | Patient alert description: When the alarm goes off, the display blinks (to allow a visual reminder), and you can program it to either sound an alarm, or vibrate, or both. |
| | Pill Capacity: | 7 compartments |
| | Dispensing mechanism: | Pillbox lid flips open (spring-loaded mechanism for easy release). LCD display indicates which compartment number to take the pill from. |
| | Power source: | Battery-powered |
| | Remote monitoring capabilities: | No |
| | Caregiver alert capabilities: | No |
| | Availability: | Market Drugs Medical 10203 97 Street, Edmonton AB ph: 780-422-1397 |
| ALRT Medication Reminder PC200<br>  | Company: | ALRT |
| | Website: | www.alrt.com |
| | Price: | $25.00 CAN |
| | Product Dimensions: | Not specified |
| | Patient alert mechanism: | Audio (e.g., beeping alarm), Visual (e.g., flashing light), |
| | Patient alert description: | Patient alert mechanism:<br>Patient alert description: Audio and visual alerts. Missed alerts continue until acknowledged. |
| | Pill Capacity: | N/A, does not store pills. |
| | Dispensing mechanism: | N/A, does not store pills. |
| | Power source: | Battery-powered |
| | Remote monitoring capabilities: | No |
| | Caregiver alert capabilities: | No |
| | Availability: | Can order from Jamp Pharma, Quebec (Connie Casola - |

| | | |
|---|---|---|
| | | conniec@genn.ca), specific local pharmacies willing to program and support product use. |
| e-pill Multi-Alarm Cube Pill Box  | Company: | e-pill |
| | Website: | http://www.epill.com/alarmcube.html |
| | Price: | $49.95 CAN |
| | Product Dimensions: | 10"H x 1" W |
| | Patient alert mechanism: | Audio (e.g., beeping alarm) |
| | Patient alert description: | Beeper alert on the top of the cube will alarm until the red re-set button is pressed by the user. |
| | Pill Capacity: | 4 compartments |
| | Dispensing mechanism: | Not specified |
| | Power source: | No |
| | Remote monitoring capabilities: | No |
| | Caregiver alert capabilities: | Battery-powered |
| | Availability: | Healthcare Solutions 5405 99 Street 780-434-3131 |

# Appendix B: Operational Definitions

## Operational Definitions

**Dosette:** A plastic box which has several compartments organized into day and time. Each compartment has a plastic lid that can be manually opened and closed. Medication is usually loaded into the dosette by the older adult or an informal caregiver (i.e., family). A dosette is intended to be used on an on-going basis and can be reused. It is typically low cost (e.g., $5-10) and found at most local pharmacies. There are no electronic components in a dosette.

**Blister packaging:** A method of using a sheet of pre-formed plastic packaging which has separate dose compartments and a foil backing. Medication is dispensed and sealed into the blister pack by a pharmacist for a nominal fee. Blister packs are intended for only one time use per compartment (i.e., once a foil backing is broken it cannot be refilled) and is usually replaced with a new blister pack at the end of each week. There are no electronic components in a blister pack.

**Medication non-adherence:** The definition of adherence will be the proportion of days with the appropriate number of doses. Non-adherence episodes can include dose-taking errors (i.e., dose omissions, dose duplication) or dose-timing errors (failure to take medications past the recommended dosing interval). An adherence level of 80 percent or greater will be considered as acceptable.

**Medication adherence technologies (MATs):** The terms medication adherence technologies, MAT (singular) and MATs (plural) are used interchangeably in this study.

**Simple MATs:** These refer to medication adherence products which have the capability to organize medications and provide electronic visual and/or auditory reminders (i.e., audible beeps, flashing lights, vibrations). Simple MATs do not have remote monitoring or caregiver notification capabilities. Medication is loaded into the simple MATs by the older adult or an informal caregiver. They are usually battery

powered, portable and mid-range in cost (e.g., $30-$80). They may be available at local health care specialty stores.

**Advanced MATs:** These refer to a higher level of medication adherence products which have additional features that include remote monitoring, caregiver notifications and dispensing mechanisms. They are significantly higher in cost (e.g., $100-$500). They typically are larger in size and require electrical power source and phone or internet connectivity. They are not available locally and must be purchased directly from the distributor.

**Remote monitoring:** The ability to assess a patient's medication taking abilities without requiring a physical visit in the patient's home. Typically provides the caregiver access to an online portal to view a patient's logged activity and can provide alerts via email, text messaging or phone if activity falls outside of the pre-established parameters (i.e., missed dosage).

**Community based health care providers:** Health professionals who provide care on an out-patient basis within a community setting. Their place of work may be a physician's office, pharmacy or community care office. It may also include visits directly in a patient's home for assessment and treatment purposes.

**Community Care services:** Health care services provided to patients within their own home. These include assistance with case management and providing formal personal care through the use of contracted care agencies.

**Older adults:** Individuals over the age of 65 years of age

**Mild cognitive impairment (MCI):** The transitional state between normal aging and dementia diagnoses such as Alzheimer disease where older adults develop memory loss but are not functionally impaired and able to complete most activities of daily living (Petersen, 2004).

**Moderate cognitive impairment:** The advancement of cognitive impairment where deficits begin to appear in other domains of cognition and often impair an older adult's ability to complete activities of daily living (Farlow, 2005). At this stage, formal dementia diagnoses can be determined.

**Pill counts:** A formal method of counting and recording the number of pills in a product to verify that the correct number was taken.

**Edmonton:** Capital city in Alberta Canada, population: 782,439 (Election and Census Services, City of Edmonton, 2009)**.**

**Surrounding areas:** Towns within a 50km radius to Edmonton, they include: Leduc, Sherwood Park, Spruce Grove and St. Albert.

**Alberta Health Services (AHS):** Alberta's publicly funded provincial health system. AHS includes 400 facilities throughout the province and includes hospitals, clinics, continuing care facilities, mental health facilities and community health sites (Alberta Health Services, 2011).

**Primary care network:** A group of family doctors working in partnership with the provincial health authority to coordinate health services for patients. It is a network of family physicians and other health providers who work together to provide primary care services to patients within their geographic areas. The network can be comprised of one or multiple clinics and services.

## Appendix C: MATs Electronic Survey Poster

Alberta Health Services

UNIVERSITY OF ALBERTA

## *Seeking input from family physicians, community pharmacists and Community Care case managers in Edmonton and surrounding areas.*

**Attitudes, knowledge and practical application of medication adherence technologies (MATs) by health care providers to improve medication adherence in older adults.**

As health care providers, what do we currently know about medication adherence technologies (i.e., electronic pill-boxes) and could it possibly help our older adults?

Dr. Katherine Lechelt, Division of Geriatric Medicine and Dr. Lili Liu, Department of OT, University of Alberta, are conducting a study on health care providers' perceptions and attitudes on medication adherence technologies.

The survey will take less than 10 minutes to complete. Responses will remain confidential and anonymous.

All respondents can enter their name for a chance to win 1 of 3 Best Buy gift cards valued at $150.00 each. Odds of winning are 1 in 160.

To participate, please enter the following link in your internet browser:

**http://app.fluidsurveys.com/s/mats-survey-2011/**

**SURVEY CLOSE DATE EXTENDED: JULY 30 2011**

**For more information on the study, a hardcopy of the survey or questions, please contact:**

**Katie Woo BScOT**
**Ph: 780-735-6059**
**Email: katie.woo@albertahealthservices.ca**

# Appendix D: MATs Electronic Survey

**Definition:**
Medication adherence can be defined as the extent to which a patient follows their medication regime as prescribed by their physician. Medication adherence technologies (MATs) are electronic pill boxes which can potentially improve adherence. There are currently several products available on the market which has some or all of these features:

- Organizes medications
- Provide electronic verbal or visual reminders
- Dispenses pills
- Alerts caregivers when doses are missed
- Reports long-term drug usage and adherence

**Purpose of this survey:**
To identify the potential challenges in maintaining medication adherence among the older adult population (adults 65 years and older).

To identify the current level of MATs awareness among health care providers in Edmonton and surrounding areas.

**Your participation is:**
Voluntary and anonymous. Your identity cannot be linked to your responses. Time commitment: This survey will only take 10 minutes to complete. Your responses will be kept confidential.

**Possible benefits:**
As clinicians, we run into medication adherence challenges with our older adult population on a daily basis. With the aging population and shortages in health care providers, the important question continues to be:

Can technology help? If yes, what strategies are needed to support the clinician and patient in technology adoption?

By completing this survey, you can "weigh in" on your own experiences and provide us your thoughts on medication adherence technology use.

After completing the survey, you will be given the option of entering your email address into a separate database. A draw will be completed when the survey closes for three $150 Best Buy gift cards.

**Do you need additional hardcopies?**
Hardcopies are available upon request.
Please contact Katie Woo via phone or email. phone: 780-735-6059, email: katie.woo@albertahealthservices.ca

**Questions or concerns?**
If you have any questions or concerns about this study, you may contact the individuals below:
Gary Faulkner, Director of Research, Glenrose Rehabilitation Hospital; Phone: 780 735-6132
Joanne Volden, Associate Dean, Graduate Studies and Research, Faculty of Rehabilitation Medicine, University of Alberta; Phone: 780-492-9674
These individuals are not linked with the study.

**1. What is your professional designation?**

- ○ Physician - Primary Care
- ○ Physician - Specialist
- ○ Nurse
- ○ Occupational Therapist
- ○ Physical Therapist
- ○ Social Worker
- ○ Pharmacist
- ○ Other

**2. Your practice setting?**

- ○ Medical Clinic
- ○ Community Care Services
- ○ Facility (i.e., acute care hospital)
- ○ Private pharmacy

**3. Practice location**

- ○ Urban center
- ○ Rural center

**4. Years of practice**

- ○ 0 - 5 years
- ○ 6 - 10 years
- ○ 11 - 15 years
- ○ 15+ years

**5. How often do you encounter medication adherence issues (i.e., overuse, inappropriate or underuse of prescribed medications) with your older adult population?**

- ○ Never (0%)
- ○ A few times (25%)
- ○ About half of the time (50%)
- ○ Much of the time (75%)
- ○ All of the time (100%)

Other, please specify:

**7. What are common reasons cited by your patients or their caregivers as issues with medication adherence?** (select all that apply)

- ☐ Cognitive decline (i.e., forgetfulness)
- ☐ Complex medication regimes
- ☐ Personal beliefs
- ☐ Limited patient knowledge on the purpose of the medication
- ☐ Adverse side effects
- ☐ Physical limitations with packaging (i.e., difficulty opening, reading or manipulating bottles, pills, inhalers or injectables)
- ☐ Financial limitations (i.e., cost of blister packaging)
- ☐ Limited caregiver awareness

Other, please specify:

**8. Which of the following strategies do you currently recommend to address medication adherence issues? (select all that apply)**

- ☐ Blister packaging
- ☐ Dosette
- ☐ Referral to community care services
- ☐ Inform the caregiver
- ☐ Electronic medication adherence products
- ☐ Individualized patient counselling
- ☐ Simplify medication regimen

Other, please specify:

**We would now like to present a continuum of medication adherence products. They range from basic non-electronic products (i.e. dosettes and blister packs) to advanced electronic products (i.e., medication adherence technologies).**


Typical features of a dosette include:

- Organizes medication
- Non-electronic visual reminders
- Portable
- Available at most pharmacies
- Medications loaded by the older adult or their caregiver
- Low cost

**9. Are you familiar with the use of dosettes (or something similar) in your clinical practice?**

○ Yes, I am familiar with this product
○ No, I am unfamiliar with this product

**9a. In your opinion, a dosette would be best used for (select all that apply):**

☐ Older adults with arthritis in their hands
☐ Older adults with mild cognitive impairment
☐ Older adults with moderate cognitive impairment
☐ Older adults with visual impairment

Other, please specify:


Typical features of a blister pack include:

- Organizes medication
- Non-electronic visual reminders
- Available at most pharmacies
- Medications filled by a pharmacist
- Small filling fee for each blister pack

**10. Are you familiar with blister packs (or something similar) in your clinical practice?**

○ Yes, I am familiar with blister packaging
○ No, I am unfamiliar with blister packaging

**10a. In your opinion, blister packaging would be best used for (select all that apply):**

☐ Older adults with arthritis in their hands
☐ Older adults with mild cognitive impairment
☐ Older adults with moderate cognitive impairment
☐ Older adults with visual impairment

Other, please specify:


These are examples of simple medication adherence technologies.

- Typical features include:
- Organizes medication
- Electronic visual and/or auditory reminders (i.e., beeping, flashing lights, vibration)
- Battery powered and portable
- Higher in cost (approx. $30-$80 dollars)
- Available at specialty health care supply stores
- Medications loaded by the older adult or caregiver

Features NOT included:

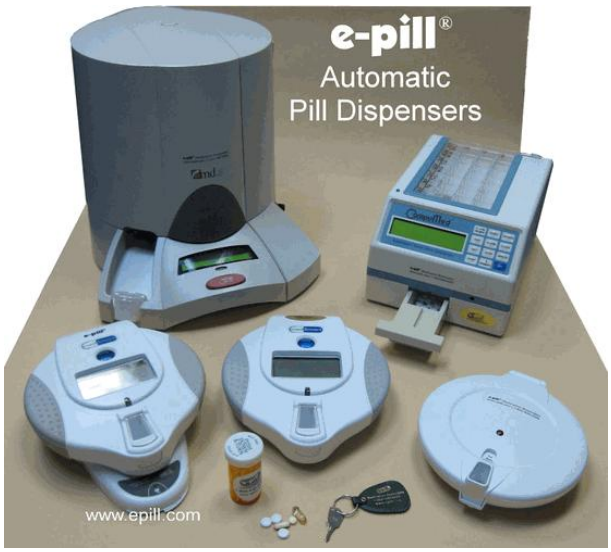
- Medication dispensing abilities
- Dosage tracking (i.e., did they take their pill at the right time?)
- Remote monitoring and caregiver notifications if a dose is missed

**11. Are you familiar with these products (or something similar) in your clinical practice?**

○ Yes, I am familiar with this product
○ No, I am unfamiliar with this product

**11a. In your opinion, this product would be best used for (select all that apply):**
☐ Older adults with arthritis in their hands
☐ Older adults with mild cognitive impairment
☐ Older adults with moderate cognitive impairment
☐ Older adults with visual impairment

Other, please specify:




These are advanced medication adherence technologies.

Typical features include:

- Organizes medication
- Electronic visual and auditory reminders
- Dispenses medication
- Dosage tracking (i.e., did they take their pill at the right time?)
- Remote monitoring and caregiver notifications if a dose is missed
- Ability to generate patient activity reports over a specified time period
- Requires a power source and internet or phone connectivity
- Higher in cost (approx. $100-$500 dollars) plus monthly monitoring fee
- Not available purchase locally at pharmacies or health care specialty stores (i.e., must contact distributor directly)
- Medications loaded by caregiver or health care provider

**12. Are you familiar with these products (or something similar) in your clinical practice?**

○ Yes, I am familiar with this product
○ No, I am unfamiliar with this product

**12a. In your opinion, this product would be best used for (select all that apply):**
☐ Older adults with arthritis in their hands
☐ Older adults with mild cognitive impairment
☐ Older adults with moderate cognitive impairment
☐ Older adults with visual impairment

Other, please specify:

**13. Now that we have reviewed the different types of products available, we would like to focus specifically on the electronic medication adherence products that you have just seen.**

**We would like to understand your current views on the use of this technology with older adults.**

**a. Overall, I am comfortable with technology**

| Strongly Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**b. I am aware of the current electronic medication adherence technologies available**

| Strongly Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**c. I believe electronic medication adherence technologies are a useful tool**

| Strongly Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**d. I regularly recommend electronic medication adherence technologies**

| Strongly Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**e. I am aware of the electronic medication adherence technologies available in my surrounding areas**

| Strongly Disagree | Somewhat Disagree | Neutral | Somewhat Agree | Strongly Agree |
|---|---|---|---|---|
| ○ | ○ | ○ | ○ | ○ |

**14. What are important factors toward selecting an electronic medication adherence technology? (select all that apply)**

- ☐ Cost
- ☐ Remote monitoring capabilities
- ☐ Ease of use
- ☐ Portability
- ☐ Medication capacity
- ☐ Availability
- ☐ Support

Other, please specify:

**15. Which strategies would help increase your comfort and knowledge of electronic medication adherence technologies? (select all that apply)**

- ☐ Research to support the use of medication adherence technologies

- ☐ Increased knowledge of local availability
- ☐ Improving the current curriculum for students
- ☐ Access to clinicians who are familiar with the technology
- ☐ Product inservices

Other, please specify:

**16. If the strategies you identified above were developed and available, would you be more inclined to recommend electronic medication adherence technologies to your older adult patients?**

- ○ Yes
- ○ No

**16. Any comments or questions about medication adherence or the current technologies available?**

Thank you. You have completed the survey.

A prize draw for one of three $150.00 Best Buy gift cards will be completed when the survey closes on June 30th 2011. Odds of winning a prize are 1 in 160.

Please complete the following skill testing question:

**8 x 6 - 5 + 9 =**

Enter your email address:

*Your email address is not linked to your survey responses. The winners of the draw will be contacted via email by the research assistant. It is the winner's responsibility to ensure the email address entered is correct. If the winner fails to respond with contact details within one week the research assistant will re-draw until a winner responds and three prizes are awarded. All email address will be destroyed after the draw and will NOT be used for other purposes.*

## Appendix E: MATs Pilot Testing Evaluation Form

**Attitudes, knowledge and practical application of medication adherence technologies (MAT) by health care providers to improve medication adherence in older adults.**

*Thank you for agreeing to help us pilot-test our survey.*
*Your feedback is valuable in the survey design process.*

**Instructions:**

1. To complete the online survey, enter the following in your internet browser: http://app.fluidsurveys.com/s/mats-survey-2011/
2. Once completed please complete the below questions.
3. Fax or email your responses to Katie Woo at:

**Katie.Woo@albertahealthservices.ca**
**Fax: 780-735-6084**

4. Please submit your responses by **Friday May 5th 2011.**

| | YES (x) | NO (x) |
|---|---|---|
| 1. Is the consent page clear? | | |
| 2. Do you understand the objectives of the survey? | | |
| 3. Do you feel comfortable answering the questions? | | |
| 4. Is the wording of the survey clear? If no, pls. explain: | | |
| 5. Are the answer choices compatible with your experiences in working with older adults? If no, pls. explain: | | |
| 6. Do any of the items require you to think too long or hard before responding? If yes, which items? | | |
| 7. Do any items produce irritation, embarrassment, or confusion? If yes, which items? | | |
| 8. Do any of the questions generate response bias (i.e., any loaded questions)? If yes, which items? | | |
| 9. Is the survey too long? | : | |
| 10. Do you feel any other important issues have been overlooked? If yes, pls. explain: | | |
| 11. Did you run into any technical difficulties accessing the survey? If yes, pls. explain the technical issues : | | |
| 12. Did you run into any technical difficulties with the images? If yes, pls. explain the technical difficulties: | | |

*Your individual responses in the pilot-test phase are not going to be recorded or reported to anyone except those who are designing the survey.*

## Appendix F: MATs Electronic Survey Information Sheet

**STUDY INFORMATION SHEET**

**Title:** **Attitudes, knowledge and practical application of medication adherence technologies (MAT) by health care providers to improve medication adherence in older adults.**

**Principal Investigator:**

- Katherine Lechelt, MD, FRCPC, Department of Medicine, University of Alberta
- Lili Liu, PhD, Professor and Chair, Department of Occupational Therapy, University of Alberta. Phone: 780-492-5108

**Co-Investigators:**

- Adrian Wagg, MB, FRCP FHEA, Professor and Chair in Healthy Aging, Department of Medicine, University of Alberta
- Grace Maier, Director, Specialized Geriatrics, Glenrose Rehabilitation Hospital
- Darrell Goertzen, Technology Service Leader, Glenrose Rehabilitation Hospital
- Katie Woo BScOT(c), TeleGeriatrics Program Facilitator, Glenrose Rehabilitation Hospital. Phone: 780-735-6059

**Background:**

Medication adherence can be defined as the extent to which a patient follows their medication regime as prescribed by their physician. Non-adherence can be related to either dose omissions or dosage timing (1).

Medication adherence technologies (MATs) are electronic pill boxes which can potentially improve adherence by providing various functions like organization, reminders, dispensing and reporting of drug usage (2). Although there are various MATs available, our clinical experience suggests that MATs are not commonly incorporated or seen in the medication regimes of our older patients.

With the Canadian population rapidly aging, it is timely to investigate if alternative tools and technology can be used to maintain older adults safely within their own home for a longer period of time.

This study will increase our understanding of the human and environmental factors which may explain this lag in technology adoption. The aim of this study is to examine the knowledge, attitudes and use of these medication adherence technologies amongst a group of health care providers dealing with older adults. Your input will also provide future direction for additional research such as medication adherence technology selection, clinical trials and product design.

(1) Osterberg L, Blaschke T. Adherence to medication. N.Engl.J.Med. 2005 Aug 4;353(5):487-497.

(2) Center for Technology and Aging. Technologies for Optimizing Medication Use in Older Adults: Position Paper October 2009.:09 August 2010.

**Purpose & Procedure:**

We aim to invite Community Care case managers, family physicians and pharmacists working in Edmonton and surrounding areas to complete a survey. This survey will consist of less than 20 questions and requires 10-15 minutes to complete. The questions ask service providers on the

current challenges they face with medication adherence within their clinical practice as well as their current perception and comfort with medication adherence technologies. This survey will be available online using a Canadian survey software tool, FluidSurveys. Hard copies are available to those who do not have or who choose not to use online access.

**Possible Benefits:**

As clinicians, we run into medication adherence challenges on a daily basis. Participants will be able to "weigh in" on the current issues with medication adherence within the older adult population. Your perspectives may help create new initiatives and research to support your current clinical practice and patients.

After completing the survey, you will be given the opportunity to enter a prize draw for three BestBuy gift certificates valued at $150 each. A skill testing question is required and the odds of winning are 1 in 160. Participating in the draw is optional and your contact information will be submitted into a separate database. Your contact information WILL NOT be linked to your responses and will be destroyed after the draw.

**Possible Risks:**

There are no known risks if you participate.

**Confidentiality:**

The research team will make every effort to keep your information private. The survey tool, FluidSurveys, is a Canadian based company with servers based in Canada.

Security measures taken by the research team and FluidSurveys include:

- An open URL to ensure that responses are not linked to your email address;
- Password protected user accounts;
- Macafee Secure Scan and Firewall protection.

By completing the survey and hitting "submit", you give implied consent for the collection and use of your responses in the study. The information collected will be kept confidential. It will be used only for this research study. All of the electronic information from the survey will be uploaded to a memory stick and removed from FluidSurveys when the survey closes on May 31st 2011. Only the members of the research team will have access to this data. A paper copy of the research will be securely stored in Corbett Hall at the University of Alberta. All records will be destroyed after seven years.

**Voluntary Participation:**
Participation is voluntary and you can stop the survey at anytime.

**Contact Names and Telephone Numbers:**
If you have concerns about your rights as a study participant, you may contact the Research Ethics Office at (780)492-2615. This office is not connected with the study.
If you have any questions or concerns you may also contact the individuals below:

- Gary Faulkner, Director of Research, Glenrose Rehabilitation Hospital; Phone: 780 735-6132
- Joanne Volden, Associate Dean, Graduate Studies and Research, Faculty of Rehabilitation Medicine, University of Alberta; Phone: 780-492-9674

## Appendix G: HREB Ethics Panel B Prize Regulations

**HREB COMPENSATION GUIDELINES**
**Approved by the University Committee on Human Research Ethics (UCHRE) March 2009**

**Compensation of Human Research Participants**
The Research Ethics Office recognizes the value of clarifying and disseminating for researchers and REB members, the principles, practices and processes related to different issues in human research ethics. These guidelines reflect current thinking at the University of Alberta about compensation of human research participants.
Compensation refers to providing subjects with money or a prize, or a chance for money or a prize, as an incentive and/or reward for participating in a research activity. This is distinct from reimbursing participants for minor incidental expenses they incur by participating in the research, for instance, transportation costs or parking, which is not problematic from an ethics perspective.
Research Ethics Boards are instructed to weigh the benefits and risks of a procedure, which means that marginal ethical considerations can be outweighed by larger benefits. Further clarification can be obtained by consulting with a Research Ethics Board member.

**1. Compensation is often not necessary**
It should not be assumed that people must be compensated in order to participate in research studies. In fact, many studies proceed without any compensation to participants. However, compensation can improve participation rates, making the sample of respondents more representative of the population under study. In some cases, participants may feel that some compensation is appropriate, given their contribution of valuable information and time.

**NOTA BENE: The recommendations contained in this document are not intended to be applicable to patient related biomedical research.** If you are considering compensation for patients participating in a biomedical study, consult with staff or Chair of the Health Research Ethics Board.

**2. Compensation should be appropriate in type and in amount**
The TCPS notes that The element of voluntariness has important implications. Consent must be freely given and may be withdrawn at any time. Undue influence may take the form of **inducement**, deprivation, or the exercise of control, or authority over prospective subjects.

The TCPS goes on to state: ...a prospective subject's choice to participate is voluntary. Pre-existing entitlements to care, education and other services shall not be prejudiced by the decision on whether to participate. Accordingly, a physician should ensure that continued clinical care is not linked to research participation, and teachers should not recruit prospective subjects from their classes, or students under their supervision, without REB approval.

In addition, care must taken “to prevent the development of a payment structure for research participation that might place undue pressure on research subjects either to join or remain within a research project...in research projects where subjects will be compensated, REBs should be sensitive to the possibility of undue inducement for participation, such as payments that would lead subjects to undertake actions that they would not ordinarily accept. REBs should pay attention to issues such as the economic

circumstances of those in the pool of prospective subjects, and to the magnitude and probability of harms".

If participants are to be compensated, the details of the compensation must be provided to the REB. The compensation must be commensurate with the risks of participation and must not be so significant that it could be perceived to be an inducement to participate. Details must be provided concerning what impact withdrawal from the study will have on compensation. It is considered coercive and thus unacceptable to have payment depend on completion of the project.

However, in many cases it may be acceptable to pro-rate the amount of compensation given to subjects who withdraw before completion or to divide the research into stages, with an honorarium attached to each stage.

**3. Non-identical compensation of participants**

Considerations of fairness favour compensating all participants equally. Sometimes a researcher has reasons to compensate respondents by unequal amounts. Unequal compensation can arise in at least the following ways: by design, by tying compensation to performance, and by chance.

*3.1. Unequal compensation by design*

It is unethical to compensate different participants by different amounts if they contribute in like manner to the research unless the differences in compensation are due to chance, to differences in performance, or to differences in custom. For example, it would be unethical to compensate men and women by different amounts.

However, a research design might require more extensive contribution of time and effort from some participants than others. An example in which differences in compensation might be appropriate is if a survey is conducted in two forms – a short printed survey sent to many prospective participants, and a long form (or one requiring personal interviews) for a smaller number of participants.

Custom may also suggest that compensation differ. For example, a study may involve parents and their small children, who may be compensated differently. However, parents should not be compensated for enrolling their children in studies and children should not be told they will be compensated as part of the recruitment process. As another example, some First Nations expect compensation for Elders that differs in kind or extent from compensation for other participants.

*3.2. Unequal compensation due to differences in performance*

A researcher may have valid reasons to want to tie compensation to some aspect of performance.

It may be necessary to motivate active or even energetic participation, for example. Informed consent requires indication of the range of compensation likely to arise. The researcher should also carefully consider the extent to which compensation must depend on performance. Participants who leave empty-handed may feel embarrassed and unfairly used. Compensation tied to performance is complicated from an ethical point of view if it is combined with compensation varying by design or compensation tied to chance. For example, it is problematic if an experiment assigns subjects to different experimental conditions that are expected to result in different levels of compensation, even if the assignment of subjects to experimental condition is done randomly.

*3.3. Unequal compensation due to chance*

Compensation may be tied to chance in many different ways. It may be tied to performance with different subjects performing slightly different tasks (perhaps due to deliberate randomization of task details). For example, the experimental task might be to decide, as quickly as possible, whether a string of letters constitutes a word in English. The strings of letters may be generated randomly, separately for each subject, in which case some subjects may, through bad luck, get more difficult strings to evaluate than other subjects. However, if each subject sees numerous such strings, the differences in compensation due to chance will be slight. The chance element should be pointed out to prospective participants as part of informed consent. More problematic is if subjects are assigned randomly into different groups, with some groups being compensated at a lower rate than others by design. To pursue the example above, there might be two experimental groups, with one group seeing long strings of characters, expected to be easier to recognize as a word or not, from shorter ones. Then, although every subject has an equal expected compensation before the study begins, they do not once they are assigned to an experimental group, and sizable differences in compensation among subjects arise which are not under their control. While such arrangements are not prohibited, they must be shown to be necessary, and subjects should be told of the differences in advance (as part of informed consent). Subjects should also be debriefed afterwards if there is any prospect of their learning of their compensation relative to others taking the study. In this way subjects who are poorly compensated know this was due at least in part to chance and to the design of the study, and not to their inability or to discrimination.

**4. Lotteries**

Some researchers wish to compensate participants using a draw or lottery, defined as a chance to win a substantial prize, instead of or in addition to giving every participant a smaller prize.

*4.1. Reasons given to use lotteries*

Researchers wishing to use lotteries as compensation have cited the following reasons.

Many potential participants would prefer a chance to win a sizeable prize rather than a small reward, such as a 1 in 100 chance at winning $100 rather than being paid $1 for sure. This preference is reflected in higher response rates, which makes the sample of respondents more representative of the population under study and thus improves the validity of the research.

It can be expensive to compensate every participant. For example, mailing $1 to every survey respondent costs more than 50 cents, raising the cost of compensation by more than 50 percent. It is much cheaper to mail a cheque to only one percent of all respondents. With surveys or experiments administered on-line, paying every respondent enough to induce an adequate response rate may encourage professional respondents, who seek to complete the study as quickly as possible, with no concern for the accuracy of their answers, in order to maximize their rate of compensation. They may defraud the researcher by completing the study multiple times using different on-line identities, receiving compensation each time.

Lotteries may be less likely to encourage such behaviours. Compensating every respondent turns every respondent into a paid participant. This can affect the respondents' attitudes in ways that are hard to detect or control for, threatening the validity of the

study. When participants are told, on the other hand, that they have a 1 in 100 chance of being compensated, they realize that they are very likely donating their time to the research, and the role of paid respondent is avoided.

A lottery may be necessary to study consequential choices. For example, studies of consumer behaviour often ask participants to make a series of choices among products that are described to them. If these products are inexpensive, then it is an easy matter to make such choices consequential without making use of a lottery. Subjects might be told that one of their choices will be chosen at random and they will be rewarded with a beverage (for example) that corresponds to their choice. Knowing this, subjects are motivated to make choices that are in line with their true preferences. No lottery is involved because every subject receives the same reward – a beverage of their choice. However, this practice can only be used to study choice for inexpensive products or services.

Lotteries are a natural means for making nontrivial choices consequential. In order to study choice among food blenders, for example, it is impossible to reward every participant with a food blender of their choice. However, choices can still be made consequential by telling them that 1 in 20 respondents will be selected at random, and each will receive the food blender they chose for a randomly selected choice. This is a lottery, because participants are not rewarded equally due to chance.

A researcher may be using a commercial panel of respondents, and such panels typically use lotteries as part of their compensation to panellists. A researcher may wish to study consumer behaviour in lottery or lottery situations.

*4.2 Legal issues pertaining to lotteries*

A lottery involving research subjects at a university does not constitute a gaming activity, as defined by section 207 of the federal *Criminal Code*. Alberta's *Gaming and Liquor Act* only requires licenses for gaming activities as defined by the *Code*. Thus no license is required.

*However, the lottery must not require subjects to pay money or other valuable consideration in order to participate. In addition, winning the lottery must be based on skill as well as chance.*

Thus, many lotteries require the participants to answer a skill-testing question in order to qualify for a chance to win the prize.

Under federal law, it is necessary that you answer a skill-testing question successfully in order to qualify for a chance to win the prize. If you wish to be considered for this prize, then please answer the following question. (Write your answer in the blank space provided.) (13 + 17) / 10 = ____.

This is only an example. It is not necessary (nor perhaps even desirable) to explain that the question is a legal requirement. Note that the question need not be very difficult by university standards. It would also be permissible, in a study that assesses subject performance in some manner (see Section 3.2, above), to require a minimal level of performance in the study to qualify for the lottery. Decision-making under risk, including gambling behaviour, is a legitimate subject of study.

However, such studies must comply with section 201 of the *Criminal Code*. Researchers requiring further information should contact the Research Ethics Office.

*4.3 Ethical issues*

A primary ethical concern is that lotteries exploit decision making weaknesses of prospective participants. In particular, potential respondents tend to focus on the size of the potential reward and give too little consideration to the small probability of winning the prize, thus constituting inducement or coercion. In addition, gambling is viewed as immoral by some prospective research participants.

*4.4. Minimum requirements for lottery incentives*

If lottery compensation is appropriate to the study, it should meet the following minimum requirements.

The ethics application must indicate why a lottery is being used instead of equal compensation (or no compensation) for every participant. The Research Ethics Board must be persuaded that the benefits of using the lottery outweigh ethical concerns.

The value of the prize should be given when recruiting participants and as part of informed consent. Under no circumstances should it be larger than $500.

The probability of winning the prize should be given when recruiting participants and as part of informed consent. This probability should be a round number, such as 1 in 100 and not .027. It should be easy for prospects to calculate in their heads the expected value of participating in the study.

To satisfy federal legal requirements, receipt of the prize must depend to some extent on skill.

If gaming behaviour is the subject of study, then participants must be told this as part of recruitment and informed consent. If the lottery is used solely as a means of compensation, then participants must be allowed to opt out of the lottery. However, even if participants withdraw from a study, they should remain in the lottery, if that is the compensation offered in that study.

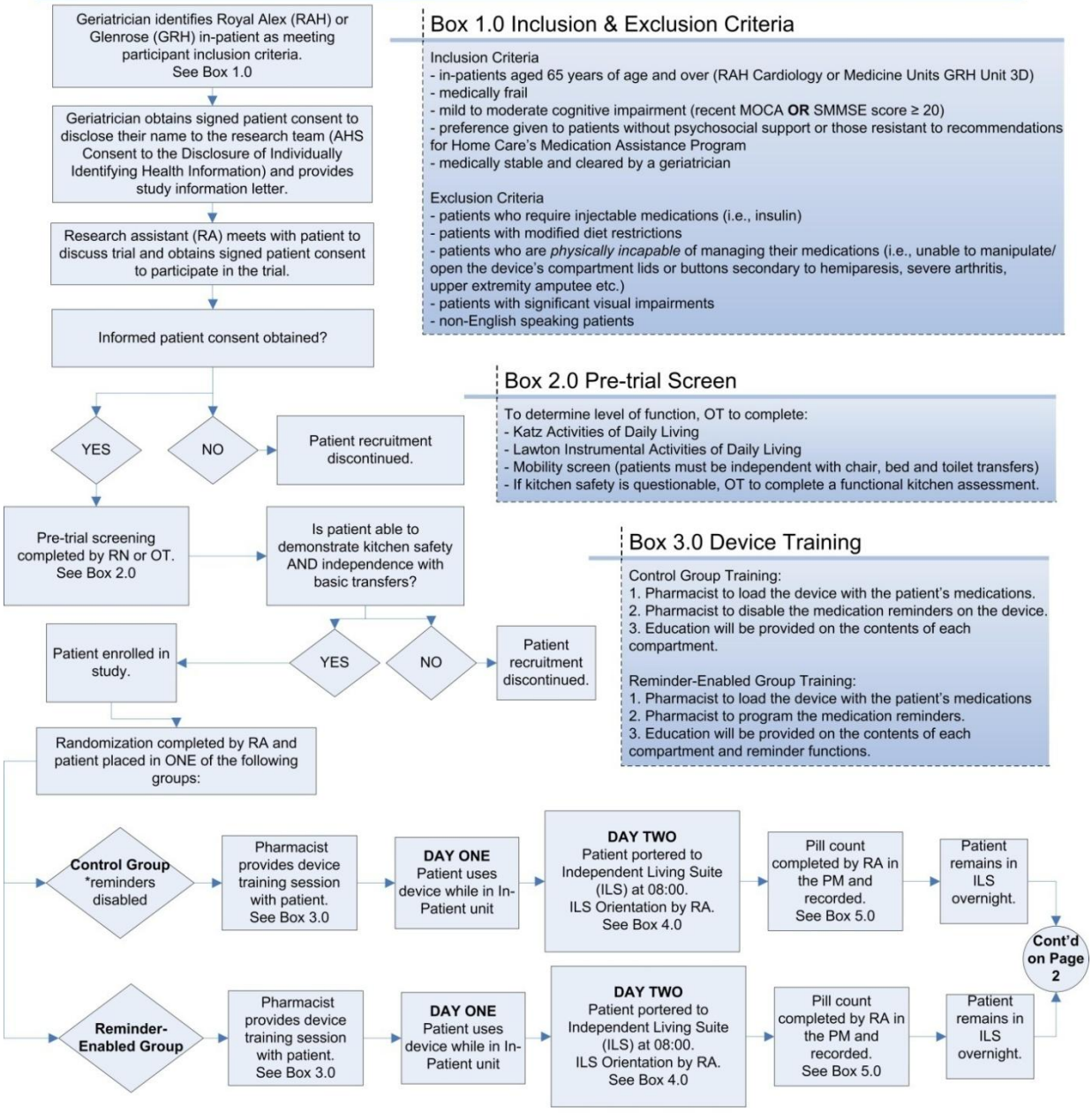
The number of prizes awarded must be equal to the probability of winning times the number of participants, with non-integer amounts rounded up to the next highest integer. That is, if the probability of winning a prize is given as 1 in 100, and there are between 401 and 500 participants, then exactly 5 prizes must be awarded. Note that this calculation is based on the total number of participants, not on the number of participants that satisfy any skill-testing requirements.

When practical, provide minimum compensation to every participant in addition to a lottery. This reduces the size of inequalities in compensation between participants due to chance.

Sometimes subjects are obtained using a service, or through another university, that uses lotteries that do not fulfill all of these requirements. Such cases are best decided on an individual basis. The research ethics application must indicate how the lottery's implementation departs from the minimum requirement given above.

## Appendix H: Proposed Randomize Control Trial Process Flows

hSITE Partnered Research Project: Linking Medication Monitoring to Hospital-Based Support
Process Flow (Updated: 11 February 2011)




## Box 1.0 Inclusion & Exclusion Criteria

Inclusion Criteria
- in-patients aged 65 years of age and over (RAH Cardiology or Medicine Units GRH Unit 3D)
- medically frail
- mild to moderate cognitive impairment (recent MOCA **OR** SMMSE score ≥ 20)
- preference given to patients without psychosocial support or those resistant to recommendations for Home Care's Medication Assistance Program
- medically stable and cleared by a geriatrician

Exclusion Criteria
- patients who require injectable medications (i.e., insulin)
- patients with modified diet restrictions
- patients who are *physically incapable* of managing their medications (i.e., unable to manipulate/ open the device's compartment lids or buttons secondary to hemiparesis, severe arthritis, upper extremity amputee etc.)
- patients with significant visual impairments
- non-English speaking patients

## Box 2.0 Pre-trial Screen

To determine level of function, OT to complete:
- Katz Activities of Daily Living
- Lawton Instrumental Activities of Daily Living
- Mobility screen (patients must be independent with chair, bed and toilet transfers)
- If kitchen safety is questionable, OT to complete a functional kitchen assessment.

## Box 3.0 Device Training

Control Group Training:
1. Pharmacist to load the device with the patient's medications.
2. Pharmacist to disable the medication reminders on the device.
3. Education will be provided on the contents of each compartment.

Reminder-Enabled Group Training:
1. Pharmacist to load the device with the patient's medications
2. Pharmacist to program the medication reminders.
3. Education will be provided on the contents of each compartment and reminder functions.

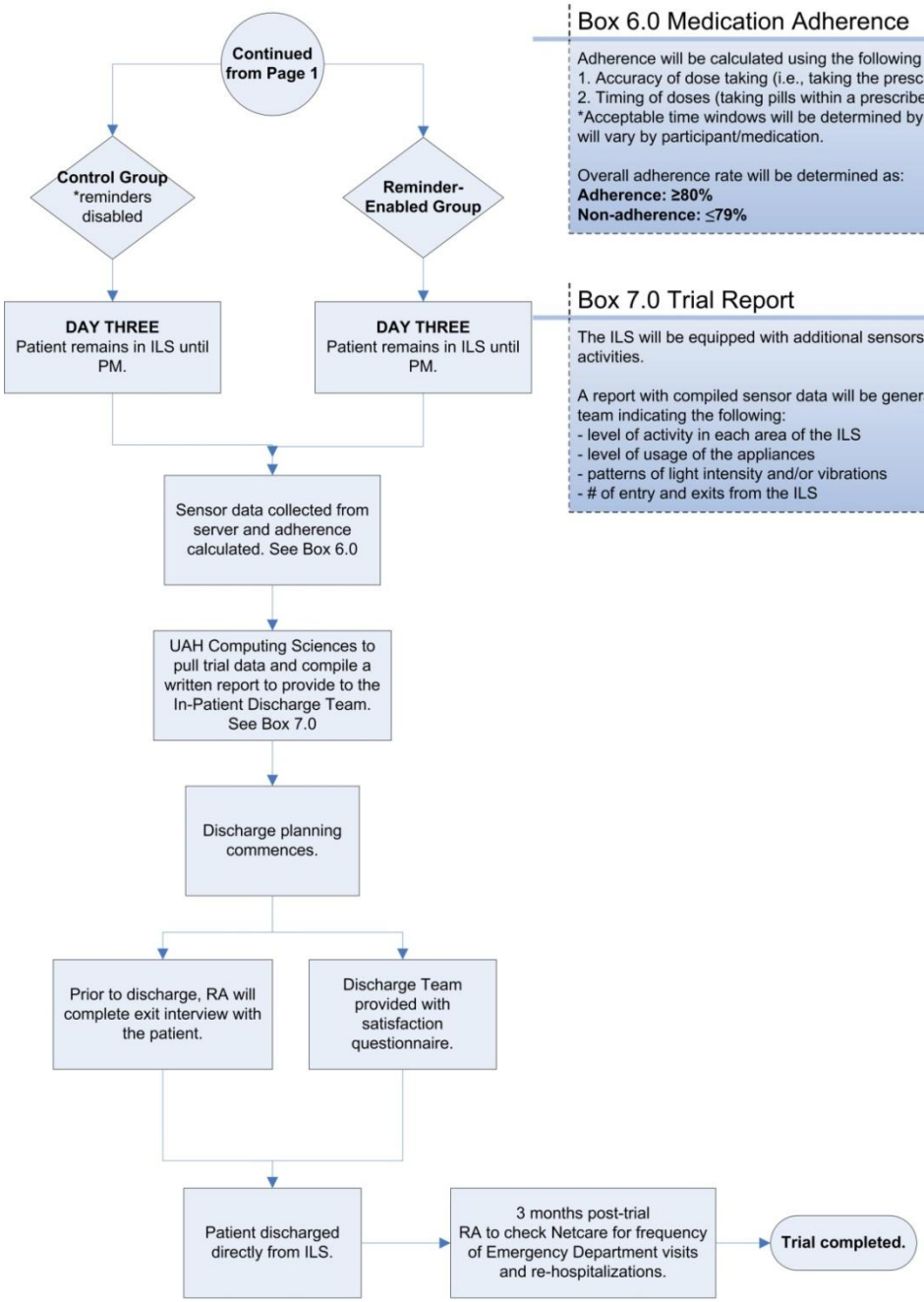
## Box 4.0 ILS Orientation

ILS Orientation will include:
- orientation the suite itself
- review of the food stocked in the ILS kitchen & Lifeline pendant
- explanation of the available GRH activities available to the participant
- 2nd review of medication adherence device usage

## Box 5.0 Pill Counts

Pill counts (recording the number of pills remaining in each compartment) will also be completed to verify that all medications were taken correctly.

hSITE Partnered Research Project: Linking Medication Monitoring to Hospital-Based Support
Process Flow




## Box 6.0 Medication Adherence

Adherence will be calculated using the following two variables:
1. Accuracy of dose taking (i.e., taking the prescribed number of pills each day)
2. Timing of doses (taking pills within a prescribed period of time).
*Acceptable time windows will be determined by the RAH pharmacist and will vary by participant/medication.

Overall adherence rate will be determined as:
**Adherence: ≥80%**
**Non-adherence: ≤79%**

## Box 7.0 Trial Report

The ILS will be equipped with additional sensors to track participant movement and activities.

A report with compiled sensor data will be generated and provided to the discharge team indicating the following:
- level of activity in each area of the ILS
- level of usage of the appliances
- patterns of light intensity and/or vibrations
- # of entry and exits from the ILS

**MATs Product Trial - Randomized Control Trial: Sample Size Calculation**

Taking the data from the paper by Hayes et al (2009) on total mean adherence in independently living healthy older adults, the minimum required sample size for an effect size = 2.69, alpha = 0.05 and study power = 0.80 is 4 participants per group (Hayes et al., 2009).

Given the heterogeneity of our trial participants, an additional 50% (n= 4) is taken into consideration to allow for mortality and attrition, for a total of 12 trial participants (control group n=6, treatment group n=6).

**Appendix I: MATs Product Trial Information Letter and Participant Consent Form**

**STUDY INFORMATION SHEET**

**Title:** Linking medication monitoring to hospital-based support

**Principal Investigator:**


- Lili Liu, PhD, Professor and Chair, Department of Occupational Therapy, University of Alberta. Phone: 780-492-5108


**Co-Investigators:**


- Eleni Stroulia, PhD, Professor, Computing Science, University of Alberta
- Ioanis Nikolaidis, PhD, Professor, Computing Science, University of Alberta
- Katherine Lechelt, MD, FRCPC, Department of Medicine, University of Alberta
- Cheryl Sadowski, Pharm.D., Associate Professor, Faculty of Pharmacy and Pharmaceutical Sciences, University of Alberta
- Adrian Wagg, MB, FRCP FHEA, Professor and Chair in Healthy Aging, Department of Medicine, University of Alberta
- Katie Woo BScOT(c), TeleGeriatrics Program Facilitator, Glenrose Rehabilitation Hospital. Phone: 780-735-6059


**Background:**

Older people can have a hard time remembering when to take their medicine. There are special pill boxes that can help people remember to take their pills. Researchers want to know if these pill boxes are useful for older people.

**Purpose:**

You are invited to be in a study. This research will tell us if this pill box can help older people remember to take your pills. Researchers also want to follow your activities within an apartment. They want to know if this information can help your doctor's team decide when you are ready to go home from the hospital.

**Procedure:**

You will be randomly assigned to one of two groups. Each group is using the pill box in a different way. Neither you nor your doctor can choose or know which group you are in. This "blinding" is necessary to test the special pill box. In an emergency, your doctor can find out what group you are in.

When you are almost ready to go home from the hospital, a therapist will work with you to find out how much help you need for making meals and getting around. A pharmacist will teach you how to use the pill box.

Next, you will spend two days in the Independent Living Suite at the Glenrose Hospital. This space is like an apartment with a kitchen, living room, bedroom and bathroom. An attendant will bring you to the apartment after breakfast. You will be able to stay in this space as if you are at home.

There is a TV, telephone and internet in the space. When you are hungry, there is food in the suite which you can prepare. You can leave the suite to go to the Glenrose cafeteria or sitting areas.

You can also make your meals and snacks. You will use the special pill box while you are in this apartment. You will sleep in this apartment overnight.

There will also be "sensors" placed in the kitchen and throughout the apartment. These sensors will tell us how you use the appliances and move about in the apartment. This information will be shared with your doctor and team. The trial ends on the second day after dinner and we will return you to your hospital bed.

A researcher will ask your doctor, nurses and therapists whether or not the information was useful to help them decide when you are able to go home. A researcher will also ask you about your experience with the special pill box.

**Possible Benefits:**

Your participation will help researchers learn if the special pillbox can help older people remember to take their pills. If they can take all of their medicines on time every day, they will be healthier. This information will also help your medical team to decide when you are ready to go home from hospital. You will receive a summary of the results when the research is finished.

**Possible Risks:**

There are no known risks if you participate. You will be required to wear a Lifeline pendant in case you need help. Medical staff will be nearby for emergencies. If you become sick or injured, the trial will be stopped immediately.

**Confidentiality:**

The research team will make every effort to keep your information private. All information given follows Alberta Health Services policies.

By signing, you give permission for the study staff to access any identifiable health information needed for the research. They may look at your past medical history and test results. The information collected will be kept confidential. It will be used only for this research study.

By signing, you give permission for the collection, use and disclosure of your medical records. A paper copy of the research will be stored in a locked filing cabinet in Corbett Hall. All electronic information will be on a secure computer at the University of Alberta. All records will be destroyed after seven years.

**Voluntary Participation:**
Participation is voluntary and you can stop anytime. Your medical care will not be affected if you choose not to participate.

**Contact Names and Telephone Numbers:**
If you have concerns about your rights as a study participant, you may contact the Research Ethics Office at (780)492-2615. This office has no affiliation with the study investigators.

If you have any questions or concerns you may also contact the individuals below:

- Gary Faulkner, Director of Research, Glenrose Rehabilitation Hospital; Phone: 780 735-6132
- Joanne Volden, Associate Dean, Graduate Studies and Research, Faculty of Rehabilitation Medicine, University of Alberta; Phone: (780) 492-9674

**PATIENT/CAREGIVER CONSENT FORM**

**PART 1**

Title of project: Linking medication monitoring to hospital-based support

**Principal Investigators:**

- Lili Liu, PhD, Professor and Chair, Department of Occupational Therapy, University of Alberta. Phone: 780-492-5108

**Co-Investigators:**

- Eleni Stroulia, PhD, Professor, Dept of Computing Science, University of Alberta
- Ioanis Nikolaidis, Professor, Dept of Computing Science, University of Alberta
- Katherine Lechelt, MD, FRCPC, Department of Medicine, University of Alberta
- Cheryl Sadowski, Pharm.D., Associate Professor, Faculty of Pharmacy and Pharmaceutical Sciences, University of Alberta
- Adrian Wagg, MB, FRCP FHEA, Professor and Chair in Healthy Aging, Department of Medicine, University of Alberta
- Katie Woo BScOT(c), TeleGeriatrics Program Facilitator, Glenrose Rehabilitation Hospital. Phone: 780-735-6059

| **PART 2** | YES | NO |
|---|---|---|
| Do you understand that you have been asked to be in a research study? | □ | □ |
| Have you read and received a copy of the attached Information Sheet? | □ | □ |
| Do you understand the benefits and risks involved in taking part in this research study? | □ | □ |
| Have you had an opportunity to ask questions and discuss this study? | □ | □ |
| Do you understand that you are free to withdraw from the study at any time without having to give a reason and without affecting your future medical care? | □ | □ |
| Has the issues of confidentiality been explained to you? | □ | □ |
| Do you understand who will have access to your records, including personally identifiable health information? | □ | □ |
| Who explained this study to you? | | |

I agree to take part in this study: YES □ NO □

Signature of research participant or agent: _____

(Printed Name): _____

Date (D/M/Y): _____

Signature of Witness: _____

I believe that the person signing this form understands what is involved in the study and voluntarily agrees to participate.

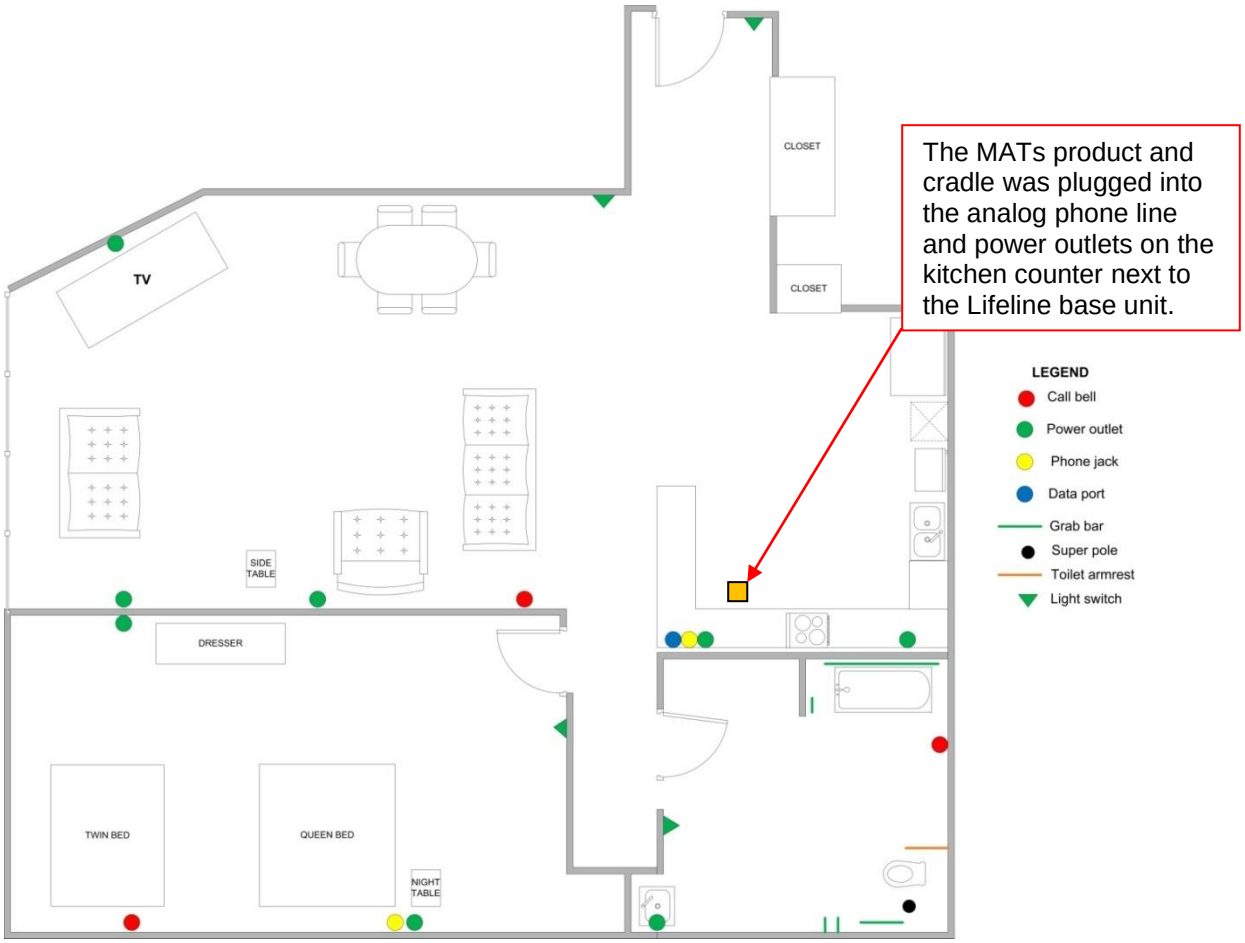
Signature of Investigator or Designee _____

Date (D/M/Y): _____

## Appendix J: Independent Living Suite Layout

**Independent Living Suite (ILS) Layout**

The ILS is an 802 sq ft. space equipped with a fully-stocked kitchen, standard bathroom, bedroom and living room. For safety measures, the ILS was equipped with three call bells, a Lifeline pendant/base unit and Nursing Unit 3A is located 15 feet away. A nursing station was located within twenty feet and on-duty nurses completed a visual inspection at shift change and responded to any patient concerns or emergencies.



## Appendix K: Independent Living Suite Orientation

**INDEPENDENT LIVING SUITE PATIENT ORIENTATION**

1. Location of the Independent Living Suite (Room 3048 GLENWEST)

2. Location of exits and elevator. Entrances to the building are open as follows:
   - Main Entrance: 5:00 AM to 11:00 PM. Telephone outside main entrance (white box) for access after 11:00 PM.
   - Parkade Entrance: 07:00 AM to 11:30 PM.
   - Auditorium Entrance: 06:30 AM to 09:00 PM

3. Independent Living Suite telephone number: 780-7999 ext 15501.
   - To make outside calls, dial 9 before the telephone number.

4. Alcoholic beverages and smoking are not permitted in the suite.

5. Use of appliances, equipment in the ILS (e.g., microwave, alarm clock).

6. Unless otherwise advised, the residents are responsible for:
   a) Washing dishes:
      - Placing dishes in dishwasher and running the cycle during admission and prior to moving out of the ILS;
      - Wiping appliances; making the bed; general tidying of the ILS; cleaning of the tub, toilet and sick when required; vacuuming as needed.

   b) Laundry of hospital linen:
      - Towels are to be placed in the hospital laundry bag;
      - Strip sheets off the bed when moving out of the ILS and place them in the Occupational Therapy laundry basket in the bedroom.

   c) Laundry of personal items:
      - Laundry facilities are available in Room 3036 (towards Unit 3D);
      - Hospital towels should be put in the laundry hamper provided;
      - Bed linen must be stripped from the bed prior to vacating the ILS.

   d) Food:
      - All perishables must be removed either by throwing them out or taking them home at the end of the assessment period;
      - The research assistant should be informed of any depleted staples.

7. The Independent Living Suite is equipped with a wireless sensor network.
   - Motion sensors: there are motion sensors in each room to detect when a person is in the room;
   - Electricity sensors: each of the appliances in the kitchen is attached to an electricity sensor to detect when the appliance is turned on;
   - Switch sensors: some of the doors and cupboards have sensors to detect when a door is opened;
   - Pressure sensors: the chairs and bed have a pressure sensor to detect when a person is seated;
   - Noise sensors: there are sensors which can detect sound BUT cannot record actual conversations;
   - Medication sensor: there is a product which can sense when you open and close each pill compartment.

There are NO video cameras and your image will not be transmitted.

**FIRE PROCEDURE**

A. FIRE DRILL IN HOSPITAL

(e.g., announcement will say "Code Red, Glenwest Room ___")

1. Ensure all room doors are closed.
2. Wait inside the room.
3. A staff member from Unit 3A will check on you.
4. When "Code Red is now over" is announced, you may resume your activities.

B. FIRE IN THE INDEPENDENT LIVING SUITE

1. If a fire starts in the Independent Living Suite, try to control the fire if you can. For example, if it is a frying pan fire: take the pan off the burner and put a lid on the frying pan.
2. Ensure all room doors are closed and leave the suite.
3. Activate the fire alarm located in the hall across from the ILS and wait outside the suite. DO NOT RE-ENTER THE SUITE.
4. A staff member from Unit 3A will come directly to assist you.

**EMERGENCY**

Nurse call bells are located in the bathroom, bedroom and living room. These are connected to Unit 3A. Help is available 24 hours per day.

I understand the above procedures for the Independent Living Suite and am aware that the supervision will be periodic. I have received a key for my exclusive use during the assessment.

| | |
|---|---|
| X _____ | X _____ |
| Patient Signature | Witness |
| Date | Date |

## Appendix L: Participant Exit Interview

**Linking Medication Monitoring to Hospital-Based Support Study**

**Exit Interview with trial participants**

Instructions: This interview should be conducted face-to-face with the client after the Independent Living Suite (ILS) trial. Questions may be addressed to the client with the assistance of informal caregivers or relatives who know the client.

Client's Study Code: _____ # of days in ILS: _____

Client name: _____ Interviewer: _____

Date interview completed (D/M/Y): _____

1. What is your age category? □ 65-75 □ 76-85 □ 85+

2. Gender: □ Male □ Female

3. Number of members in your household? □ 1-2 □ 3-4 □ 5-6

4. What is your current living arrangement?

□ live with spouse
□ live with spouse and child(ren)
□ live with child(ren) and no spouse
□ live alone
□ other, describe: _____

5. Describe your housing:

□ private detached house
□ condominium
□ apartment rental
□ retirement community
□ seniors lodge
□ group home
□ other, describe: _____

6. How do you currently do these activities at home?

| | Without help | With some help | Completely unable to do it | Comments |
|---|---|---|---|---|
| Use the telephone | | | | |
| Shopping | | | | |
| Make meals | | | | |
| Housekeeping | | | | |
| Laundry | | | | |
| Manage medications | | | | |
| Manage money | | | | |

7. Describe your experience with the Medication Adherence Product:

| | **Strongly Disagree** | **Disagree** | **Neutral** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|---|
| The lids were easy to open | | | | | |
| The buttons were easy to press | | | | | |
| I was able to hear the beep | | | | | |
| I was able to hear the voice messages | | | | | |
| I was able to see the flashing light | | | | | |
| I knew which compartment to open | | | | | |
| The display was easy to read | | | | | |
| The text messages were helpful | | | | | |
| I liked the size of the product | | | | | |
| If a friend were in need of similar help, would you recommend this product to him or her? | | | | | |
| It was important to me to take my medications correctly | | | | | |
| I would keep the product if possible | | | | | |

Comments on the medication adherence product:

7. What did you like BEST about the Medication Adherence Product?

8. What did you like the LEAST about the Medication Adherence Product?

9. Overall, how would you consider your health to be?

□ Excellent □ Very Good □ Good □ Fair □ Poor

10. How many medications do you currently take?

11. If your medications could be monitored using this product, you would feel:

a. More independent? □ YES □ NO
b. Safer? □ YES □ NO
c. Peace of mind? □ YES □ NO

12. Would you pay a monthly fee for this service?

□ YES □ NO

13. If yes, what amount would you pay to have your medications monitored?

□ $50 per month
□ $40 per month
□ $25 per month
□ $10 per month

14. Do you think that another organization should pay for this service?

□ YES □ NO

15. If yes, which organization should pay for this?

_____

16. Do you have any other comments?

_____

_____

_____

## Appendix M: MATs Product Trial Report

**hSite – Independent Living Suite (ILS) Trial Report**

**Participant number: hSite 01**
**Trial start date & time: Saturday July 30th 2011 09:30 AM**
**Trial end date & time: Sunday July 31st 2011 6:30 PM**

**Medication schedule tracked:**

| | Electronic Alerts Programmed | Therapeutic Window | Percentage of Times Pills Taken Within Schedule Limit |
|---|---|---|---|
| **Hydrochlorothiazide** | 09:00AM | ± 1 hour | 100% |
| **Vitamin D** | 09:00AM | ± 1 hour | 100% |
| **Altace** | 09:00AM | ± 1 hour | 100% |
| **Pantoprazole** | 09:00AM | ± 30 minutes | 100% |
| **Multivitamin** | 09:00AM | ± 1 hour | 100% |
| **Celebrex** | 09:00AM & 6:00PM | ± 30 minutes | 100% |
| **Calcium** | 09:00AM & 6:00PM | ± 30 minutes | 100% |
| **Tylenol** | 09:00AM, 12:00PM, 6:00PM & 09:00 PM | ± 1 hour | 100% |

**Overall Medication Adherence Rate*: 100%**

**Medication adherence rate is calculated as the percent in which the patient opened the correct bin of the medication adherence device within the pre-stated therapeutic window.*

**Comments:**

- Average response time to taking the pill (i.e., opening the bin compartment) after the electronic alert activated was **1 minute.**
- Therapeutic windows determined by GRH pharmacy.
- Patient's two inhalers were not tracked for adherence.
- Pill count at the end of each day verified accuracy.
- Patient was unaware that she was on Altace in hospital and unsure of medication's purpose.
- Patient reported difficulties opening the medication adherence device and had issues hearing the voice alerts. Patient had no issues with hearing the audible beeps.
- Patient currently uses a dosette at home.

**SUMMARY OF PATIENT ACTIVITY**

# of times Lifeline activated: **0**
# of times call bell activated: **0**
# of times patient left the suite: **0**
Times patient was checked on by research assistant or GRH staff:

- July 30th 2011: 12:25PM, 5:26PM
- July 31st 2011: 8:31AM, 12:30PM, 6:00PM

**MEAL MANAGEMENT***

***** Sensor data correlated with information from the grocery list, research assistant's patient checks and patient self-report.

Patient independently prepared the following meals unless otherwise noted:

| | |
|---|---|
| **SATURDAY July 30th 2011** | |
| **11:16 AM** | Coffee maker activated and was left on warming function until **1:08 PM** (auto-shut off). |
| **12:06 PM** | Toaster activated. Patient independently prepared a buttered toasted multi-grain bagel, yogurt and strawberries for lunch. |
| **4:54 PM** | Coffee maker activated and was left on warming function until **6:51PM** (auto-shut off). |
| **5:20 PM** | Patient called research assistant. Research assistant's observations: Patient was unsure of how to use digital oven to bake a frozen meal (fish and chips). Research assistant reviewed oven use. With cueing, patient able to turn on and pre-heat oven to 450 degrees. Patient independently opened package, placed meal on aluminum lined cookie sheet and placed in oven. Patient able to read the directions on the package and checked on the meal 15 minutes later without cueing. Patient followed recommended cooking time and remembered to pull out the meal 10 minutes later. Patient able to reach into oven and remove meal independently. Required additional teaching on how to turn off the stove. |
| **9:18 PM** | Microwave activated for 1.4 min. |
| **SUNDAY July 31st 2011** | |
| **7:34 AM** | Coffee maker activated and left on warming function until **09:32AM** (auto-shut off). |
| **8:01 AM** | Toaster activated. Patient had a toasted multi-grain bagel and yogurt for breakfast. |
| **11:05 AM** | Microwave activated for 1.3 min. |
| **12:17 PM** | Toaster activated. Patient had a toasted multi-grain bagel for lunch. |
| **12:18 PM** | Microwave activated for 1.4 min. |
| **5:20 PM** | Microwave activated for 2.5 minutes to heat up frozen tv dinner. |
| **5:25 PM** | Microwave activated for 1.5 additional minutes. Likely frozen dinner was not cooked through yet. |
| **5:30 PM** | Patient reports she independently cooked remaining 2 pieces of frozen fish in the oven. Patient did not require assistance from the research assistant to turn on or off the digital oven. |

**Comments:**

- Fridge was opened **20 times**.
- Freezer was opened **9 times.**
- Dishwasher opened **1 time for 6 seconds.** **Patient likely was just looking at the dishwasher. Patient hand-washed all dishes independently and returned them to the cupboard.*
- Cupboards and drawers in the kitchen were opened **61 times.**
- Motion activity suggests that patient stayed either in or near the kitchen when the kitchen appliances were activated.
- Grocery list was developed by the patient. Additional items on the list included: one tomato and 2 pieces of carrot cake.

**TOILETING**

**7 toileting events** recorded on **Saturday July 30th 2011 between 11:24 AM and 10:36 PM.**

- Actual times recorded on Saturday: 11:24AM, 2:07PM, 3:38 PM, 4:52PM, 6:04PM, 9:07PM, 10:32PM

**9 toileting events** recorded on **Sunday July 31st 2011 between 1:45 AM and 5:11 PM.**

- Actual times recorded on Sunday: 1:53AM, 3:45AM, 7:28AM, 7:56AM, 9:58AM, 12:55PM, 2:53PM, 4:23PM, 5:11PM.

**Comments:**

- Average time spent sitting on the toilet: **4 minutes.**
- Maximum time spent sitting on toilet: **8 minutes and 20 secs.**
- Lighting sensors indicate that during the day time patient would turn **OFF** the bathroom light after use. The sensors also indicate that the patient leaves the bathroom light **ON** throughout the night, likely to illuminate the pathway to the bathroom from the bedroom.
- Sensors suggest that on average, patient spends more time sitting on the toilet at night time than during the day.
- Motion at the sink immediately after each toileting event suggests the patient washed her hands 87.5% of the time after toileting.
- Patient stated the diuretic increased the frequency of toileting while in hospital.

**BED**

Patient went to bed at **10:36 PM on Saturday** and woke up at **7:19 AM on Sunday** morning.
Total time spent in bed during the night: **8.0 hours**

**Comments:**

- Of these 8 hours, patient got up 4 times to go to the bathroom and the periods of **uninterrupted** sleep are distributed as follows: 3.25 hours, 1.5 hours, 2 hours and 1.25 hours.
- Bed sensors were not triggered during the daytime which suggests that patient did not take a nap in bed.

**TELEVISION**

| **Saturday July 30th 2011** | |
|---|---|
| **10:38 AM** | Television turned on |
| **10:20 PM** | Television turned off |
| **Sunday July 31st 2011** | |
| **07:34 AM** | Television turned on |
| **08:33 AM** | Television turned off |
| **9:07 AM** | Television turned on |
| **5:32 PM** | Television turned off |

**CHAIR DATA**

The patient sat on the following chairs for meals, to use the phone, watch tv or to nap:

- white armchair 1: **40 minutes**
- white armchair 2: **57 minutes**
- kitchen chair by the phone: **198 minutes or 3.3 hours**
- burgundy lift chair: **480 minutes or 8 hours**

**Comments:**

- Patient would also periodically sit on her 4 wheeled walker but these occurrences could not be tracked.

**ADDITIONAL COMMENTS**

- Patient was groomed and dressed at each patient check.
- Patient required assistance from the research assistant to don the knee brace on Sunday. Patient did not wear the knee brace on Saturday.

All sensor events are also displayed in an electronic timeline, to access go to:
https://smartcondo.ca/ILS/p1/
Username: **ils_p1**
Password: **921642396**

# hSite – Independent Living Suite (ILS) Trial Report

**Participant number: hSite 02**
**Trial START: Thursday September 29th 2011 08:45 AM**
**Trial END: Friday September 30th 2011 06:00 PM**

**TRIAL SYNOPSIS:**
This patient was admitted into the ILS for a 32 hour period. During this period, he was able to achieve a 90% adherence rate to his medication regimen with the assistance of electronic reminders. Although we are unable to comment on his medication taking abilities without reminders, this trial suggests that electronic reminders could potentially ensure that medications are taking within 30 minutes of the prescribed time.

This patient was also able to independently prepare basic meals without a safety incident. He did find it useful to sit on a stool for meal preparation. This patient did choose to shower and completed a standing tub transfer with the assistance of bathing aids. He did report that this was tiring and sensor activity indicated that he went back to bed afterwards to rest. One episode of urinary incontinence was reported in the night time. Overall, the trial was completed without any safety incidents and the patient is open to having a bath chair and Lifeline system at home. Additional details obtained from the medication adherence product, sensor network and patient checks are summarized below.

## PRE-TRIAL ASSESSMENTS

| Assessment | Date | Score |
|---|---|---|
| MMSE | 16Sept2011 | **26/30** |
| Katz Index of Independence in Activities of Daily Living | 26Sept2011 | **4/6** *(2 points lost on Bathing & Continence)* |
| The Lawton Instrumental Activities of Daily Living | 26Sept2011 | **7/8** (*1 point lost on Food Preparation)* |

## MEDICATION ADHERENCE

| | Electronic Alerts Programmed | Therapeutic Window | % of Times Pills Taken Within Schedule Limit |
|---|---|---|---|
| **Norvasc** | 9:00 AM | ± 30 minutes | 100% |
| **Atacand** | 9:00 AM | ± 30 minutes | 100% |
| **Bisoprolol Fumarate** | 9:00 AM | ± 30 minutes | 100% |
| **Calcium** | 9:00 & 6:00 PM | ± 30 minutes | 100% |
| **ASA** | 9:00 AM | ± 30 minutes | 100% |
| **Flomax** | 9:00 AM | ± 30 minutes | 100% |
| **Prednisone** | 9:00 AM | ± 30 minutes | 100% |
| **Senokot** | 9:00 PM | ± 30 minutes | **0%** |
| **Vitamin D** | 9:00 AM | ± 30 minutes | 100% |
| **PEG Packet** (not included in medication adherence product) | Patient to take as needed, 4 packages left with patient at start. | | 1 package taken on Sept 29th 2011, 3 remained intact. |

**Overall Medication Adherence Rate*: 90%**
**Medication adherence rate is calculated as the percent in which the patient opened the correct bin of the medication adherence product within the pre-stated therapeutic window.*

**Comments:**
- The medication adherence product would provide audible (i.e., beeping and visual prompts) and visual alerts (i.e., flashing light) for each dosage time.
- Therapeutic windows determined by GRH pharmacy and pill counts verified accuracy.

- Patient practiced using the product at bedside on Wednesday September 28th 2011 for 24 hours prior to entering the ILS.
- **Non-adherence with Senokot.** Medication adherence product indicates that this medication was taken only once on **September 30th at 7:20AM**. Pill count revealed 2 Senokot pills were left in the product at the end of the trial.
- Average response time to taking a pill (i.e., opening the bin compartment) after the electronic alert activated was **11 minutes.**
- Patient stated he had no issues with hearing the audible beeps but could not clearly hear the verbal prompts.

**SUMMARY OF PATIENT ACTIVITY**

# of times Lifeline activated: **0**
# of times call bell activated: **0**
# of times patient left the suite: **4** *(to attend therapy at 11:30 and 2:00 PM each day)*

**Thursday September 29th**

- The patient left at **11:35 AM** and came back at **12:05 PM**, time spent away: **30 min**.
- The patient left at **13:58 PM** and came back at **15:14 PM**, time spent away: **1 h 15 min**.

**Friday September 30th**

- The patient left at **11:20 AM** and came back at **12:01 PM**, time spent away: **41 min**.
- The patient left at **13:52 PM** and came back at **15:01 PM**, time spent away: **1 h 8 min**.

# of times patient was checked on by research assistant or GRH staff: **4 per day** *(average 15 minutes/visit)*
# of visits by family while in the suite: **3 visits in total** *(average 45 minutes/visit)*

**MEAL MANAGEMENT****
*******Sensor data correlated with information from the grocery list, research assistant's patient checks and patient self-report.*

| **Thursday September 29th 2011** | |
|---|---|
| **8:38AM** | Coffee maker activated and was left on warming function until **10:37AM** (auto-shut off). |
| **9:03AM** | Stove activated. Patient pan-fried bacon and two eggs. |
| **9:35AM** | Microwave activated. Patient was preparing macaroni and cheese in advance for lunch and dinner. Patient cooked the pasta for 2 minute intervals, checking in-between for a total of 8.1 minutes. |
| **5:04PM** | Coffee maker activated and was manually shut off by the patient at **5:10PM.** |
| **4:48PM** | Microwave activated. Patient cooked a piece of chicken and warmed up his macaroni and cheese for a total of 12 minutes. |
| **Friday September 30th 2011** | |
| **7:09AM** | Coffee maker activated and left on warming function until **9:15AM** (auto-shut off). |
| **7:12AM** | Toaster activated. Patient had 2 pieces of toast and yogurt for breakfast. |
| **12:08PM** | Microwave activated. Patient cooked a 2nd box of macaroni and cheese for 2 minute intervals, checking in-between for a total of 8.1 minutes. For lunch, patient had macaroni and cheese, a can of tuna, canned peaches, cranberry juice and coffee. |
| **12:13PM** | Coffee maker activated and left on warming function until **2:12PM** (auto-shut off). |
| **5:02PM** | Coffee maker activated and was manually shut off by the patient at **6:09PM.** |

**Comments:**

- Patient independently prepared all of the following meals.
- Patient was able to operate all of the appliances independently (required a quick demo on microwave use at the beginning of the trial but otherwise did not ask for assistance in using appliances).
- Fridge was opened **32 times****.
- Freezer was opened **0 times.**
- Dishwasher opened **0 times.** Patient independently hand-washed all dishes at the sink**.**

- Cupboards and drawers in the kitchen were opened **87 times*.**
  ***This may include visitor activity (i.e., daughter opening the cupboards during her visit).***
- Motion activity suggests that patient stayed in the kitchen when the stove, microwave or toaster was activated.
- Patient found the stool in the kitchen useful to sit on for meal preparation.
- Grocery list was developed by the patient and included: macaroni and cheese, cottage cheese, yogurt, cranberry juice, apples, peaches and milk. Patient did not want any fresh or canned vegetables.

**TOILETING AND BATHING**

**A total of 16 toileting events were recorded.**

**6 events recorded on Thursday September 29th 2011 between 08:00AM-12:00AM.**

- Actual times recorded on Thursday: 08:46AM, 12:08PM, 4:24PM, 8:14PM, 11:20PM and 11:26PM.

**10 events recorded on Friday September 30th between 12:00AM and 6:15PM.**

- Actual times recorded on Friday: 1:23AM, 2:48AM, 6:45AM, 7:39AM, 8:49AM, 9:09AM, 10:58AM, 3:30PM, 4:06PM and 6:14PM.

**The humidity and motion sensors indicated that the patient showered independently on September 30th 2011 at 6:25AM.**

**Comments:**

- Patient reports an episode of urinary incontinence at night time where he subsequently washed his pyjamas in the sink and hung them to dry in the bathroom.
- Lighting sensors indicate that the patient would use the bathroom light for each toileting event even during night time.
- Motion at the sink immediately after each toileting event suggests the patient washed his hands **73%** of the time after toileting.
- A bath chair, tub grab bar and bathmat were used for the shower. Patient stated that he found the bath chair useful and would be open to having one at home.

**MOBILITY**

An accelerometer was attached to the patient's 4 wheeled walker and the usage times recorded are as follows:

| **Thursday September 29th 2011** | |
|---|---|
| **Time Period** | **Motion detected** |
| Between 9:00-12:00 PM | 4 minutes and 2 seconds |
| Between 12:00-4:00 PM | 18 minutes and 14 seconds |
| Between 4:00 – 5:30 PM | 8 seconds |
| **Friday September 30th 2011** | |
| **Time Period** | **Motion detected** |
| Between 6:00-9:00 | 36 seconds |
| Between 9-12:00 PM | 4 minutes |
| Between 12:00-4:00 PM | 13 minutes and 32 seconds |

**Comments:**

- Overall, patient used his walker minimally in the suite.
- No motion with the walker was detected during night time and suggests the patient did not use his walker to go to the bathroom.
- Majority of the time the walker was in motion was when it was used to travel from the Independent Living Suite to the 11:30 and 2:00PM therapy sessions on the 4th floor.

**BED**

The patient went to bed at **8:16PM on Thursday night** and woke up at **6:06AM on Friday morning.**
Total time spent in bed during the night: **9 hours and 10 minutes.**

**Comments:**

- Of these 9 hours, patient got up 3 times to go to the bathroom and the periods of **uninterrupted** sleep intervals are distributed as follows: 3h 1min, 1h 53min, 1h 14min and 3h 2min.
- The patient returned to bed on **Friday morning from 7:55AM to 8:23AM (28 minutes) to rest**. He stated he had a restless night and was tired from showering and making breakfast.
- The patient returned to bed again **Friday afternoon from 3:36PM to 4:03PM (27 minutes) to rest again after therapy.**

**TELEVISION**

| **Thursday September 29th 2011** | | **Minutes** |
|---|---|---|
| Time periods TV is turned on | **10:05AM to 11:28AM** | 83.5 |
| | **1:20PM to 1:33PM** | 13.2 |
| | **3:27PM to 8:12PM** | 285.4 |
| **Friday September 30th 2011** | | |
| Time periods TV is turned on | **8:24AM to 10:55AM** | 151.1 |
| | **3:02PM to 3:27PM** | 24.8 |
| | **4:09PM to 4:11PM** | 1.9 |
| | **4:28PM to 5:54PM** | 85.6 |
| | **Total time watching TV** | **645.38min (10h 45min)** |

**Comments:**

- Patient did not have issues operating the remote control.

**CHAIR DATA**

The patient sat on the following chairs for meals, watch TV or prepare meals (i.e., stool):

| **Chair** | **Location** | **Total time spent in this chair** |
|---|---|---|
| Burgundy lift chair | Living room | 464 minutes (7h 44min) |
| White armchair | Living room | 11 minutes |
| 2 chairs by the dining table | Living room | 71 minutes |
| Stool | Kitchen | 60 minutes |
| | **Total time seated** | **606 minutes (10h 6min)** |

**Comments:**

- Patient was able to complete independent chair transfers in all of the chairs listed above (i.e., no complaints of seat height and did not utilize the mechanical lift function on the lift chair etc).

**ADDITIONAL COMMENTS**

- Patient was groomed and dressed at each patient check.
- Patient indicated that he would like to pursue installing Lifeline when he returns home. His daughter, Lois, indicated she would like the Lifeline contact information.

All sensor events are also displayed in an electronic timeline, to access go to:
Website: https://smartcondo.ca/ILS/p2/
Username: **ils_p2**
Password: **921642396**

## Appendix N: Health Care Provider Evaluation

**Linking Medication Monitoring to Hospital-Based Support Study**

**Healthcare Provider Questionnaire**

Instructions: You are invited to participate in this study by completing this questionnaire. As a healthcare provider involved with this client's discharge planning, your feedback and comments are needed to complete the study. Your participation is voluntary. Completion of this questionnaire implies that you give consent to the research team to include your data in the analyses of the results. Your identity will be kept confidential and no one other than the University of Alberta researcher (Dr. Lili Liu) and her research assistant will have access to the questionnaires. Only aggregate data will be reported in any publication or presentation of the research findings.

Client's Study Code: Date (D/M/Y):

Your professional designation (i.e., physician, RN, OT, SW, etc):

| | **Strongly Disagree** | **Disagree** | **Agree** | **Strongly Agree** |
|---|---|---|---|---|
| **1. The Independent Living Suite (ILS) report is easy to read and interpret.**<br>Comments: | 1 | 2 | 3 | 4 |
| **2. The ILS report provided additional information regarding the patient's ability to manage their medications.**<br>Comments: | 1 | 2 | 3 | 4 |
| **2. The ILS report provided additional information regarding the patient's ability to manage their activities of daily living (ADLs).**<br>Comments: | 1 | 2 | 3 | 4 |
| **3. The ILS report assisted with our discharge recommendations.**<br>Comments: | 1 | 2 | 3 | 4 |

| | | | | |
|---|---|---|---|---|
| | | | | |
| **4. The ILS trial increased the patient's insight regarding his/her abilities to manage his/her medications and ADLs.**<br><br>Comments: | 1 | 2 | 3 | 4 |
| **5. The ILS report would have been more useful if it included the following information:**<br><br>●<br><br>●<br><br>● | | | | |
| **6. I accessed the electronic timeline (listed at the end of the report).** | **YES** | **NO** | | |
| **7. If yes, I found the electronic timeline provided useful information.** | **YES** | **NO** | | |
| **8. Additional comments or suggestions:** | | | | |