ABSTRACT

Title of Thesis:	APPLICATION OF DIFFUSION OF INNOVATIONS: A DESCRIPTIVE PILOT STUDY ON THE PERCEPTIONS OF HOME MONITORING SYSTEMS BY ADULTS 45 TO 64 YEARS OF AGE
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Background: Improving the function and quality of life of older adults is a key objective identified in *Healthy People 2020*. Prevention efforts that address the needs of older adults while respecting their desire to remain independent are critical towards meeting this objective. Home monitoring systems (HMS) are a relatively new consumer health technology product that holds promise in enabling independence among seniors in their homes by delaying admittance into institutionalized settings and yet it struggles with low adoption rates in the consumer market. The purpose of this pilot study was to detect and measure the anticipated innovation attributes of HMSs to inform its positioning and promote faster diffusion rates by describing potential adopters among adults 45 to 64 years of age. **Methods:** An existing survey was modified to collect perceptions of three anticipated attributes of innovation as they relate to the intention of adopting an HMS as a preventive health behavior. The survey modification was theoretically based on the Diffusion of Innovations (DOI) piloted among residents of Chevy Chase and Bethesda, Maryland (*N*=71). Logistic regression and Pearson correlation analyses were used to detect evidence to support whether perceived relative advantage, compatibility and

complexity and demographic variables were associated with the intention to adopt an HMS in the future. **<u>Results:</u>** Majority of participants were highly educated, perceived themselves to be in very good health, were or had been caretakers and intended to adopt an HMS in the future. Evidence was found supporting the DOI variables were positively correlated with the intention to adopt an HMS at statistically significant levels ($p < .01$ and $.05$). However, high ORs and wide 95% CIs caution the use of these variables as precise predictors of innovativeness and small sample size inhibits the interpretation that a pure statistical relationship exists. Additional findings included the potential of using caretaker status as a predictive variable and purchasing an HMS directly from the manufacturer emerged as an insight into consumer behavior. **<u>Conclusion:</u>** Findings from this study can help us understand how assistive technologies like HMSs are perceived and describe characteristics of early adopters. These preliminary insights can inform future research and improve efforts to encourage faster rates of adoption, particularly in the consumer marketplace where rapid diffusion of promising technologies can have the greatest impact on improving health outcomes for a new aging population.

APPLICATION OF DIFFUSION OF INNOVATIONS: A DESCRIPTIVE PILOT
STUDY ON THE PERCEPTIONS OF HOME MONITORING SYSTEMS BY
ADULTS 45 TO 64 YEARS OF AGE

by

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TABLE OF CONTENTS

Tables

Figures

Chapter 1: Introduction

PROBLEM STATEMENT

As documented in *Healthy People 2020,* a key topic area that is worthy of the

nation's focused attention is to improve the "health, function, and quality of life of older

adults" (HealthyPeople.gov, 2020 Topics & Objectives, Overview tab). Playing an

increasingly significant role in quality of life is the adequate provision of long-term

services and supports (LTSS), which include the support that older adults need to

perform activities of daily living (ADLs) for sustained periods of time (90 days or more)

in order to remain independent in their homes as they age (Kassner, 2011).

Prevention objectives that address the shortage of LTSS for older adults with

disabilities can increase their confidence in managing chronic conditions and decrease

"functional limitations" while also reducing the substantial burden that unpaid caregivers

bear when taking care of an older loved one. Reducing the proportion of older people

and caregivers who have unmet needs for LTSS are part of the 10-year targets that

would enable more Americans to maintain their independence while delaying premature

admittance to institutionalized care (HealthyPeople.gov, 2020 Topics & Objectives,

Objectives tab).

In a widely cited AARP (formerly known as the American Association of Retired

Persons) survey, 89% of Americans age 50 years and older want to "remain in their

homes indefinitely" and 85% would want to at least remain in their community if they

are unable to remain independent in their homes (AARP, 2005, p. 1). Unfortunately,

many Americans are also ill-prepared to remain in their homes should a health event

occur that impairs their ability to execute ADL's like moving from room to room, eating, dressing, bathing and toileting. In a 2009 study on health behavior and perceptions on healthy aging, researchers found that although people placed a high value on healthy aging, they rarely took action to encourage it (Deeks et al., 2009). An example of inaction was found in an earlier study where less than half of elderly households have made any home modifications that would enable them to safely remain in their homes longer (Kochera, 2002). Instead, people wait and are often reactive to events such as when a fall occurs, which may be too late to prevent the downward spiral in health status that threatens their ability to remain independent in their homes. Accidents such as falls can often lead to premature admission into long-term care facilities such as assisted living or nursing homes (Wiener et al., 1990) and up to 30% of those who fall suffer from injuries which can increase their risk for early death (Centers for Disease Control and Prevention, 2011).

A critical first step towards delaying institutionalization by promoting greater independence at home is to increase the awareness of personal risk factors. Increased awareness of potential health conditions that threaten independent living can increase demand for support services, which are currently either in short supply or under-utilized (U.S. Department of Health and Human Services [HHS], 2011). A number of studies show increased awareness of risk factors is an evidenced-based means of preventing falls among the elderly when done as part of a multifaceted approach (Capezuti, 2008; Kochera, 2002; Nevitt, et al., 1989; Rand Report, 2003).

One way to increase awareness of risk factors while directing appropriate care response is through the use of home monitoring systems (HMS) as part of a proactive

approach to promoting positive health outcomes while managing healthcare costs. As summarized in a 2010 article published in the *Journal of American Geriatrics Society*, "properly designed monitoring technology" that produces "continuous physiological data" were cited as a promising way to decrease hospital readmission rates while lowering the associated healthcare costs for certain conditions (Kaye et al., 2011 and Kang et al., 2010, p. 1580). Kang and team explain that the continuous monitoring of physical function contributes to a greater understanding of risk factors that change over time, possibly during different increments of time and would therefore better enable the prediction of disease in its early stages versus capturing data at sporadic or much more limited points in time (Kang et al., 2010). Given the relative newness of technology that enables continuous monitoring in the home, studies documenting efficacy and impact on long-term health outcomes are still being conducted, however a few have shown improved disease management is facilitated by consistent monitoring of blood pressure and glucose levels in the home (Chavanu et al., 2008 & Tamborlane et al., 2008). Additionally, many HMSs come with medication reminders, which have been shown to improve compliance as a critical component to preventing hospitalizations for heart failure (Shah et al., 1998).

HMSs are also consistent with the individual's desire to age in place while providing more personalized and actionable data to promote healthy aging and independent living without placing additional burdens on the beneficiary. A distinguishing objective guiding the development of continuous monitoring technology is that the person being monitored should not feel the device is intruding on their daily life and therefore having the device in their home environment should be "transparent

and minimally intrusive" (Kang et al., 2010, p. 1582). HMSs can be less burdensome

and more discreet than personal emergency response systems (PERS) which feature a

panic button that the person must wear in order to have the button readily accessible to

press before an alert can be sent to an emergency call service. In contrast, an HMS is

intended to prevent an emergency from occurring while requiring no additional action

from the individual being monitored. This is done by placing wireless motion sensors in

discreet areas throughout the home, such as in the bedroom, bathroom and kitchen to

continuously and unobtrusively, monitor the individual's daily activity. Depending on

the user's preferences, alerts can be sent to a caretaker via email or text message should

any irregularities in routine be detected above acceptable algorithmic thresholds. Such

changes can indicate the threat of a future health event, such as a debilitating fall that can

compromise the individual's ability to remain independent at home for as long as

possible.

      This explorative descriptive study leverages two constructs from the theory

Diffusion of Innovations (DOI) as originally posited by Everett Rogers to modify a

survey instrument. The modified instrument was used to measure the anticipated

innovation attributes of HMSs in order to describe potential *adopters* for the use of an

HMS as a preventive health behavior. The survey was piloted among a sample of 71

adults 45 to 64 years of age residing in Chevy Chase and Bethesda, Maryland. The

primary hypothesis of this study is that the constructs from the DOI theory will hold

true. By showing that an association exists between the study participants'

innovativeness, defined as their intention to adopt an HMS in the future and their

perceived r*elative advantage, compatibility* and *complexity* of HMSs, as posited by the

DOI theory. Additional research questions addressed in this study include whether a relationship between background variables and innovativeness exists and whether clear preferences for purchasing an HMS in the future emerge among the responses captured by this piloted survey.

SIGNIFICANCE OF THE STUDY

Industry Impact

Unlike previous DOI studies where the theory was generally used to describe diffusions that have already occurred in the past, the findings from this descriptive study will contribute to what Rogers referred to as "acceptability" research since it has the potential for informing the positioning of HMSs before it has "diffused in a priority population" and can "identify a basis for positioning the innovation so that it will…have a more rapid rate of adoption" through consumer marketing activities in the commercial sector (Rogers, 2003, p. 227). By collecting formative consumer perceptions of the relative advantage, compatibility and complexity of an HMS and using them to describe potential adopters, the study can contribute to a greater understanding of the consumer landscape for a healthcare innovation that holds promise for improving health outcomes and reducing costs but is struggling to gain a rapid rate of adoption.

Beginning to identify the anticipated perceptions around the attributes of an HMS by the *innovativeness* of adults 45 to 64 years of age now can help inform the marketing efforts aimed at these adults ten to fifteen years in the future when their need for assistance to remain independent in their homes becomes more pressing. The ability to anticipate future needs or "deal with abstractions" versus the "here-and-now" is what

Rogers cites as a personality variable that is associated with early adopters (Rogers, 2003, p. 289).

Findings from this study will be used to describe some characteristics of potential adopters among adults 45 to 64 years of age with regard to the intended adoption of an HMS in the future as a means to delay premature institutionalization as a result of a preventable fall or health incident such as reoccurring urinary tract infections. Describing the characteristics of these early adopters can begin to inform the potential size of the audience segments for HMSs so marketing managers have some guidance for planning an investment strategy. Tiered investment strategies would help pioneering health technology start-up companies realize greater efficiencies of their limited marketing dollars in the short-run in order to yield a higher return on their investments in the long-run. By detecting if a possible relationship exists between consumer innovativeness and demographic variables such as age, education, health, work and caregiving status, these characteristics can be used to inform efforts in media planning, direct response targeting tactics and tailored messaging.

Responses to the survey question about preferences for where to purchase an HMS can begin to inform affinity partnerships that companies should pursue as part of their product distribution strategies. Currently, HMSs are provided directly through their manufacturers, who are often small technology start-up companies with little brand recognition of their own. Formative insights provided through this study on the type of retail outlets consumers would want to purchase HMS from could inform the development of larger consumer surveys. Data collected from larger consumer surveys could generate evidence compelling enough to broach partnerships with established

consumer retail outlets such as brick and mortar locations in pharmacy retail (e.g., CVS),

electronic (e.g., Best Buy), general packaged goods (e.g., Costco) or through their online

retail counterparts or primarily online giants like Amazon. Successful partnerships with

big retail could increase the rate of adoption exponentially for HMSs. The products

would become more widely available through an existing distribution channel, benefit

from the added marketing muscle to increase awareness while also promoting a greater

sense of compatibility among adopter categories when the products are sold through

familiar suppliers and alongside complimentary products.

Research Impact

From a research perspective, this study will attempt to inspire more consumer

research that leverages health behavior theory, such as DOI as the framework for posing

more effective market research questions. Although much has been published in the

realm of both academic literature and professional trade publications about the promise

that the general category of technology-enabled healthcare or aging in place technology

holds (Chavanu et al., 2008; Kang et al., 2010; Litan, 2008; Mitchell, 1999; Rashidian,

2010; Tamborlane et al., 2008), there remains a gap in the literature to explain why

specific products like HMSs, a seemingly advantageous and established technology,

have had such slow adoption rates among consumers. In a recent edition of the

McKinsey Quarterly, the market for this technology was placed at a mere 3% of national

health spending, which although "increasing by about 9% annually" was considered

"solid but hardly booming growth" (Kayyali et al., 2011). The same article summarizes

arguments that point to a number of "financial and operational barriers" that hold back

growth, but does not reference the importance of social systems and the consumer perceptions that also influence healthcare spending.

Publications from well-regarded research groups such as the AARP Public Policy Institute, the Rand Corporation and LeadingAge's (formerly known as AASHA or the American Association of Homes and Services for the Aging) Center for Aging Services Technologies (CAST) have all reported on the general barriers that prevent a more rapid diffusion of aging in place technologies among Baby Boomers and older cohorts. Findings from these reports have consistently concluded that a lack of awareness, reluctance to adopt new technologies and perceived high out-of-pocket costs not reimbursed by private insurance, Medicare or Medicaid are to blame (Alwan & Nobel, 2007; Barrett, 2011; Mattke et al., 2010). Although these findings are extremely valuable for describing the landscape for the aging services field, they do not go deep enough in explaining barriers or potential benefits, which is where the application of health behavior theory could provide a useful framework. Such insights can lend a greater context for understanding the dimensions of consumer behavior.

The rapid adoption of the most promising aging in place technology products is where diffusion is most likely to gain a firm foothold before the larger field can move far enough ahead to have any real impact on improving quality of care at lower costs while respecting consumer choice. Increasing this rate of adoption is particularly critical by the time the Baby Boom generation ages into becoming the largest cohort of consumers of long-term care services in American history since they also pose the greatest burden on our nation's healthcare resources (Mashburn, 2011).

Program Competencies

       This study will provide the opportunity to meet the final requirements for obtaining the Master of Public Health degree from the University of Maryland College Park's School of Public Health. Completion of the Master's Thesis will reflect the successful demonstration of the Master of Public Health competencies with a concentration in Behavioral and Community Health. As outlined in Table 1, the specific competencies and how they will be demonstrated in this study reflect both those that are listed under "Public Health Core Competencies" and those listed under "Community Health Education Cognate Competencies" (University of Maryland, 2009).

Table 1: *MPH Program Competencies*

Competency	Method of Demonstration
Core	
1-a: Identify social and behavioral causes of morbidity and mortality.	Literature review and statement of research problem
1-b: Explain contributing behaviors and determinants of behaviors (e.g. predisposing, enabling, reinforcing).	Literature review and development of analytical framework
2-c: Recognize how theory can be used to address health problems.	Application of Diffusion of Innovations theory to survey design modification
6-a: Describe concepts about probability and probability distributions.	Formation of research questions and analysis of survey results
7-a: Use descriptive statistics appropriate to the measurement variable.	Analysis of survey results
8-d: Compute estimates and/or test statistics using a standadard statistical software package.	Analysis of survey results via SPSS Version 20
10-a,b,c: Draw appropriate inferences based on statistical analysis used in public health research.	Analysis of survey results and discussion of conclusion
12-a: Describe major public health problems (e.g. local, national).	Literature review and statement of research problem
Cognate	
1-e: Conduct an assessment of organizations and programs that impact health problems facing a specific community using theory.	Literature review and significance of study
2-b: Conduct formative research with target audiences, experts, and gatekeepers that informs the intervetion process.	Background research and discussions with Dr. Majd Alwan of CAST and Adam Barth of BeClose
2-c: Use assets mapping as tool for community needs assessment.	Background research using Maryland Vital Statistics Report and WikiMaryland
4-a,b,c: Apply evidence-based approaches in the development and evaluation of social and behavioral science interventions.	Literature review and modificaiton of survey instrument
5-a: Apply considerations for designing and delivering health instruction for different educational settings and learners.	Development of HMS product flow and modified survey
5-b: Using theory, develop strategies that impact health problems facing a specific community.	Formation of research questions and analysis of survey results
6-a: Use the language of research.	Execution of Masters Thesis
6-g: Use ethical approaches with human subject in research.	Obtained IRB Approval
8-a: Apply various resources including the scientific literature, professional assocation/government materials, guidelines, and carefully assess other resources for health education.	Literature review and significance of study
8-b: Obtain appropriate resources in response to varied requests for health education information.	Literature review and significance of study
8-c: Evaluate the appropriateness of different resources and materials for different audiences.	Development of HMS product flow and modified survey
9-a,b,c,d,e: Communicate and advocate for health and health education.	Dissemination of findings with UMD SPH, CAST, BeClose and APHA Aging & Public Health Section

Chapter 2: Background

CHAPTER SUMMARY

This chapter includes a review of the relevant literature, starting with a detailed description of HMSs, followed by a description of the Baby Boomer generation as it relates to the adoption of healthcare technology products such as an HMS. This chapter also includes a brief description of the DOI theory, specifically covering the *innovation attributes* and *adopter categories*, which are the main constructs that served as the theoretical basis for this study. To provide additional clarity for the reader, there is the inclusion of relevant terminology that is associated with the DOI theory. This chapter then concludes with the central hypothesis and research questions.

LITERATURE REVIEW

Home Monitoring Systems

The innovation that is the focus of this study is the HMS or more specifically, the intent to adopt an HMS in the future as a preventive health behavior. Although still relatively unknown among average consumers, HMSs hold a prominent place in the suite of products collectively referred to as "assistive technologies", "aging in place technologies", "technology-enabling healthcare", "home safety technology devices" or simply, "eHealth", which is the application of digital data that is stored and transmitted electronically – frequently through the internet – for healthcare purposes (Mitchell, 1999). Given the persistent concerns over unsustainable healthcare costs, a shortage in professional caregivers and an aging population that is living longer, HMSs stand to play

an important role in public health as an "upstream solution". That is HMSs can be used to prevent the occurrence of more serious health incidents such as debilitating falls in the home and empower older adults to be more proactive about their healthcare by giving them direct access to their own personal and actionable health information. HMSs can also make it easier for older adults to facilitate their care coordination with both informal and formal caregivers, is less expensive than traditional care associated with emergency room visits or premature institutionalization in assisted living or nursing home facilities and allows them to remain independent in their homes longer.

The published empirical data on the long-term impact that HMSs can directly have on health outcomes is still developing, however the expanded category of tele-health, in which remote monitoring is a significant component, has been credited with decreasing the use of more expensive medical resources, improving adherence to treatment for chronic diseases and improved post-acute care (Litan, 2008). In a collaborative study between Kaiser Permanente Colorado, the American Heart Association and the Microsoft Corporation, patients with uncontrolled hypertension were randomized into either a home monitoring group or the usual standard of care group. Results indicate that patients in the home monitoring group were 50% more likely to have their blood pressure under control when compared to the control group (Kaiser Permanente, 2010). In studies conducted by the Veterans Health Association significant cost savings were found when enrolling patients in a tele-health program. Annual costs for program participants averaged at $1,600 per patient per annum compared to $13,121 for home –based primary care services and $77,745 for nursing home care services (Darkins, et al. 2008).

Shift to Consumer Market

Data collected from large medical and research institutions like Kaiser Permanente and the Veterans Health Association have demonstrated clear care and cost benefits of remote monitoring, however the findings do not always translate well when the same technology is commercialized for individual consumers. The perception of the monitoring technology is that they are invasive with respect to the monitored individual's privacy, are expensive, highly specialized with multiple components and produce data that only technically-trained healthcare professionals in clinical settings can interpret (Mattke et al., 2010).

Fortunately as technology develops, it ultimately becomes more affordable and efficient, allowing for greater gains to be made in a consumer market. Cost can dramatically affect the perceived relative advantage of an HMS. Rogers (2003, p. 230) stated that "a new product may be based on a technological advance that results in a reduced cost of production for the product, leading to a lower selling price to consumers". Manufacturers learned that less can be more when introducing new technologies with simpler functionality. The reduced demand on functionality combined with a decrease in manufacturing costs, enabled firms to offer the less-intimidating systems at more accessible prices.

An example of how HMSs are becoming more affordable was provided in a recent article on home technology featured in the *New York Times*. In the article, a senior director of technology for the Custom Electronic Design and Installation Association, Dave Pedigo, gave credit to the arrival of touch-screens in personal hand-held devices as lowering the cost for what would have been custom-made controllers. The controllers

would have cost as much as "several thousand dollars each" compared to incorporating an iPad controller which runs at $499 each (Manjoo, 2011). Simple models of HMSs like the one in Figure 1 are also easier to install since they consist of light-weight wireless sensors that do not need to be mounted onto walls or wired by professionals. Since being covered in the *New York Times*, HMSs have also been referenced in varying degrees in other mainstream media outlets such as *National Public Radio, ABC*, *CNN.com* and *USA Today*, which could promote greater compatibility as it becomes more familiar to a larger audience.
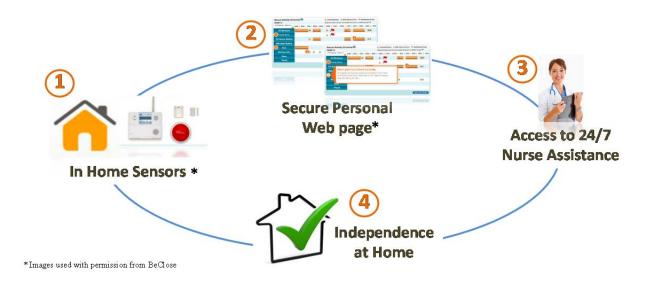
Although companies offer a wide range of sophistication of the technology and subsequent costs (Bruce, 2011), for the purposes of this study, the most basic and affordable example of an HMS was used for developing the survey and for comparing costs with other long-term care services and supports. At the time of reviewing the literature and consumer resources of HMSs for this study, the Principal Investigator found the sensors could be available for a few hundred dollars and come with a monthly service fee. None of the companies offering HMSs on-line were offering to buy back the hardware should a customer decide to discontinue using the service; however a few did provide customers with service duration options. The most affordable service fee that was found advertised by a service provider was $49 a month for a one-year commitment or $79 month-to-month (beclose.com). According to a 2011 joint survey conducted by Genworth Financial, Inc. and the National Eldercare Referral Systems, the initial equipment costs (starting at $299) and $49 monthly cost of using an HMS seems relatively affordable when compared to the national median hourly rate of hiring a licensed home health aide is $19 (or $152 for an 8-hour day) (2011). HMSs appear even

more affordable when compared the monthly median rates published in the same survey

for a nursing home facility, which ranges from $193 (for a semi-private room) to $213

(for a private room) and the monthly rate for an assisted living facility is $3,261

(Genworth, 2011).

A basic HMS is illustrated below in Figure 1, which was used to familiarize

study participants with the technology before they answered the survey questions.

Figure 1: *Home Monitoring System - How it Works*

1) Place small wireless sensors in key places throughout your home (ex: bedroom, bathroom, kitchen, living room).

2) The sensors will capture your day-to-day routine on a secure, private web page where you & your caregivers can log on to learn about your daily patterns.

3) If any small or reoccurring changes are noticed, (restless sleep, moving slower from room to room, etc.), you can get the advice of registered nurses 24/7 on whether the changes should be addressed before they turn into bigger health issues, such as a debilitating fall.

4) Regular monitoring of your physical activity gives you information to proactively manage your health so that you can remain independent in your home longer.

Secure Personal Web page*

Access to 24/7 Nurse Assistance

In Home Sensors *

Independence at Home

*Images used with permission from BeClose

Increasing the affordability while reducing the complexity of HMSs can initially lead to greater perceived relative advantage, while also promoting trialability and observability, two innovation attributes which can increase adoption rates (Rogers, 2003). If HMSs are more affordable, there is less risk for potential adopters to try out a system, thus increasing its trialability, particularly if it offers an alternative to more drastic and expensive changes like hiring in-home help or moving into an assisted living facility. As more seniors set up HMS in their homes and remain in their communities, there is a greater likelihood that others would notice or inquire about the product, thus increasing the monitoring system's observability. Increased trialability and observability when promoted by the product's perceived relative advantage, compatibility and decreased complexity can all culminate into bringing about exponential growth, thus having a mainstreaming effect or what Rogers (2003, p. 474) referred to as the point of "critical mass" when the adoption rate of an innovation becomes self-sustaining.

If early adoption takes place in homes inhabited by opinion leaders, HMSs can potentially go from a source of embarrassment or self-consciousness when perceived as being "for old people" to something that may hold a status-conferring quality such as a "three-car garage in a suburban home" (Rogers, 2003, pg. 231). The possibility of this shift in perception was captured in the same *New York Times* article which made the point that "such advances [like HMS] are likely to be installed in the fanciest of homes first" (Manjoo, 2011). Although it may be a stretch for assisted technologies like HMSs to become status symbols, HMSs do have the potential to go from being perceived as a home "safety" technology to having a more contemporary association as a home "health & wellness" technology. Such an association could be particularly meaningful when

positioned as a preventive healthcare product such as healthcare mobile phone applications, which are targeting younger seniors.

Baby Boomers

Participants recruited for this study were adults between the ages of 45 to 64 who are often referred to as the "Baby Boomers". This term describes the cohort of Americans who were born between 1946 and 1964 when there was a significant rise in birthrates following World War II. As the name entails, Baby Boomers are a historically large segment of the population, making up 25% of the population in 2011 (Day, 2010). In contrast to the preceding "silent generation" who were born between 1926 and 1945, Baby Boomers have higher rates of obesity and arthritis (Leveille et al., 2005) and their burden of other chronic disease will only increase as they age (Hodes and Sulzman, 2007). Based on their population size and increasing healthcare needs, it is clear why Baby Boomers are projected to become the largest consumers of long-term care services (Mashburn, 2011).

Relative to previous generations, Baby Boomers are expected to live longer, work longer and be more realistic about their retirement years with regards to their health and financial wellbeing. Often characterized as an indulgent group who came of age during years of great American prosperity, a study commissioned by AARP found that Boomers have become more conservative about their finances with fewer "defining retirement as a time to indulge themselves" and feeling that they will "have enough money and financial security" from 1998 to 2004 (ASW, 2004, p. 6). A decline was also found in perceived health status as the percentage of Boomers who considered

themselves to be in very good or excellent health dropped by six percentage points (ASW, 2004, p.8). In a study conducted by the AARP Public Policy Institute, 63% of those 50 and older said they were worried about being able to afford their healthcare (Rix, 2011).

The shift towards more realistic expectations about retirement may be influenced by the large percentage of Baby Boomers (over 51%) who are also caregivers of their elderly parents and have therefore witnessed the aging process first hand (AARP International, 2010). In the Healthy@Home 2.0 Report, caregivers were profiled as being 45 to 75 years of age with 64% of the participants surveyed reporting that they currently provide care for an older relative or friend (Barrett, 2011). When asked what their top three concerns were as caregivers, the response was lack of time, inadequate finances and high levels of stress, sadness or frustration either due to lack of support from others or difficulty with the person they were caring for (Barrett, 2011).

Despite the trends associated with increasing concerns over health, finances and retirement, Boomers remain a resilient and optimistic group who seem committed to redefine aging and therefore willing to compromise privacy and take on greater responsibility for their own health. Over eight in ten (81%) Boomers said that they would be willing to give up some of their privacy if they needed help to remain in their homes (Barrett, 2011). In the same survey, 95% said they would like to know as much as they could about their personal health conditions and 94% said they wanted to help their doctors monitor their health (Barrett, 2011).

Boomers also seem open to embracing new technologies such as HMS in order to remain independent at home longer. Unlike their parents, Boomers are better educated,

more familiar and comfortable with technology (Coughlin, 2006) and have high self-efficacy when it comes to planning their retirement. This finding compliments the statistic that over 89% of Boomers want to age in place (AARP, 2005). In the previously mentioned AARP commissioned study on retirement, most Boomers (61%) are confident in their ability to plan for their future and do not want to be a burden to their children (ASW, 2004). In a briefing published by the Massachusetts Institute of Technology AgeLab, a survey conducted by the Rehabilitation Institute of Chicago and cited in a 2004 issue of *Time Magazine* found that over 80% of Boomers "fully expect scientific and technological advances to improve their lives as they age" (Coughlin, 2006, p. 1). The same article even references "lead adopters" of the "most high-tech, high design, and high-priced" as being 50 or older (Coughlin, 2006, p. 1).

THEORECTICAL FRAMEWORK

Grounding this study is Rogers' Diffusion of Innovations (DOI) theory, which attempts to explain why certain innovations (new products, services, ideas or practices) are adopted more rapidly than others within a social system. Rogers initially introduced the DOI theory in 1962 having been perplexed as to why farmers near his home in Iowa slowly adopted if at all, new agricultural practices that appeared to be obviously beneficial (Rogers, 2003). As published again in the fifth and latest edition of his book, Rogers characterized the DOI theory as containing "four main elements [that are] the innovation, communication channels, time and the social system" (Rogers, 2003, p. 11).

For this study, the innovation is the preventative behavior of adopting an HMS in order to prevent adverse health events such as debilitating falls that may lead to

premature institutionalization. The communication channels that will be discussed as potential facilitators of the future adoption of HMSs will be mainstream media, including broadcast, print and online channels, as well as intrapersonal such as peer-to-peer influence. The element of time is in the future as study participants will be asked to consider purchasing an HMS when they would need help in order to remain independent safely in their homes, based on the expectation that they will experience normal physical decline that comes with age. The social system from which the study participants will be recruited is the community of largely adults 45 to 65 years of age residing in Chevy Chase and Bethesda, Maryland.

Innovation Attributes

Although the DOI theory proposes many constructs to explain how a new idea, service or technology spreads in a given population, the constructs that are most germane to this study are the first three *attributes of an innovation* and the characteristics associated with the *adopter categories* as they relate to the rate of adoption of a particular innovation. In his book, Rogers summarizes previous innovation research studies and identified five perceived characteristics that make an innovation more or less desirable to adopt within a social system.

The rate of adoption for an innovation is more rapid if members of a social system perceive it to be better than what the innovation is intended to replace (*perceived relative advantage)*; is consistent with their values, experiences and needs as potential adopters (*perceived compatibility);* is not overly complicated to understand or use (*perceived complexity);* lends itself to be used without a significant commitment in time,

effort or expense *(perceived trialability);* and possesses benefits that are readily

identified by the user and others (*perceived observability)* (Rogers, 2003).

Since this study will pilot a survey concerned with a preventive health behavior

and whether or not the behavior would occur in the future, the survey will ask

respondents about their anticipated beliefs of the relative advantage, compatibility and

complexity of an HMS. Rogers acknowledges that not all five attributes will be relevant

for all innovations or for a particular set of respondents and suggested to "first elicit the

main attributes of innovations from the respondents as a prior step to measuring these

attributes as predictors of the rate of adoption." (Rogers, 2003, pg. 225). The use of an

HMS as a home safety technology product has had a very slow rate of adoption and is

only beginning to diffuse since awareness of the technology as a consumer product has

only started to be promoted in mainstream media rather recently (Bruce, 2011).

Consequently, trialability and observability do not readily apply to the concept of HMSs,

which may still be too abstract for the survey participants.

Adopter Categories

In his DOI theory, Rogers acknowledges that members within a social system

may largely be homogenous as far as socio-economic or demographic characteristics go

but that individually, they can possess different degrees of "innovativeness" or have

different thresholds for the amount of risk they are willing to take on before adopting an

innovation relative to others within the same social system. For this study, responses to a

five-point Likert scale were used to measure the degree to which respondents (adults 45

to 64 years of age living in Chevy Chase and Bethesda, Maryland) anticipate an HMS

would be relatively advantageous, compatible and complex with respect to helping them remain independent in their homes longer.

In traditional diffusion research, where the diffusion of an innovation is complete at 100% adoption within a social system, adopter categories are assumed to follow a normal distribution curve when plotted against a Cartesian X and Y-axis as depicted below in Figure 2. Along the X-axis is a measure of time and the Y-axis is the percentage of the members of the social system who have adopted the innovation at a given point in time. Since this study is concerned with a preventive health behavior which would happen in the future, the adoption is what Rogers refers to as "incomplete".
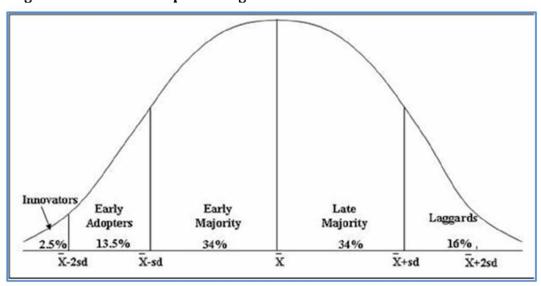
Figure 2: Potential Adopter Categorization on the Basis of Innovativeness

Retrieved 10, 25, 2011 from http://robsdoc.wikispaces.com/DiffusionLit

DEFINITION OF STUDY TERMS

   To fully inform the reader and provide for an ease of reference, key terms related to the Diffusion of Innovations (DOI) theory as defined by Everett Rogers are provided below.

1. *Compatibility*: The degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. An idea that is incompatible with the values and norms of a social system will not be adopted as rapidly. (Rogers, 2003, p. 15)

2. *Complexity*: The degree to which an innovation is perceived as difficult to understand and use. New ideas that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and understandings. (Rogers, 2003, p. 16)

3. *Diffusion*: The process by which an innovation is communicated through certain channels over time among the members of a social system. (Rogers, 2003, p. 11)

4. *Innovation*: An idea, practice, or object that is perceived as new by an individual or another unit of adoption. It presents an individual or organization with a new alternative to solve problems. (Rogers, 2003, p. 12)

5. *Innovativeness*: The degree to which an individual (or other unit of adoption) is relatively earlier in adopting new ideas than other members of a system. (Rogers, 2003, p. 267)

6. *Preventive Innovation*: New idea that an individual adopts now in order to lower the probability of some unwanted future event. (Rogers, 2003, p. 265)

7. *Rate of Adoption*: The relative speed with which an innovation is adopted by members of a social system. (Rogers, 2003, p. 265)

8. *Relative Advantage*: The degree to which an innovation is perceived as better than the idea it supersedes. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption will be. (Rogers, 2003, p.15)

9. *Trialability*: The degree to which an innovation may be experimented with on a limited basis. New ideas that can be tried on an installment plan will generally be adopted more quickly than innovations that are not divisible. (Rogers, 2003, p.16)

10. *Observability:* The degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt. (Rogers, 2003, p.16)

Integral to the explanation of this study is the use of the following terms. These terms are not specific to the DOI theory, but they may hold multiple meanings. For the purposes of clarification, the intended meaning for the terms as they relate to this study are specified as follows:

1. *Activities of Daily Living (ADLs):* include the ability to move from one place to another, eat, bathe, toilet, and dress in addition to the ability to control the bladder and bowels. (Wiener et al., 1990)

2. *Aging in place*: Having the mental and physical capability of living in one's own home in old age; not having to move from one's present residence to receive care or services in old age *(Retrieved October 15, 2011 from*

   http://dictionary.reference.com/browse/aging+in+place)

3. *Baby Boomer:* Anyone who belongs to the cohort of Americans born between 1946 and 1964 *(Retrieved October 15, 2011 from*

    http://www.census.gov/population/www/socdemo/age/2006%20Baby%20Boomers.pdf)

4. *Caregiver*: A person who provides direct care – as for children, elderly people, or the chronically ill (*Retrieved October 15, 2011 from http://www.merriam-webster.com/dictionary/caregiver*)

5. *Home Monitoring System (HMS)*: Safety technology that is equipped with processing and communication capabilities placed in common household areas to constantly monitor changes in regular movement and relays that information to designated caregivers and health providers *(Retrieved October 15, 2011 from http://www.leadingage.org/CAST.aspx*)

6. *Instrumental Activities of Daily Living (IADLs):* include the ability to use transportation, shop for necessities, prepare meals, and perform house work. (Wiener et al., 1990)

HYPOTHESIS

The primary hypothesis of this study is that among adults 45 to 64 years of age living in Chevy Chase and Bethesda, Maryland, the central construct of the Diffusion of Innovations theory will hold true with regard to the intention to adopt an HMS in the future as a preventive health behavior. Innovation attributes (relative advantage, compatibility and complexity) will be consistent with the theory when used to describe the innovativeness of potential adopters. For a visual representation of the components

used to form this hypothesis, an analytical framework is provided in Figure 3. That is adults 45 to 64 will demonstrate greater innovativeness (the intention to adopt an innovation) by considering the use of an HMS in the future if they anticipate the attributes of an HMS as being:

- Relatively advantageous by:

  - Giving them greater control over managing their health as they age

  - Being more preferable than hiring a home health aide

- Relatively compatible with their:

  - Willingness to be monitored in order to maintain independence longer

  - Plans for remaining independent in their homes as they age

- Not overly complex:

  - For them to install the sensors in their homes

  - For them to understand how to read and interpret the data presented in charts/graphs on their secure website

RESEARCH QUESTIONS

In addition to describing the potential adopters by measuring the anticipated relative advantage, compatibility and complexity attributes of an HMS and comparing those responses to the intent of adopting an HMS in the future, this study attempted to provide greater context for describing potential adopters based on demographic characteristics and consumer behavior such as purchase preferences. Those additional

26

questions are as follows:

1. Will an association exist between independent variables (age, education, health and work status) and the intent to adopt an HMS in the future be detected?

2. Will an association exist between caretaking status, the perceived presence of a future caretaker and the intent to adopt an HMS in the future be detected?

3. Will clear preferences for where to purchase an HMS in the future emerge?

Chapter 3: Methods

STUDY DESIGN

The study is an exploratory descriptive study that seeks to find evidence to support whether an association exists between the perceived innovation attributes and the intention to adopt an HMS in the future as posited by the DOI theory. Additionally, the study seeks to detect whether an association exists between demographic variables and the intention to adopt an HMS. The DOI innovation attributes and the demographic variables will be used as the independent variables and the intention to adopt an HMS in the future will serve as the dependent variable.

In the instances where evidence of an association exists, this study will attempt to describe the nature (either positively or negatively correlated) and the potential magnitude or strength of that association. Given the limitations in sample size, it is not the purpose of this study to quantify whether a pure statistical relationship exists between the independent and dependent variables mentioned.

Instrument Modification

An existing survey instrument called the *Adult Monitoring Candidates: In-Home Monitoring Survey,* was modified and renamed as the *Home Monitoring System Survey*, containing 16-items and piloted to measure the anticipated DOI variables that were selected as the innovation attributes of interest. The innovation attributes or the relative advantage, compatibility and complexity of an HMS, were captured to describe potential adopters among adults 45 to 64 years of age residing in Chevy Chase and Bethesda,

Maryland.

To the Principal Investigator's knowledge no survey instrument existed that would adequately measure the DOI constructs among a senior population with respect to a technology-enabled health product. This conclusion was reached after a literature review of articles published before the fall of 2011 was conducted. The author also consulted with Muhiuddin Haider, Ph.D, a direct mentee and doctoral student of Rogers who applied the DOI theory in evidence-based research and tested the theory in over a dozen countries, However, after speaking with Majd Alwan, Ph.D. and SVP of Technology at LeadingAge, a survey developed by Alwan and team at the University of Virginia Medical Automation Research Center, called the *Adult Monitoring Candidates: In-Home Monitoring Survey* was suggested for modification. The existing survey exhibited high content-validity when tested on a senior audience to inform the product development of HMSs in 2005 (see Attachment A).

To inform the survey modification so that the appropriate DOI psychometric properties would be accurately captured, survey items from two resources containing previously-validated items using the DOI constructs were referenced. The first was an instrument developed by Atkinson who applied the DOI theory to develop an instrument to measure perceived attributes of an health education CD-ROM using college students from the University of Maryland College Park (Atkinson, 2007). The second resource referenced consisted of construct items validated by Moore and Benbasat (1991). Rogers himself deemed their methodology as being "sophisticated and careful" and could be useful for informing other techniques in future investigations (Rogers, 2003, p. 225).

In recognition of inadequate health literacy as a potential barrier to understanding

and responding to the survey questions, the modified survey was subjected to the Simplified Measure of Gobbledygoop (SMOG) readability test (McLaughlin, 1969). Based on a count of 30 sentences with 50 words exceeding three or more syllables, the approximate reading grade level (plus or minus 1.5 grades) was that of the 10th grade level.

Sample Size

The format of the modified survey was distributed as hard paper copies. The hard paper copies were distributed to participants recruited as a convenience sample from neighborhood public spaces where the author used a small sign identifying the study as being associated with the University of Maryland, College Park to attract participants. The public spaces where recruitment took place included the outside entrances of the Chevy Chase and Bethesda branch libraries and the foyer of the Jane E. Lawton Community Recreation Center. Participants for the study were recruited with the goal of obtaining a sample size of 68 based on the output from the online sample size calculator, a free application retrieved from http://www.raosoft.com/samplesize.html.

For the purposes of this explorative descriptive study, the following input values were used in the Raosoft online sample size application. A 10% margin of error was used for the tolerance level, a confidence level of 90% and a response distribution was conservatively estimated at 50% assuming an equal number of survey participants would respond yes or no to the question of whether they would get an HMS in the future to help them remain independent safely in their homes. As a reference point, an N of 345 participants would have had to be recruited in order to obtain a 5% margin of error with

a 95% confidence level. The sample size was based on a population size of 20,763 adults 45 to 64 years of age residing in Chevy Chase or Bethesda, Maryland (U.S. Census Bureau, 2010).

Sample Population

The targeted participants for this study were adults 45 to 64 years of age who reside in Chevy Chase and Bethesda, Maryland. Adults in this age range represent a relatively heterogeneous population (Economic Research Service, 2009) where life-stage and health status, which affect considerations for undertaking preventive health behaviors, may be more useful as a descriptive category than absolute age. A 64-year old may have young children in the household as a result of a second marriage and therefore may have financial and health demands similar to that of a 45-year old parent. Conversely, a 55-year old who is overweight and smokes may have the same burden of chronic disease and financial insecurity as a frail 64-year old. Consequently, this age range represents a relatively large percentage of the population, often referred to as the Baby Boomers, who are in various stages of planning for their retirement and how they want to age in place. They are also anticipated to significantly impact the nation's healthcare resources and consumer landscape, making them a population for commercial providers of aging in place technologies to pay attention to.

Based on the importance of homophily, defined by Rogers (2003, p. 19) as "the degree to which pairs of individuals who interact are similar in certain attributes, such as beliefs, education, social status, and the like for effective communication within a social system", the residents of Chevy Chase and Bethesda, Maryland were selected due to

their relative homogeneity within a rather heterogeneous age segment. Residents of Chevy Chase and Bethesda exhibit shared characteristics that are conducive to innovativeness or the likelihood of rapidly adopting an innovation like an HMS in order to prevent premature institutionalization.

Although the ethnic and cultural make-up of the community has grown increasingly diverse, the socio-economic status is consistently upper-middle class as reflected in the high median household income compared to the U.S. national average ($103,000 vs. $56,000) and higher percentage of bachelor or postgraduate degrees obtained (80% vs. 28%) (USCB, 2010). These characteristics are likely to lend the population to be what Rogers (2003) refers to as "cosmopoliteness" or having an orientation outside of a social system therefore making them more open to new ideas.

The intention of this study was to describe potential adopters, particularly those who intend to adopt an HMS based on anticipated perceptions from the innovation attributes as posited by the DOI theory. Insights from a "best-case scenario" population will be more informative to future marketing campaigns and research interested in promoting a rapid adoption rate of home safety technology products by targeting early adopters and early majority categories. Although the need for home-based healthcare may be greater among a more disadvantaged population (a strategy Rogers refers to as that of "greatest resistance"), barriers such as a lack of access to a high-speed internet connection, higher rates of physical debilitation and isolation present socio-economic challenges that are beyond the scope of this pilot study.

Protection for Human Subjects

Institutional Review Board (IRB) approval was secured from the University of Maryland College Park. An expedited review was granted since participants were not subject to any medically invasive procedures and no vulnerable populations were asked to participate in the study. Informed consent forms were developed based on the IRB template found at http://www.umresearch.umd.edu/IRB/consent.html. Signed, written consents were requested from all participants prior to completing the survey.

All study participants were given the ability to retain the right to withdraw from the study, have the Principal Investigator's contact information for questions and remain anonymous with the exception of those who wished to receive results from the pilot study. Additionally, all survey responses were stored on a password-protected computer and will be stored in locked cabinets in the School of Public Health building at the University of Maryland, College Park. Only the Principal Investigator and student researcher will have access to the data. Due to limited resources associated with a Master's thesis, participants of the pilot were not compensated as participation was strictly voluntary. Results from the study were made available to those participants who requested it.

OPERATIONAL DEFINITIONS OF VARIABLES

The *Adult Monitoring Candidates: In-Home Monitoring Survey* was modified to measure the perceived attributes of an HMS. The modified survey, renamed as the *Home Monitoring System Survey,* included a brief explanation of the project and the fact that

the survey is being piloted as part of a Master's thesis was disclosed. A brief description

of an HMS accompanied a visual to aid in the explanation of how a basic HMS works.

The modified survey was reduced from the original 24-item survey down to 16 items to

minimize respondent burden and took less than 15 minutes to complete. The response

format of the survey to the DOI questions was a five-point Likert scale: 1= strongly

disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The following are

sample questions from the modified survey that correspond to the innovation attribute

constructs of an HMS as informed by the DOI theory.

Anticipated Relative Advantage:

1. Getting a home monitoring system would give me greater control over my health as I age.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

1. A home monitoring system would be more preferable than hiring a home health aide.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

Anticipated Compatibility:

1. I would be willing to have my movements monitored if it would help me maintain my independence safely at home longer.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

1. Getting a home monitoring system would fit in with how I plan on remaining independent in my home as I age.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

Anticipated Complexity:

1. It would not be difficult to set up a home monitoring system in my home.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

1. I am comfortable reading charts and graphs on a computer screen.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

Figure 3 provides an analytical framework of this study. A brief overview of the DOI constructs (*innovation attributes* and *innovativeness*) and how the survey instrument will be used to collect perceptions of the preventive health behavior of adopting an HMS. Based on the association of the innovation attributes with the innovativeness of the survey respondent, the data will be analyzed to describe the potential adopter categories.

Figure 3: Analytical Framework of DOI and HMS

Based on the Diffusion of Innovations theory, a survey instrument was modified and piloted with a 5-point Likert scale.

The instrument will be used to measure anticipated innovation attributes of a home monitoring system in order to describe potential adopters among adults 45 to 64 years of age living in Chevy Chase and Bethesda, Maryland.

Independent Variables:
(Anticipated) Innovation Attributes

Dependent Variable:
Intention to adopt innovation, a
Home Monitoring System (HMS)

Relative Advantage: To what degree do I anticipate getting an HMS would give me greater control over my health as I age?

1	2	3	4	5
Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

Positive correlation with innovativeness

Compatibility: To what degree do I anticipate getting an HMS would fit into my plans to remain independent at home?

1	2	3	4	5
Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

Positive correlation with innovativeness

Complexity: To what degree do I anticipate installing & operating an HMS would not be difficult?

1	2	3	4	5
Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

Negative correlation with innovativeness

PLAN OF ANALYSIS

For the purposes of this descriptive study, data were entered and statistical analyses were run using the IBM SPSS Statistics Standard GradPack version 20 for Windows as the statistical software.

Data Coding and Entry

All survey responses were collected and entered into the SPSS Statistics Data Editor. Data were coded as being nominal, ordinal or as an interval. Responses to the DOI questions that were captured on a five-point Likert scale were nominal and coded as follows: 1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. Responses to background questions ascertaining employment and health status were ordinal and coded from 1 to 5. For employment, "1" represented the lowest value and was assigned to "Not currently working – other" while "5" was the highest value and coded for "Employed full time". For health status "1" represented "poor" while "5" represented "Excellent". Responses to highest level of education completed was also ordinal and coded from 1 to 7 with "1" representing "some grade school" and "7" representing "postgraduate degree".

Questions that resulted in a binary outcome such as "would you get a home monitoring system in the future…" were coded as a "1" for yes and "0" for no. Questions about purchase preference of an HMS were coded so that each option "Online retail, Pharmacy, General Retail, etc" was treated as having a separate binary outcome. The only question that resulted in an open response and coded as an interval was "what is your current age" where respondents were asked to write in their age, which was then entered into the data set.

Data Analysis Procedures

The first step of the data analysis was to run a basic frequency analysis for all variables to get a description of the demographics in the participant sample and the participants' responses. For the continuous variable of age, the mean, median, mode and standard deviation were reported. For categorical variables, proportions within each category were reviewed. The frequency of responses for purchase preferences of an HMS was captured to answer the question of whether a preference would emerge among the sample of respondents.

To answer the hypothesis and research questions one and two, a logistic regression analysis was performed to find if there was any evidence to support whether an association existed and if so, what the nature and magnitude of that association was. Any independent variables that appeared to be associated with the intention to adopt an HMS were reviewed for statistical significance ($p < 0.05$). A series of Pearson correlation analyses was used to determine what the nature (positive or negative) and relative strength of the associations between the variables would be.

In order to enable the regression and correlation analyses to be run, the responses to the DOI questions were transformed to create one continuous variable for each of the three innovation attributes (relative advantage, complexity and compatibility).These were then run individually against the responses to the intent to adopt an HMS as a dependent variable. The three innovation attributes were also combined to form one composite variable to reflect overall innovativeness where the higher the value, the more innovative the respondent. The resulting composite DOI variable was then compared to the HMS dependent variable and the nature of the association was noted and organized

into Table 4. The next chapter will discuss the results of these analyses, as well as the

findings related to participant characteristics and purchase preferences of an HMS.

Chapter 4: Results

Findings Regarding Participant Characteristics

A total of 71 adults participated in this pilot study by completing the *Home Monitoring System Survey*. All survey questions were answered, resulting in no missing data. All participants had to reside in either Chevy Chase or Bethesda, Maryland, have the desire to remain in their homes as they aged versus moving into an institution such as an assisted living facility and fall into the age range of 45 to 64 years of age in order to be eligible for the study. Table 2 displays the demographics of this sample of participants.

To provide greater context for describing potential adopters, demographic variables that included age, employment, health and education status were captured. With an age range of 45 to 64 in a relatively modest sample size (N=71), the mean was 55, median was 56 and the mode was 48 with a standard deviation of 6. When looking at both self-reported age and employment status, the sample generally fell into one of two ends of the spectrum. When asked to report their age, the majority of participants either belonged to the oldest age bracket of 60 to 64 (35%) or the youngest 45 to 49 bracket (27%). When asked about employment status most were still employed full time (41%) with a significant percentage identified as being retired (34%).

Regarding health status and education, the participants tended to lean towards the higher end of the spectrum, being in good health and highly educated. When asked about their health, a majority of respondents perceived themselves to be in "very good" health (48%) while only a few believed themselves to be in either "fair" (3%) or "poor" (1%) health. When asked about the highest level of education completed, the skew was more

apparent with more than half responding as having completed a "postgraduate" degree (58%), followed by "college" (34%). None of the participants sampled replied as having obtained a level of education below "some college". This high concentration of participants having obtained either a college or postgraduate degree is consistent with the demographic census data reported for Chevy Chase and Bethesda, Maryland where the percentage of bachelor or postgraduate degrees obtained was more than twice that of the general population (80% vs. 28%) (USCB, 2010).

Most of the 71 participants of this study fell into an age range that is representative of the Baby Boomer generation (47 to 65 years of age). More than half (51%) of Baby Boomers are caregivers, having taken care of an older relative or friend (AARP International, 2010). Given the over representation of caregiving among Baby Boomers and the relevance caregiving has towards the provision of LTSS for the country's aging population, participants of this study were asked about their caregiving status and if they knew of someone who would become their caretaker when they themselves reached old age. The author was interested to see how caretaking was represented in this sample and ultimately, if results from these two survey questions on caretaking had any relationship with the intention to adopt an HMS in the future as a preventive health behavior. Consistent with the AARP study, a little more than half of the survey's respondents reported having taken care of an older relative or friend (52%) and many more reported having someone who would look after them in old age (61%).

When asked if they would get an HMS in the future to help them age independently at home, 45 of the participants or 65% marked "yes". Since this skew towards the intention to adopt an HMS was larger than the previously conservative

estimate of 50% , the author went back to the Raosoft sample size calculator and revised

the input to reflect the 65% response distribution. The impact to the recommended

sample size went down but was negligible, going from an N = 68 down to an N = 62.

Table 2: *Frequency of Participant Demographics*

Age	Count	Percent
45 - 49	19	27%
50 - 54	16	23%
55 - 59	11	15%
60 - 64	25	35%
Total	*71*	*100%*
Education Level*	**Count**	**Percent**
Some College	6	8%
College (Associate or Bachelors)	24	34%
Postgraduate	41	58%
Total	*71*	*100%*
Work Status	**Count**	**Percent**
Not currently working - other	1	1%
Not currently working - retired	24	34%
Homemaker	4	6%
Employed part time	13	18%
Employed full time	29	41%
Total	*71*	*100%*
Health Status	**Count**	**Percent**
Poor	1	1%
Fair	2	3%
Good	19	27%
Very Good	34	48%
Excellent	15	21%
Total	*71*	*100%*
Caretaking Status	**Count**	**Percent**
Q10. Are you currently or have you ever taken care of an older relative or friend?		
No	34	48%
Yes	37	52%
Total	*71*	*100%*
Care for You	**Count**	**Percent**
Q11. Do you know someone who could look after you if you needed help in your old		
No	28	39%
Yes	43	61%
Total	*71*	*100%*
Intention to Adopt an HMS	**Count**	**Percent**
Q13. Would you get a home monitoring system in the future to help you remain independent safely in your home longer?		
No	25	35%
Yes	46	65%
Total	*71*	*100%*

*There were no responses for education levels below "some college".

Findings Regarding DOI Innovation Attributes

In order to test the study's hypothesis, a series of statistical analyses was performed to collect evidence of whether an association between the select innovation attributes and the intention to adopt an HMS in the future existed. If evidence supported the existance of an assocation, further analysis was done to acertain whether the nature of that assocation was consistent with the DOI theory. To review, the primary hypothesis is that among adults 45 to 64 years of age, residing in Chevy Chase or Bethesda, Maryland, an association would exist between the perceived innovation attributes (relative advantage, compatibility and complexity) of an HMS and the intention to adopt an HMS in the future. Respondents who perceived an HMS as being relatively advantagous, compatitible with their beliefs and not overly complex to use or understand are more likely to demonstrate their innovativeness by answering "yes" to the question of whether they intended to get an HMS in the future to help them remain independent safely in their home longer.

As displayed below in Table 3, the results from the logistic regression anlaysis supports the hypothesis by providing evidence that all three innovation attributes are assocated with the intention to adopt an HMS with significance values below the statistical significance level ($p < 0.05$), particuarly for perceived relative advangtage and compatibility with a significance level of ($p < 0.01$). The odds ratio (OR) for all three innovation attributes are all well above 1.0 and are signficant at the 95% confidence interval (CI) level. However the strength of this association should be approached with some caution. As indicated by the unusually high OR = 15.31 and the wide range of the 95% CI: 3.53, 66.45, perceived compatibility appeared to be a highly imprecise variable

to predict the intention to adopt an HMS in the future. This is likely due to the small sample size (N=71), which makes this measure vulnerable to the influence of extreme values or outliers.

Table 3: *Logistic Regression Analysis of DOI Variables & HMS*

Variable	B	S.E.	df	Sig.	Exp(B)	95% CI Lower	Upper
Complexity	0.49	0.20	1	0.02	1.64	1.10	2.43
Constant	-3.26	1.59	1	0.04	0.04		
Relative Advantage	1.10	0.26	1	0.00	2.99	1.81	4.94
Constant	-6.64	1.70	1	0.00	0.00		
Compatibility	2.73	0.75	1	0.00	15.31	3.53	66.45
Constant	-18.08	5.12	1	0.00	0.00		

Similarly, the results from the Pearson correlation analyses, displayed in Table 4 also provided evidence to support that an assocation exists between the innovation attributes and the intention to adopt an HMS in the future. Individually, the three DOI variables are shown to be positively correlated with intent. Perceived relative advantage (0.64) and compatibility (0.80) are shown to be highly correlated at the significance level of ($p < 0.01$) while perceived complexity is also positively correlated (0.30), but less so at the significance level of ($p < 0.05$).

When the DOI variables were transformed into one composite variable, the results remained consistent in supporting that the higher the perceived relative advantage, complexity and compatibilty were positively correlated with the intention to adopt an HMS at the significance level of ($p < 0.01$).

Table 4: *Pearson Correlations of DOI Variables with HMS*

	HMS	Complexity	Relative Advantage	Compatibility	Complexity + R.Adv + Compatibility
HMS	1	0.30*	0.64**	0.80**	0.76**
Complexity		1	0.32**	0.36**	0.64**
Relative Advantage			1	0.67**	0.86**
Compatibility				1	0.88**
Complexity + R.Adv + Compatibility					1

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Findings Regarding Demographic Variables

To provide greater context for describing potential adopters, additional research questions involved the capture of demographic variables to determine if any of the variables were associated with the intention to adopt an HMS as a future preventive health behavior.

RQ #1: Will an association exist between independent variables (age, education, health and work status) and the intent to adopt an HMS in the future be detected?
A logistic regression analysis failed to show evidence to support that any of the independent demographic variables were significantly associated with the dependent variable of intention to adopt an HMS in the future. As shown below in Table 5, the significance levels of age, education, work and health status were well above the accepted significance level ($p < 0.05$) and all 95% CI included the value of 1.0. The results from the Pearson correlation analysis were consistent with this finding as exhibited in Table 6 where no assocation was found at either the significance level ($p < 0.01$ or 0.05).

RQ #2: Will an association exist between caretaking status, the perceived

presence of a future caretaker and the intent to adopt an HMS in the future be

detected?

When the element of caretaking was analyzed, the variable reflecting perceived presence of a future caretaker was not significantly associated with the intent to adopt an HMS. However, there was evidence to support that an association did exist between caretaker status and intent. Results from the logistic regression analysis revealed an OR of 4.82 and 95% CI: 1.67, 13.96. Again, based on the high OR and wide CI range, the precision of the caretaker variable as a predictor of intent should be viewed with caution. This again is likely a function of the small sample size and vulnerability to extreme values in the data set. Results from the Pearson correlation analysis show that caretaker status is positively correlated with intent to adopt at the significance level ($p < 0.01$).

Table 5: *Logistic Regression Analysis of Demographic Variables & HMS*

Variable	B	S.E.	df	Sig.	Exp(B)	95% CI Lower	95% CI Upper
Age	-0.06	0.04	1.00	0.14	0.94	0.87	1.02
Constant	3.92	3.02	1.00	0.08	50.24		
Education	0.34	0.38	1.00	0.38	1.40	0.67	2.94
Constant	-1.57	2.46	1.00	0.52	0.21		
Work Status	0.23	0.19	1.00	0.21	1.26	0.88	1.82
Constant	-0.22	0.70	1.00	0.75	0.80		
Health Status	0.28	0.30	1.00	0.36	1.32	0.73	2.37
Constant	-0.45	1.16	1.00	0.70	0.64		
Caretaker Status	1.57	0.54	1.00	0.00	4.82	1.67	13.96
Constant	-0.12	0.34	1.00	0.73	0.89		
Caretaker for you	0.55	0.51	1.00	0.28	1.73	0.64	4.67
Constant	0.29	0.38	1.00	0.45	1.33		

Table 6: *Pearson Correlations of Demographic Variables with HMS*

	HMS	Age	Education	Work	Health	Caretaker	Care for You
HMS	1.00	-0.18	0.11	0.15	0.11	0.36**	0.13
Age		1.00	-0.11	-0.37**	-0.19	0.02	0.13
Education			1.00	0.13	0.17	-0.01	-0.01
Work				1.00	0.28*	0.20	-0.05
Health					1.00	0.09	0.16
Caretaker						1.00	-0.02
Care for You							1.00

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Additionally, results from the Pearson correlation analysis suggested that a relationship exists between the individual demographic variables themselves. Work status was negatively correlated with age ($p < 0.01$), which suggests that the older the

respondent, the less likely he or she was to be employed full time. In contrast to age, health status was shown to be positively correlated with work also at the significance level ($p < 0.05$). This suggests that a person was more likely to perceive themselves as being in good health if employed full or part time versus those who were unemployed.

Findings Regarding Purchase Preferences

In addition to describing potential adopters of HMSs based on demographic variables and their perceptions using the DOI variables, the author was interested in describing the behavior of potential adopters as consumers. This was expressed through the following question:

RQ #3: Will clear preferences for where to purchase an HMS in the future emerge?

The results from the frequency analysis showing the purchase preferences among study participants for an HMS are displayed below in Table 7. Overall, results were fairly constant with little variance in percentages of responses for home improvement, pharmacy, general retail, and responses for "none of the above". There was a slight preference for purchasing an HMS from an electronics store (14.5%) and an online retail outlet (16.9%), however the greatest preference for purchase was directly from the manufacturer or service provider (25%)

Table 7: *Frequency of Purchase Preferences of an HMS*

Purchase Preference	Count	Percent
Q12. Where would you want to purchase a home monitoring system? (Check all that apply)		
Directly from manufacturer or service provider	31	25.0%
Online retail (ex: Amazon)	21	16.9%
Home improvement (ex: Home Depot, Lowes)	10	8.1%
Pharmacy (ex: CVS, RiteAid)	13	10.5%
Consumer electronics (ex: Best Buy, Radio Shack)	18	14.5%
General retail (ex: Costco, Walmart, Target)	15	12.1%
None of the above	16	12.9%
Total	*124*	

Chapter 5: Discussion

SUMMARY OF CENTRAL FINDINGS AND IMPLICATIONS

This explorative study was piloted among residents of Chevy Chase or Bethesda, Maryland who want to remain in their homes or their communities as they age. Based on this sample of adults 45 to 64 years of age, potential adopters of an HMS can be described as largely older Baby Boomers who were either working full time or retired, believed themselves to be in good or very good health and have obtained a high level of education with the majority of them having completed a postgraduate degree or at minimum have had some college. When asked if they would get an HMS in the future, a surprisingly high percentagae of them demonstrated innovatieness with 65% of the participants marking "yes", they would get an HMS in the future.

Findings from this descriptive study provided evidence to support that an association does exist between the perceived attributes of an innovation and the innovativeness of the individuals who hold those perceptions as posited by the DOI theory. The nature of this association is positively correlated, which means that the more an individual perceives an HMS as being relatively advantageous, compatible with their beliefs and less complex to use or understand, the more likely that individual's intention is to adopt an HMS. Adoption of an HMS would be perceived as a preventive health behavior that enables a person to remain in their residence of choice. The desire to "age in place" can refer to their immediate home or in another physical dwelling that is still in their community, thus delaying the premature move out of their homes or communities and into an institutionalized setting due to what could have been a preventable adverse health event such as a debilitating fall, a reoccurring urinary tract infection or missed

medication adherence.

Knowing that a potential audience segment perceives an HMS as not being compatible with how the segment wants to manage their health or that the information provided by HMSs on a website is too difficult to access or interpret can inform the positioning of product benefits. These efforts can directly address deficiencies in consumer awareness, knowledge or understanding. Knowing how an HMS is perceived against the DOI innovation attributes can also inform improvements in product development such as a better user-interface on the website to make the personal data more accessible and sensitive to lower health literacy levels of a diverse consumer audience. Such insights could also support the streamlining of product features that may be contributing to the perceived complexity of using an HMS.

Of the demographic variables that were analyzed, which included age, education, work and health status, none appeared to be significantly associated with the intention to adopt an HMS. Additionally, perceived presence of a future caretaker also did not appear to be associated, neither possessing a negative or positive correlation that was statistically significant. This is surprising since individuals who believe they will have a caretaker in the future may not see the need for an HMS, thus contributing evidence of a negative correlation. Those who did not expect a future caretaker may see an HMS as helping them meet a future need that otherwise may go unmet due to the absence of a future caretaker, thus exhibiting a positive correlation.

The analyses did however provide evidence to support that caretaker status was significantly associated with the intention to adopt an HMS. The association was positively correlated, which suggests that individuals who have witnessed and attended

to the provision of LTSS of an aging relative or friend may be more aware or realistic of their own future needs as they themselves age. This is an important finding with potential implications from both a marketing and a public health perspective. Given the large percentage of Baby Boomers who are caregivers, there may be an emerging audience segment who are faster to adopt an HMS and be more receptive to marketing messages that promote technological innovations like HMS to help them gain greater control over managing their health versus burdening their family members. From a public health perspective, greater use of supportive technologies like HMS may reduce the percentage of aging adults who have unmet LTSS needs, a prevention objective in *Healthy People 2020* (HealthyPeople.gov, 2020 Topics & Objectives, Objectives tab).

An insight into consumer behavior that emerged from this study suggests that potential adopters prefer to purchase HMSs directly from the manufactuer. The preferance to purchase directly from a manufacturer could indicate that consumers expect they would receive a higher level of support in using an HMS from that manufacturer. One possible explanation for this perference may be that people have lower expectations for customer support in general retail outlets. Consumers may perceive that a manufactuer of an HMS is more familiar with the set up and trouble-shooting of the monitoring devices. They may also be more knowledgeable and professional in explaining how the sensitive data can be accessed and interpreted on the secure website.

LIMITATIONS

Participant Recruitment – Potential Responder Bias

There are four main limitations to the methodology of this pilot study. The first limitation in methodology is in the manner by which participants were recruited. No incentive was provided and recruitment was purely voluntary as a convenience sample. Since the sample was not randomly selected, the findings from this study are vulnerable to responder bias. The absence of missing data in all 71 surveys may be indicative of this bias where responders may have felt compelled to complete the survey or provide responses that favored the adoption of an HMS in the presence of the survey administrator. Therefore the findings from this study have limited generalizability for a larger population and are intended as explorative to inform future studies.

Omission of Race, Gender & Marital Status – Lack of Uniformity

Another limitation of this study is associated with the instrument modification where race, gender and marital status were not captured in an effort to include variables that were supported by the DOI theory and literature review to hold greater promise as predictor variables for the intention to adopt an HMS. Although race, gender and marital status were part of the set of demographic questions captured in the origial *Adult Monitoring Candidates: In-Home Monitoring Survey,* they were omitted from the modified *Home Monitoring System Survey*, therefore breaking from traditional uniform data collection standards. Given the absence of participant incentive and the subsequent need to minimize respondent burden, the *Home Monitoring System Survey* was reduced from 24-items to one containing 16-items and piloted to measure the anticipated DOI

variables that were selected as the innovation attributes of interest. Additional

background questions that were selected over race, gender and marital status were age,

education level, work and health status. These demographic questions were selected

based on the author's interpretation of "personality variables" that were generalized for

earlier adopters by Rogers (2003, p. 289). Questions associated with caretaking were

selected based on the literature review which indicated caretaking as an important

element in aging among the Baby Boom generation.

Sample Size - Limited

      The third and likely most significant limitation of this pilot study involves the

small sample size. As previously referenced, participants in this study represent a small

sample of a narrow segment of the general population. The sample was taken from a

population that exhibits a relatively high socio-economic and educational background,

which may be most open to innovation given what Rogers termed as their

"cosmopoliteness". Studying a population that is more likely to adopt an innovation

allows researchers to describe a best-case scenario" to identify factors that are most

conducive to rapid adoption rates. Isolating and verifying these elements could help

researchers and marketers target other populations, which exhibit similar characteristics

to promote greater adoption.

      Although the intention behind conducting this exploratory descriptive study was

to determine whether there was evidence to support that an association exists between

the DOI variables, demographic variables and the intention to adopt an HMS as a

preventative health behavior, it cannot be emphasized enough that the purpose of this

study was not to quantify the existence of a pure statistical relationship or to validate the modified instrument referred to as the *Home Monitoring System Survey*. The modest sample size (N=71) may have been adequate to identify the presence of an association and where significant, the nature and strength of that association, however these associations should be treated as directional in nature.

For those variables where there was evidence of an association but with an unusually high OR or a wide 95% CI, the precision of those variables to predict the likelihood of an intention to adopt an HMS should be approached with some caution. It is likely that the small sample size makes the analysis highly vulnerable to extreme values or outliers in the data set. For those variables where there was no evidence to support that an association exists, the reason may again be attributed to the small sample size where the effect of the variable was not large enough to be detected. This does not mean that no association exists and that those variables should be dismissed given the limitations of this single study.

Application of Theory – Potential Individual Bias

Regarding the application of the DOI theory to describe potential adopters of an innovation like HMSs, it should be acknowledged that the DOI theory has been criticized as having a bias towards the innovation-individual where "patterns of adoption reflect fixed personality traits". This could be problematic since human behavior and perception can be changed. A more "innovation-systems fit" approach which allow one to consider the broader context in which the innovation is being presented and therefore take into consideration the elements in that context that affect individual behavior

(Bourdenave, 1976, Greenhalgh et al., 2004). There are many factors outside of the individual adopter that can influence the rate at which an HMS is adopted. For example, in health care, the role that payment mechanisms such as private insurance or Medicare reimbursements play cannot be overstated. Influencers such as physicians, caregivers and peers can also influence individual adoption rates that can turn what was once a "late adopter" or "laggard" into "an early adopter" which rejects the DOI's treatment of these categories as static, "stereotypical and value-laden terms" (Greenhalgh et al., 2004).

Conversely, it can also be argued that within the context of the relationships of new technology and older adults, there should be more emphasis on the individual and not less. Although "structural approaches provide important social insights," they are limited in aiding our "understanding of how older adults might actively incorporate technology in their daily lives and in the contexts" that are most meaningful to them (Rodeschini, 2011).

Although this study focused on the individual to describe potential adopters, the complexity of shaping consumer perception in order to influence their behavior likely requires a balanced application of behavior and systems theory. Possessing a more holistic understanding of adopter characteristics and the environment in which those adopters are influenced is likely more effective at promoting greater trial and ultimately adoption rates of promising technology. This is particularly true in the healthcare market, where the dynamic nature of technological innovations, the increasing need for LTSS and pressure to decrease healthcare costs seem to have long outpaced the time and money needed to conduct careful studies that show meaningful use.

DIRECTIONS FOR FUTURE RESEARCH AND INTERVENTIONS

As discussed throughout this paper, an area for future research is the execution of the *Home Monitoring System Survey* to a sample size that is large enough (N > 345) to more precisely quantify the relationship between the independent DOI and demographic variables with the dependent variable of intent to adopt an HMS. A larger sample size would allow for a more rigorous test of the validity and reliability of the modified instrument. Findings from the larger test should be statistically significant enough to be more generalizable for a larger segment of the population. For example, the survey could be administered to residents of multiple towns which exhibit similar socio-economic demographics but are located in different geographic regions.

Additional variables that allow for easier media targeting such as gender, marital status and income could also be considered in the data capture. However respondent burden should be carefully considered when expanding the current survey beyond its 16-item count. Providing an incentive may allow for the administration of a longer survey and encourage a higher rate of survey participation. Delivering the survey through the phone or mail may also allow for a randomized selection, which would address the inherent bias of convenience sampling where the presence of the survey administrator may influence the responders.

CONCLUSION

Little is still known about the impact of assistive monitoring technologies on health outcomes because of the shortage of qualified cases or users to quantitatively demonstrate real impact. Given the nation's historic period of healthcare reform and the

increasing attention given to public health and technology as "upstream" paths toward reducing costs while improving the quality of care for older adults, an investment in research that looks to encourage faster adoption rates of promising technology becomes critical for providing the needed cases to support the necessary research on the efficacy of those innovations.

This study is innovative since it is the first study to the author's knowledge, to measure the perceptions and demographic characteristics to describe potential adopters of HMSs using participants in Chevy Chase and Bethesda, Maryland to illustrate a "best-case scenario" for the rapid adoption of a promising assistive technology. In addition to serving as a requirement for the attainment of a Master in Public Health from the department of Behavioral and Community Health, the author intends to share the findings from this study with LeadingAge's Center for Aging Services Technologies (CAST) and BeClose, a healthcare technology start-up and manufacturer of HMSs. It is the author's hope that the findings from this study can inform future research and improve efforts to encourage faster rates of adoption, particularly in the consumer marketplace where rapid diffusion of promising technologies can have the greatest impact on improving health outcomes for a new aging population.

Chapter 6: Appendices

Appendix A: IRB Application Approval

UNIVERSITY OF MARYLAND
INSTITUTIONAL REVIEW BOARD

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Initial Application Approval

DO NOT REPLY TO THIS EMAIL ADDRESS AS IT IS UNMONITORED

To: Principal Investigator, Dr. Cheryl Holt, Behavioral and Community Health
Student, Quynh Tran, Behavioral and Community Health

From: James M. Hagberg
IRB Co-Chair
University of Maryland College Park

Re: IRB Protocol: 11-0813 - Application of Diffusion of Innovations: A Descriptive Study on the Perception of Home Monitoring Systems by Maryland Adults 45 to 64 Years of Age

Approval Date: January 12, 2012

Expiration Date: January 12, 2013

Application: Initial

Review Path: Expedited

The University of Maryland, College Park Institutional Review Board (IRB) Office approved your Initial IRB Application. This transaction was approved in accordance with the University's IRB policies and procedures and 45 CFR 46, the Federal Policy for the Protection of Human Subjects. Please reference the above-cited IRB Protocol number in any future communications with our office regarding this research.

Recruitment/Consent: For research requiring written informed consent, the IRB-approved and stamped informed consent document will be sent via mail. The IRB approval expiration date has been stamped on the informed consent document. Please note that research participants must sign a stamped version of the informed consent form and receive a copy.

Continuing Review: If you intend to continue to collect data from human subjects or to analyze private, identifiable data collected from human subjects, beyond the expiration date of this protocol, you must submit a Renewal Application -http://www.umresearch.umd.edu/IRB/renewal.html) to the IRB Office 45 days prior to the expiration date. If IRB Approval of your protocol expires, all human subject research activities including enrollment of new subjects, data collection and analysis of identifiable, private information must cease until the Renewal Application is approved. If work on the human subject portion of your project is complete and you wish to close the protocol, please submit a Closure Report http://www.umresearch.umd.edu/IRB/closure.html) to irb@umd.edu.

Modifications: Any changes to the approved protocol must be approved by the IRB before the change is implemented, except when a change is necessary to eliminate an apparent immediate hazard

Appendix B: Consent Form

Project Title	Application of Diffusion of Innovations: A Descriptive Study on the Perceptions of Home Monitoring Systems by Maryland Adults 45 to 64 Years of Age
Purpose of the Study	This research is being conducted by Quynh Tran under the guidance of Cheryl L. Holt, PhD at the University of Maryland, College Park. We are inviting you to participate in this research project because you are between 45 and 64 years of age, reside in Chevy Chase or Bethesda, MD and intend to age in your home or community. The purpose of this research project is to measure your intent to get a home monitoring system in the future as a preventive health behavior that may help you age in your home or community.
Procedures	The procedures involve: • Your signed consent on this consent form. • Your written completion of a16-question survey on how you feel about getting a home monitoring system to help you remain independent in your home longer. • An example of a question is: "Would you get a home monitoring system in the future to help you remain independent safely in your home longer?" • Completion of the survey should take 15 minutes or less.
Potential Risks and Discomforts	Any potential risks or discomforts that you may incur by participating in this study are expected to be minimal and may be related to possible anxiety brought on by thinking about the natural decline that occurs with aging or the loss of independence. Concern over the loss of confidentiality may also be a potential risk. Please see "Confidentiality" below for how your privacy will be protected.
Potential Benefits	There are no direct benefits to participants. However possible indirect benefits include awareness of healthcare technology that may help you age in your home or community safely and independently. We hope that, in the future, other people might benefit from this study through improved understanding of the benefits around the home monitoring system as an innovation that will help them remain in their homes longer as they age.
Confidentiality	Any potential loss of confidentiality will be minimized by storing data in a secure location such as a password protected computer. If we write a report or article about this research project, your identity will be protected to the maximum extent possible. Your information may be shared with representatives of the University of Maryland, College Park or governmental authorities if you or someone else is in danger or if we are required to do so by law.

University of Maryland College Park

Medical Treatment	The University of Maryland does not provide any medical, hospitalization or other insurance for participants in this research study, nor will the University of Maryland provide any medical treatment or compensation for any injury sustained as a result of participation in this research study, except as required by law.
Right to Withdraw and Questions	Your participation in this research is completely voluntary. You may choose not to take part at all. If you decide to participate in this research, you may stop participating at any time. If you decide not to participate in this study or if you stop participating at any time, you will not be penalized or lose any benefits to which you otherwise qualify. If you decide to stop taking part in the study, if you have questions, concerns, or complaints, or if you need to report an injury related to the research, please contact the investigator, Dr. Cheryl L. Holt, University of Maryland, 2369 School of Public Health Building, College Park, MD 20742; 301-405-6659; cholt14@umd.edu. You may also contact the student investigator, Quynh Tran, 7203 Ridgewood Ave., Chevy Chase, MD. 20815; 301-907-5961; vanstinger2205@yahoo.com.
Participant Rights	If you have questions about your rights as a research participant or wish to report a research-related injury, please contact: University of Maryland College Park Institutional Review Board Office 1204 Marie Mount College Park, Maryland, 20742 E-mail: irb@umd.edu Telephone: 301-405-0678 This research has been reviewed according to the University of Maryland, College Park IRB
Statement of Consent	Your signature indicates that you are at least 18 years of age; you have read this consent form or have had it read to you; your questions have been answered to your satisfaction and you voluntarily agree to participate in this research study. You will receive a copy of this signed consent form. If you agree to participate, please sign your name below.
Signature and Date	**PARTICIPANT NAME** [Please Print]
	PARTICIPANT SIGNATURE
	DATE

IRB APPROVED
EXPIRES ON

JAN 1 2 2013

UNIVERSITY OF MARYLAND

Appendix C: Survey Recruitment Sign

UNIVERSITY OF MARYLAND
COLLEGE PARK STUDY

If you reside in Bethesda or Chevy Chase, MD.,
we want to know how you feel about a technology
that may help you remain independent

in your home longer.

Please take our short survey.
Responses are kept confidential.

Appendix D: Home Monitoring System Survey

Home Monitoring System Survey

Thank you for taking the time to complete this survey. Your opinions about using a home monitoring system are very important.

Introduction to Study:

In this study, we are interested in understanding how you would feel about using a wireless home monitoring system to monitor your movements when you need help remaining independent, alone in your home.

This study is part of a Master's thesis in Public Health at the University of Maryland, College Park. Your responses will be kept anonymous.

Home Monitoring System: How it Works:

1) Place small wireless sensors in key rooms throughout your home (ex: bedroom, bathroom, kitchen, living room).

2) The sensors will capture your day-to-day routine on a secure, private website where only you & those you've selected can log on to see your daily movement patterns.

3) If any small or reoccurring changes are noticed, (restless sleep, moving slower from room to room, etc.), you can get the advice of registered nurses 24/7 on whether the changes should be addressed before they turn into bigger health issues, like a debilitating fall.

4) Regular monitoring of your physical activity gives you information to manage your health proactively to help you remain independent in your home longer.

② Secure Personal Web page*

③ Access to 24/7 Nurse Assistance

① In Home Sensors *

④ Independence at Home

* Images used with permission from ReClow

Page 1 of 4   Adult Monitoring Candidates: In-Home Monitoring Survey; MODIFIED 12.19.11
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For the following questions, check *ONE* box for your answer unless otherwise noted.

1. It would not be difficult to set up a home monitoring system in my home.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

2. A home monitoring system would be more preferable than hiring a home health aide.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

3. Getting a home monitoring system would give me greater control over my health as I age.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

4. I am comfortable reading charts and graphs on a computer screen.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

5. Getting a home monitoring system would fit in with how I plan on remaining independent in my home as I age.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

6. I would be willing to have my movements monitored if it would help me maintain my independence safely at home longer.

Strongly Disgree	Disagree	Neutral	Agree	Strongly Agree

7. Do you currently live in Chevy Chase or Bethesda, Maryland?
   - ☐ Yes
   - ☐ No

8. What is your current age? _____ years

9. Would you like to remain in your home as you age?
   - ☐ Yes
   - ☐ No

10. Are you currently or have you ever taken care of an older relative or friend?
    - ☐ Yes
    - ☐ No

11. Do you know someone who could look after you if you needed help in your old age?
    - ☐ Yes
    - ☐ No

12. Where would you want to purchase a home monitoring system? (Check *all* that apply)
    - ☐ Directly from the manufacturer or service provider
    - ☐ Online retail (ex: Amazon.com)
    - ☐ Home improvement store (ex: Home Depot, Lowes)
    - ☐ Pharmacy (ex: CVS, RiteAid)
    - ☐ Consumer electronics (ex: Best Buy, Radio Shack)
    - ☐ General retail (Costco, Walmart, Target)
    - ☐ None of the above

13. Would you get a home monitoring system in the future to help you remain independent safely in your home longer?
    - ☐ Yes
    - ☐ No

14. What is the highest level of education you have completed? (Check *only one*)

- ☐ Some grade school
- ☐ Some high school
- ☐ High school diploma or General Educational Development (GED)
- ☐ Post-high school certificate program
- ☐ Some college
- ☐ College degree (Associate or Bachelors)
- ☐ Postgraduate degree

15. What best describes your current work status? (Check *only one*)

- ☐ Employed full time
- ☐ Employed part time
- ☐ Homemaker
- ☐ Not currently working – retired
- ☐ Not currently working – other

16. How would you describe your general health?

- ☐ Excellent
- ☐ Very good
- ☐ Good
- ☐ Fair
- ☐ Poor

Thank you very much for your time and thoughtful responses to this survey. Your opinions are very important to us and will remain anonymous.

Appendix E: Questionnaire Item from Health CD Rom Survey (Atkinson, 2007)

Table 4
Factor Loadings for Oblique Rotation by a Priori Attribute and Questionnaire Item

Factor	Factor Score	a Priori Attribute	Questionnaire Item
1	.9260	Relative Adv.	*HealthQuest* is better than using workbooks or paper and pencil tests for learning about health.
	.7811	Relative Adv.	*HealthQuest* is more interesting than other materials I have used as part of a course.
	.7227	Relative Adv.	Using *HealthQuest* made learning about health a better experience than I would have otherwise.
	.6538	Relative Adv.	I learned about health more quickly and easily because of using *HealthQuest*.
	.5934	Compatibility	*HealthQuest* fit right into the way I like to take courses.
	.4818	Compatibility	I think other classes should have programs like *HealthQuest*.
	.4249	Relative Adv.	I had more fun learning about my health because of using *HealthQuest*.
	.4019	Relative Adv.	*HealthQuest* offered me real advantages over the way I usually take classes.
2	.8193	Simplicity	I had no difficulty finding the information that I wanted.
	.8031	Simplicity	I had no difficulty understanding how to get around in *HealthQuest*.
	.7663	Simplicity	I had no difficulty understanding how *HealthQuest* technically worked.
	.7304	Simplicity	I had no difficulty getting the program to work on a CD-ROM.
	.7001	Simplicity	I had no difficulty in getting the activities to work.
3	.8574	Trialability	Being able to try out *HealthQuest* was important in my deciding whether or not to buy it.
	.6823	Trialability	Being able to try out *HealthQuest* was important in my decision to use it.
	.5642	Trialability	I am more likely to want to use *HealthQuest* because of being part of this pilot test.
	.5124	Compatibility	The name "*HealthQuest*" made me want to use the program.
4	.8242	Observability	Other students seemed interested in *HealthQuest* when they saw me using it.
	.8070	Observability	People can tell that I know more about my health since I've used *HealthQuest*.
	.6518	Observability	Other students using *HealthQuest* liked using it.
5	.6148	Observability	I would have no difficulty in telling friends what *HealthQuest* is like.
	.5889	Compatibility	Using this program made what I was learning in class seem more relevant to me.
	.5103*	Observability	I would have no difficulty in telling others taking this course how *HealthQuest* improved it.
	.5062	Compatibility	*HealthQuest* helped me learn more about myself while also learning about health.
6	.7565	Compatibility	*HealthQuest* helped me to learn more about technology while also learning about personal health.
7	.8841	Trialability	I really won't lose much by trying *HealthQuest*, even if I don't like it.
	.6105	Trialability	I like being able to try out *HealthQuest* before deciding whether I like it or not.
8	.8042	Simplicity	I had no difficulty controlling the audio and video segments.
	.4529	Simplicity	I had no difficulty understanding the information in *HealthQuest*.
	.4437	Observability	My instructor for this health class seemed to like using *HealthQuest*.

Appendix F: List of Items by Construct (Moore & Benbasat, 1991)

Table 4
Factor Loadings for Oblique Rotation by a
Priori Attribute and Questionnaire Item

Factor	Factor Score	a Priori Attribute	Questionnaire Item
1	.9260	Relative Adv.	*HealthQuest* is better than using workbooks or paper and pencil tests for learning about health.
	.7811	Relative Adv.	*HealthQuest* is more interesting than other materials I have used as part of a course.
	.7227	Relative Adv.	Using *HealthQuest* made learning about health a better experience than I would have otherwise.
	.6538	Relative Adv.	I learned about health more quickly and easily because of using *HealthQuest*.
	.5934	Compatibility	*HealthQuest* fit right into the way I like to take courses.
	.4818	Compatibility	I think other classes should have programs like *HealthQuest*.
	.4249	Relative Adv.	I had more fun learning about my health because of using *HealthQuest*.
	.4019	Relative Adv.	*HealthQuest* offered me real advantages over the way I usually take classes.
2	.8193	Simplicity	I had no difficulty finding the information that I wanted.
	.8031	Simplicity	I had no difficulty understanding how to get around in *HealthQuest*.
	.7663	Simplicity	I had no difficulty understanding how *HealthQuest* technically worked.
	.7304	Simplicity	I had no difficulty getting the program to work on a CD-ROM.
	.7001	Simplicity	I had no difficulty in getting the activities to work.
3	.8574	Trialability	Being able to try out *HealthQuest* was important in my deciding whether or not to buy it.
	.6823	Trialability	Being able to try out *HealthQuest* was important in my decision to use it.
	.5642	Trialability	I am more likely to want to use *HealthQuest* because of being part of this pilot test.
	.5124	Compatibility	The name "*HealthQuest*" made me want to use the program.
4	.8242	Observability	Other students seemed interested in *HealthQuest* when they saw me using it.
	.8070	Observability	People can tell that I know more about my health since I've used *HealthQuest*.
	.6518	Observability	Other students using *HealthQuest* liked using it.
5	.6148	Observability	I would have no difficulty in telling friends what *HealthQuest* is like.
	.5889	Compatibility	Using this program made what I was learning in class seem more relevant to me.
	.5103*	Observability	I would have no difficulty in telling others taking this course how *HealthQuest* improved it.
	.5062	Compatibility	*HealthQuest* helped me learn more about myself while also learning about health.
6	.7565	Compatibility	*HealthQuest* helped me to learn more about technology while also learning about personal health.
7	.8841	Trialability	I really won't lose much by trying *HealthQuest*, even if I don't like it.
	.6105	Trialability	I like being able to try out *HealthQuest* before deciding whether I like it or not.
8	.8042	Simplicity	I had no difficulty controlling the audio and video segments.
	.4529	Simplicity	I had no difficulty understanding the information in *HealthQuest*.
	.4437	Observability	My instructor for this health class seemed to like using *HealthQuest*.

Appendix G: Adult Monitoring Candidates: In-Home Monitoring Survey (Alwan et al., 2005)

Adult Monitoring Candidates: In-Home Monitoring Survey

Thank you for taking the time to complete this survey. Your opinions about the use of in-home monitoring systems for older adults are very important.

Introduction to project:

In this study, we will evaluate the feasibility of using an unobtrusive In-home Monitoring Systems (IMS) to monitor selected Independent Activities of Daily Living (ADLs*) of Older Adults while they are in their living setting / residence. IMS uses small, discrete sensors and computer technology to monitor an individual's activities, in a dignified manner, while they are in their home. The system automatically and securely collects the activity data- the monitored individuals do not have to do or wear anything special.

The feasibility evaluation phase will primarily target the acceptance of the technology by both Informal Caregivers** and Older Adults, the **need** for the technology, utility of the technology to Caregivers (both Professional and Informal), acceptable monitoring devices, willingness to share the collected information with appropriate parties, and willingness to pay for the monitoring services. Study groups are adult Professional and Informal Caregivers, and Adult Monitoring Candidates (primarily Older Adults). We will also be asking your opinion about the potential impact of this technology on Professional and Informal Caregivers, as well as the Adult Monitoring Candidates.

> * **ADL**s (Activities of Daily Living) include the ability to move from one place to another, eat, bathe, toilet, and dress in addition to the ability to control the bladder and bowels. **IADL**s (Instrumental Activities of Daily Living) include the ability to use transportation, shop for necessities, prepare meals, and perform house work.

> ** An **Informal Caregiver** is a person who is not paid to provide care services such as a family member, a friend, or a volunteer, etc.

Section One: Your Environment

1. In what type of setting do you currently live?

   ☐ Private home / apartment

   ☐ Independent living facility

   ☐ Assisted living facility

   ☐ Continuing care retirement community (a community offering different levels of care services)

   ☐ Skilled nursing facility

   ☐ Other, specify:_____

70

2. Do you have a primary person who helps provide care for you (home health aide, nurse, nurse aide, family member, or friend, etc.)?

☐ Yes

☐ No ————————➤   If No, go to question 4.

3. What is your relationship to the primary person, family member or friend who helps take care of you?

☐ My adult child (son / daughter)

☐ My spouse / significant other

☐ Sibling (brother / sister)

☐ Any other relative, specify:_____

☐ Friend

☐ Neighbor

☐ Other, specify:_____

<u>Section Two: General opinions about the use of in-home monitoring systems</u>

4. Do you think it is a good idea to have your activities <u>monitored</u> in your <u>designated home</u>? *"By <u>monitored</u> we mean the use of any technology (such as electronic equipment/ devices), including those that measure vital signs (such as pulse, breathing rate and blood pressure), and possibly cameras, for the assessment of your functional abilities and health; we will ask you about specific technologies later."*

☐ Yes
☐ No ———┐
☐ Unsure—┘

     If "No" or "Unsure"

     Why do you not wish to have your activities monitored? *(Check <u>all</u> that apply.)*

     ☐ Not necessary for me

     ☐ Personal privacy issues (e.g., I am a very private person, and do not wish anyone to know about my health or abilities to perform my ADLs*)

☐ Information privacy / security (e.g., unauthorized individuals might get access)

☐ The equipment might change the way my residence (home / apartment) looks

☐ The equipment might get in the way

☐ Other, specify: _____

5. In general, how _useful_ would it be to have the following activities monitored in your place of residence?

	not at all useful	a little useful	moderately useful	very useful	extremely useful
Pulse while in bed	☐	☐	☐	☐	☐
Breathing while in bed	☐	☐	☐	☐	☐
Body temperature while in bed	☐	☐	☐	☐	☐
Restlessness while in bed (sleep quality)	☐	☐	☐	☐	☐
Falls	☐	☐	☐	☐	☐
Bathing / showering	☐	☐	☐	☐	☐
Meal preparation	☐	☐	☐	☐	☐
Movement about the residence	☐	☐	☐	☐	☐
Stove / Microwave use	☐	☐	☐	☐	☐
Walking abilities and balance	☐	☐	☐	☐	☐
Taking medications	☐	☐	☐	☐	☐
Other ADLs / IADLs* Specify:_____	☐	☐	☐	☐	☐
Other, specify: _____	☐	☐	☐	☐	☐

6. Do you think the following activities _should_ be monitored?

	Yes	No	Unsure
Pulse while in bed	☐	☐	☐
Breathing while in bed	☐	☐	☐
Body temperature while in bed	☐	☐	☐
Restlessness while in bed (sleep quality)	☐	☐	☐

	Yes	No	Unsure
Falls	☐	☐	☐
Bathing / showering	☐	☐	☐
Meal preparation	☐	☐	☐
Movement about the residence	☐	☐	☐
Stove / Microwave use	☐	☐	☐
Walking abilities and balance	☐	☐	☐
Taking medications	☐	☐	☐
Other ADLs / IADLs* Specify___	☐	☐	☐
Other, specify:_____	☐	☐	☐
_____	☐	☐	☐

7. **Please rate your acceptability of the following types of monitoring systems.**

	definitely not acceptable	probably not acceptable	neither or not sure	probably is acceptable	definitely is acceptable
Cameras that record activities	☐	☐	☐	☐	☐
Cameras that produce body outline images without details	☐	☐	☐	☐	☐
Sound recorders	☐	☐	☐	☐	☐
Motion detectors	☐	☐	☐	☐	☐
In-home falls detectors	☐	☐	☐	☐	☐
Wearable fall detectors	☐	☐	☐	☐	☐
Automatic emergency response system / device	☐	☐	☐	☐	☐
Wireless object use detectors (e.g., wirelessly tagged dishes)	☐	☐	☐	☐	☐
Other, specify: _____	☐	☐	☐	☐	☐

8. Do you think the following people and agencies, associated with you, should have access to the monitoring information?

	Yes	No	Unsure
Your adult children (son / daughter)	☐	☐	☐
Your spouse / significant other	☐	☐	☐
Your sibling (brother / sister)	☐	☐	☐
Any other relative	☐	☐	☐
Friend	☐	☐	☐
Neighbor	☐	☐	☐
Volunteer Informal Caregiver**	☐	☐	☐
Health Care Provider	☐	☐	☐
911 Emergency Services	☐	☐	☐
Home Health Agency	☐	☐	☐
Hospital	☐	☐	☐
Medicare agency	☐	☐	☐
Medicaid agency	☐	☐	☐
Health Insurance company	☐	☐	☐
Yourself	☐	☐	☐
Other, specify: _____	☐	☐	☐

Section Three: Benefits and recommendations

This section is focused on the benefits of in-home monitoring systems and the reasons why you would choose an in-home monitoring system.

9. What are the potential benefits of in-home monitoring to <u>you</u>? *(Check <u>all</u> that apply.)*

☐ Show others how my ADLs* are

☐ Help me stay healthy and active

☐ Allow others to know whether I have taken my medications or not

☐ Notify others if I have fallen

☐ Allow others to know if I am not sleeping well

☐ Allow me to live at home safely instead of a nursing home or assisted living facility

☐ Allow my caregivers to possibly detect emerging / new health issues early

☐ Allow my caregivers to better manage my existing chronic health conditions

☐ Improved care coordination among my caregivers and health care providers
☐ Other, specify: _____

10. What are the potential benefits of in-home monitoring to your Professional Caregiver(s), such as doctors and/ or nurses? *(Check all that apply.)*

☐ Show others how my ADLs* are
☐ Help me stay healthy and active
☐ Allow others to know whether I have taken my medications or not
☐ Notify others if I have fallen
☐ Allow others to know if I am not sleeping well
☐ Allow me to live at home safely instead of a nursing home or assisted living facility
☐ Allow my caregivers to possibly detect emerging / new health issues early
☐ Allow my caregivers to better manage my existing chronic health conditions
☐ Improved care coordination among my caregivers and health providers
☐ Other, specify: _____

11. What are the potential benefits of in-home monitoring to your Informal Caregiver(s), such as family or friends? *(Check all that apply.)*

☐ Show others how my ADL* are
☐ Help me stay healthy and active
☐ Allow others to know whether I have taken my medications or not
☐ Notify others if I have fallen
☐ Allow others to know if I am not sleeping well
☐ Allow me to live at home safely instead of a nursing home or assisted living facility
☐ Allow my caregivers to possibly detect emerging / new health issues early
☐ Allow my caregivers to better manage my existing chronic health conditions
☐ Improved care coordination among my caregivers and health providers
☐ Other, specify: _____

12. Under what conditions listed below would you choose to have an in-home monitoring system? *(Check all that apply.)*

	I would choose	I would NOT choose	I am not sure
If the system or monitoring was provided at no cost to me or my family	☐	☐	☐

75

If I could select <u>what</u> is to be monitored (e.g., select from bed, gait, fall, and / or ADL monitors)	☐	☐	☐
	I <u>would</u> choose	I <u>would</u> <u>NOT</u> choose	I am not sure
If I could control <u>when</u> I was monitored (e.g., I could turn all or part of the monitoring system on / off as I desire)	☐	☐	☐

13. How would the cost of the in-home monitoring impact whether or not you would want such a system?

	I <u>would</u> want	I <u>would</u> <u>NOT</u> want	I am not sure
Monitoring is free to me and my family	☐	☐	☐
Monitoring is <u>less than</u> $50 per month	☐	☐	☐
Monitoring is $50-$100 per month	☐	☐	☐
Monitoring is $101-$150 per month	☐	☐	☐
Monitoring is <u>more than</u> $150 per month	☐	☐	☐

14. Do you think that an in-home monitoring system could help <u>your caregivers</u> provide better care for you?

☐ Yes
☐ No
☐ Unsure

15. Do you think that an in-home monitoring system could help <u>you</u> live a safer life?

☐ Yes
☐ No
☐ Unsure

16. Do you think that an in-home monitoring system would improve <u>your</u> quality of life?

☐ Yes
☐ No
☐ Unsure

<u>Section Four: Demographics</u>

17. What is your gender?

☐ Male

☐ Female

18. What is your current age?

_____ years

19. What is your ethnicity?

☐ Hispanic or Latino

☐ Not Hispanic or Latino

20. What is your race? (*Please choose one.*)

☐ American Indian or Alaskan Native

☐ Asian

☐ Black or African American

☐ Native Hawaiian or other Pacific Islander

☐ White

☐ Bi-racial / multi-racial, please specify: _____

☐ Other, please specify: _____

21. What is the highest level of education you have completed?

☐ None

☐ Some grade school

☐ Some high school

☐ High school diploma or GED

☐ Post-high school Certificate program

☐ College degree (Associate)

☐ College degree (Bachelor)

☐ Graduate degree (Master)

☐ Graduate degree (Doctoral)

22. What is your current work status?

☐ Employed full time

☐ Employed part time

☐ Homemaker

☐ Not currently working – retired

☐ Not currently working – other

23. What is your current marital status?

☐ Single, never married

☐ Separated

☐ Divorced

☐ Widowed

☐ Married

24. How would you describe your general health?

☐ Excellent

☐ Very good

☐ Good

☐ Fair

☐ Poor

Thank you very much for completing this survey. Your opinions are very important to us!

Appendix H: SMOG Readability Test Results

The "SMOG" Readability Test
(Short Version)

For materials containing > 30 sentences

1. Count off 10 consecutive sentences at the beginning, middle and end of the text.

2. Count the number of words with 3 or more syllables in the 30-sentence sample.
   Answer: **50**

3. Use the answer to step 2 to look up the reading grade level in the chart.

For materials containing < 30 sentences

1. Count the number of sentences: _____

2. Count the number of words with 3 or more syllables in the sample: _____

3. Divide the number of sentences in the sample into 30 (i.e., 30/25) and multiply this number by the number of words from step 2.
   Answer: _____

4. Use the answer to step 3 to look up the reading grade level in the chart.

Note:
- A sentence is defined as a string of words punctuated with a period, exclamation point, or question mark.
- Hyphenated words are considered one word.
- Numbers should be considered as if they were written out (i.e. both "25" and "twenty-five" should be considered to have 3 or more syllables).
- Proper nouns should be considered
- Abbreviations should be considered in their unabbreviated form.

"SMOG" Conversion Chart

Number of words with 3 or more syllables in a 30 sentence sample:	Approximate Reading Grade Level (plus or minus 1.5 grades)
0 – 2	4
3 – 6	5
7 – 12	6
13 – 20	7
21 – 30	8
31 – 42	9
43 – 56	10
57 – 72	11
73 – 90	12
91 – 110	13
111 – 132	14
133 – 156	15
157 – 182	16

Reading level of this material: ____**10**____ th Grade (plus or minus 1.5 grades)

4/14/08

http://prevention.sph.sc.edu/tools/SMOG.pdf

79

Appendix I: Approval Email of BeClose Marketing Materials

From: "Barth, Adam" <ABarth@beclose.com>
To: "vanstinger2205@yahoo.com" <vanstinger2205@yahoo.com>
Sent: Thursday, October 20, 2011 4:03 PM
Subject: FW: Graduate Work - BeClose as Example of Home Monitoring System

QT,

My name is Adam Barth. I am the principal engineer and I am in charge of academic outreach here at
BeClose. I don't think that it will be a problem to let you use the marketing materials, but I would love to talk
to you a little bit about what you are planning to do since it sounds very interesting. I am out of town until
Monday, but do you have some time early next week to talk? Is there a time on Monday that works for you?

Adam Barth, Ph.D.
Principal Engineer
BeClose

From: Quynh Tran [mailto:vanstinger2205@yahoo.com]
Sent: Wednesday, October 19, 2011 11:08 PM
To: BeClose (Info)
Cc: mjviederman@charter21.com
Subject: Graduate Work - BeClose as Example of Home Monitoring System

Hi there,

I'm not sure if "info@" is strictly a sales contact, which is why I am cc'ing the media contact
"mjviederman@" in hopes of being directed to the right person.

I am a 2nd year masters in public health student who would like to survey Baby Boomers about using
Home Monitoring Systems (to consider using for themselves in their future post-retirement years - vs.
- now for their parents). The installation of a Home Monitoring System would be positioned as a
preventative health behavior to promote aging in place by preventing accidents, such as falls in the
home from occurring.

Given relatively low awareness of these products and an aversion to facing the prospect of aging as
well as technology (for some), I would like to use some of your marketing images (on your website &
the brochure PDF) to help survey participants visualize the product - thereby making Home
Monitoring Systems more tangible.

I am not being funded by a grant or a larger study. The survey I am piloting will be to collect
directional qualitative data for use in my Masters Thesis. For the purposes of the thesis and any
publications that may come from it in the future, I will of course give credit to BeClose. The survey
would be administered to 50-65 year-olds in Chevy Chase and Bethesda Maryland.

Please let me know if I may use the BeClose online marketing materials for my research & if there
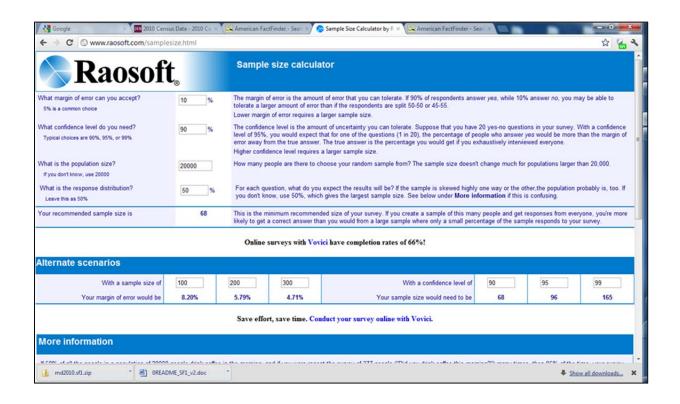are additional steps I need to take in order to secure this approval.

Your help / direction would be greatly appreciated.
Thank you,
~QT

Quynh Tu Tran
p: 202.258.7646
e: vanstinger2205@yahoo.com

Appendix J: Raosoft Sample Size Calculator

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