



The Health Impact of the Intelligent Home

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Intro

This white paper provides information on the research backdrop and the future potential for our Intelligent Home. We hope it will inspire individuals to think about ways to join or partner with Lake Nona Institute to further develop these technologies and explore potential use cases, using the home as a sort of “living laboratory” to pilot and assess new products and techniques.

Organization

Section I: Rationale behind our approach to constructing and using the Intelligent Home.

Section II: The second section provides a review of some pertinent medical research that demonstrates the feasibility and effectiveness of many of the components of the home, and similar systems of health tracking and coaching.

Section III: A sampling of potential research questions the home may help answer in its function as a living test bed. Next, the report demonstrates examples of research and innovation opportunities made possible by the Intelligent Home. Finally, the report provides a brief overview of future health themes and events planned for the home.

Rationale for Approach

The design and intention here is to create a home that helps improve and sustain health; a nurturing environment. This can take form in the most technologically advanced device and the simplest pairing of an image and story in a frame. A nurturing environment is restorative and proactive. It cues the individual and spurs them towards where they find health and meaning — on a regular basis. The very act of creating this environment acknowledges that nurturing is a basic human need—not always something special or extravagant—but something essential. The attributes of a nurturing environment are attributes that connect people to their better intentions, to where they find purpose and inspiration for health (Shepherd, 1997). The

Intelligent Home presents opportunities to find methods and measure the effects of creating a nurturing environment that address multiple dimensions of health.

With this home, we hope to illustrate ways that individuals and providers can work together to make their home a way to help improve and maintain the overall health and well-being of the family. A handful of conditions and health issues are currently being surveyed and addressed within the home, but we intend this model to be upgradable and flexible, such that we can accommodate and assess future conditions and points of concern.

Our aim is for the Intelligent Home to be useful not just as a single example or demonstration, but as a living laboratory and test bed to spur thinking and experimentation. In addition, we hope that the technologies and processes spurred by or vetted within the environment of the home will expand out from the individual family to the community level. Systems and models for families have the potential to interface and transfer out to the larger neighborhood and the population of patients served by particular practitioners or organizations.

The Value of Wellness:

The value of wellness is both personal and socio-economic. In addition to the impact that people can experience in their daily quality of life estimates show that of the nearly \$3 trillion spent annually on U.S. healthcare costs, 69% are heavily influenced by consumer behaviors, over 30% can be directly attributed to behaviorally-influenced chronic conditions, and medication compliance alone costs \$100 billion (Dixon-Fyle, Gandhi, Pellathy, & Spatharou, 2012).

Observably, lifestyle has a significant impact on healthcare expenditures – so much so that employers, major players in healthcare, and now retailers are seeking ways to help individuals improve their daily well-being and ultimately reduce healthcare spending.

Most recently, health promotion – in the form of wellness programs – has been gaining traction for its diverse array of potential impact on population health management. Wellness programs engage participants in a broad range of health education initiatives, create environments conducive to healthy lifestyles, and provide convenient access to health-oriented resources. While they have only recently started to receive large amounts of mainstream publicity, these programs have a history of success that is well documented in the scientific literature, ranging from improvements in biometric values, to improvements in health-related behaviors such as exercise and diet, to even more complex health issues, such as substance abuse and mental health (Loeppke 2013; Osilla 2012; Byrne 2011; Merrill 2011).

The Intelligent Home:

To maximize the potential for wellness initiatives to succeed, efforts must go further than merely implementing programs. An individual's ambient environment (or living space) must also be optimized to create a setting in which success is made easier and more achievable.

Intelligent homes are state-of-the-art residences designed with multiple cooperative and connected interfaces that encourage individuals to make healthful choices.

These smart homes transform the way individuals “make themselves at home” into ways they can help make themselves healthier. The interfaces connect residents more closely with the community, providers, insurers, and employees to minimize behavior-influenced healthcare costs. Inspired by innovations from Cisco, Florida Blue, GE, UCF, the VA, and Wellness &

Prevention, Inc., a Johnson & Johnson company, among other partners, the Ashton Woods model is an Intelligent Home that helps individuals re-imagine everyday living.

The Art of Presentation:

One way to optimize an individual's environment is to support positive behaviors by influencing daily decision-making. Understanding what impacts our everyday choices will enable us to shape the environment to support and promote positive behaviors. Choice architecture teaches us that we can structure our environment in ways that maximize the probability of making healthier choices by making them both easy and desirable while simultaneously creating subtle barriers to prevent making less healthy decisions. For example, convenience and accessibility of calorically dense fast foods encourages their consumption - it is much faster and easier to go to the local drive-thru for a greasy cheeseburger and an enormous, sugary drink than it is to cook a balanced, healthy meal at home. But what if this wasn't the case? What if your kitchen was specifically designed to make cooking a healthy meal for your family quick and convenient, and was even stocked with healthy foods that were organized in such a way that made them seem more accessible and appealing? Or with smaller plates that provided visual cues that made consuming appropriate portions easier? Having a plan for how your kitchen is organized will help you keep the healthy foods in reach, and the not-so-healthy ones stashed away for when you want a treat! (Ferriday & Brunstrom, 2008) Such an environment would make the choices required to live a healthy lifestyle much easier and would support healthy decisions.

In the same way that choice architecture can impact decisions, reframing the way that people think about concepts like nutrition can also support healthy changes. For example, it's important to eat a balanced diet and do so with moderation. (Schwartz & Byrd-Bredbenner, 2006.) Yet in America, many people believe that more is better; portion inflation is a major contributor to obesity and its comorbidities. Therefore, helping people appreciate the benefits of appropriate portion sizes, as well as understand the consequences of overconsumption, supports positive behavior change. (Schwartz & Byrd-Bredbenner, 2006). Similarly, Americans could be encouraged to embrace frequently eating small meals and snacks as a way to enhance performance rather than skipping meals, or consuming fewer or only one large meal, as a way to lose weight or manage time. It has been estimated that 95% of people who lose weight regain it. Healthy lifestyles could be made more palatable and sustainable by replacing the belief that a healthy diet means being deprived of your favorite foods with recommendations that encourage consuming a balance of desired or "want" foods with nutrient dense "need" foods.

Background Evidence

mHealth

Mobile technology is increasingly being used for assisted living for chronic conditions by offering ongoing monitoring, self-tracking, coaching/support, and reporting. In a literature review on mobile health-enabling technologies, Von Bargen, Schwartze, and Haux (2013) found that the most common disease addressed in these studies was diabetes, followed by AIDS, cardiac insufficiency, cancer, asthma, COPD, and schizophrenia, in addition to vitals monitoring. The cell phone features used for communication are primarily SMS and MMS messaging, along with some usage of telephone and videophone calls.

SMS messaging to help patients manage ongoing chronic conditions such as diabetes have shown promising results for patient self-monitoring/tracking as well as for providers to send

supportive and coaching messages. In their pilot of a telemedicine system to support glycemic control for adolescents, Rami et al. (2006) saw improved control when using the telemedicine solution for tracking versus using a paper diary method, as well as general high perception scores rating the program very good and wanting to continue. These programs are primarily helpful when combined properly with regular treatment plans to offer additional convenience and bridge gaps between consults. Sweet Talk, an SMS system for young persons with diabetes, improved self-efficiency (rating increased from 56.0 ± 13.7 to 62.1 ± 6.6) and self-reported adherence (rating increased from 70.4 ± 20.0 to 77.2 ± 16.1) when combined with conventional therapy; 82% of surveyed patients felt Sweet Talk improved their self-management, and 90% wanted to continue receiving messages (Franklin et al., 2006). With their Mobile Prescription Therapy (MPT) system for diabetes condition tracking, records access, and coaching, WellDoc has seen positive results in all components of care, including declines in HbA1c levels of 1.2% more among participants using the MPT solution versus patients receiving usual care, estimated cost savings per user per month of \$390 - \$630, as well as a 58% reduction in ER visits and 100% reduction in hospitalizations from the prior year among patients using the MPT (Quinn et al., 2011; Peeples & Iyer, in press; Katz, Mesfin, & Barr, 2012).

Mobile programs have also demonstrated some success in improving general health knowledge and awareness. Several mobile SMS health programs have shown some success in changing behavior. In their messaging program to improve sunscreen use, Armstrong et al., at Harvard's Center for Connected Health (2009), saw higher adherence rates among participants than the control group. The final mean daily adherence rate was 56.1% for the reminder group versus 30% for the control. Weight control and exercise programs have made up the majority of studies and also show general success. The MobileMums program, which sent 3-5 text messages per week to new mothers increased self-reported physical activity frequency by 1.82 days per week and walking exercise frequency by 1.08 days per week (Fjeldsoe, Miller, & Marshall, 2010). Other programs have also demonstrated increases in physical activity among the test groups (Hurling et al., 2007; Shapiro et al., 2012).

Telehealth

Mobile and telemedicine technologies within the home can also help patients stay in touch with their doctors and other healthcare providers in more convenient ways, allowing for increased doctor-patient communication while still lowering costs. In his two-year assessment of a system for mobile e-visits with doctors, Dr. William Thornbury (2013) saw approximately 15% increase in practice capacity alongside an almost equivalent percentage drop in per-capita costs, with a 97% rate of patient satisfaction and an average turnaround time of less than three minutes per consult.

Ambient Health

Home-embedded and mobile technologies for assisted living show promise for improving conditions for at-risk patients and condition maintenance for patients with chronic conditions. Mobile biometric monitoring has demonstrated use in assessing and monitoring risk for cardiovascular disease by tracking blood pressure, and assisting patients by processing data via a rule-based reasoning engine (Hervás et al., 2013). Embedded activity monitoring technologies within the home as well as via mobile devices are showing promise in monitoring and life improvement for elderly individuals who may be at risk for various health issues and can even track falls (Prescher et al., 2012; Bourke et al., 2012; Villacorta, Jiménez, Del Val, &

Izquierdo, 2011). A pre-emptive approach to patient falls and age-related diseases can also be addressed by using sensors within the carpet to track a patient's gait, which can be measured using stride cadence and length coupled with time-on-toe to time-on-heel ratio (Middleton, Buss, Bazin, & Nixon, 2005).

Though most assisted living and mobile health technologies rely on explicit and potentially even intrusive interactions, such as manually inputting data or wearing/using additional biometric sensing devices, current work is proceeding on using subtle communication and interaction mechanisms, such as color coding, which showed a 92% correct interpretation rate among participants with cognitive disabilities when used by augmented household objects to display food freshness (García-Herranz, Olivera, Haya, & Alamán, 2012).

Fitness and Wellness

The concept of the intelligent home is intended to help make a healthy lifestyle easier, and one of the ways this is accomplished is by making certain health-promotion resources available and easily accessible. One such resource, available to those who choose to participate in the Lake Nona Life Project, is Digital Health Coaching (DHC). DHC is an internet-based tool that uses participant feedback (guided by intelligent algorithms and established therapeutic techniques) to help individuals achieve a healthier lifestyle. Put simply, DHC provides immediate, private access to some of the same evidence-based behavioral recommendations and interventions you might receive from a face-to-face session with a clinician – all tailored to your specific needs and situation. The specific evidence for Digital Health Coaching spans across wellness and disease management, and has been associated with meaningful economic value in each of these areas. Participants in the Highmark BCBS employee wellness program (which included health risk assessments, online programs, coaching, biometric screenings, and fitness campaigns) showed health care costs lowered by \$176 per participant per year, an ROI of 1.65:1 (Naydeck et al., 2008). Assessment of the HMSA BCBS plan in Hawaii's use of HealthPass demonstrated ROI ranging from 1.16:1 to 2.83:1, with an average cost savings per participant of \$350 (Schwartz, et al., 2010).

Among specific health related topics, some studies have shown improvements as well. Kaiser Permanente (2010) has shown consistent positive results with their HealthMedia® digital coaching programs, demonstrating weight loss, smoking cessation, and stress reduction among more than 50% of participants that provided feedback following their completion of a related digital coaching program. Another study, published just this year, showed that participants experienced significant reductions in pain intensity and unpleasantness scores following completion of tailored DHC for chronic pain management (Nevedal, *et al.*, 2013).

The advancement of wellness research now includes longitudinal community health studies. The community based approach to research was made famous by studies such as the Framingham Heart Study (<http://www.framinghamheartstudy.org/>), which focused on cardiovascular disease using a cohort of nearly 5,000 residents of Framingham, Mass. Now in its third generation, the Framingham Heart Study has contributed much of what we know today about heart disease and the associated risk factors. The Nurses' Health Study, another widely-cited study, has made similar invaluable contributions to our understanding of breast cancer and other women's health issues by studying data from more than 200,000 nurses over more than 35 years (<http://www.nhs3.org>). The Lake Nona Life Project is a modern-day version of these landmark efforts, conducted within a master-planned community, developed with sophisticated

technology, and in a community focused on sustainability, education and health and wellness. By combining these cutting edge technological components with a deliberate and informed design, the intelligent home will be a valuable addition to the living laboratory utilized by the Lake Nona Life Project.

Future Research & Collaboration

The beauty of the Lake Nona Life Project is collaboration. Already, leaders from industry, science, government, and academia have come together with a common goal in mind: to explore our greatest health challenges. We believe technology can play a large part in developing solutions and through collaborations like the Lake Nona Life Project and the Intelligent Home, we will be looking into:

- How are mobile devices being integrated into daily health and wellness regimens?
- Whether exergames are effective for motivating people to exercise?
- What is the combined effect of multiple nutrition and fitness interventions in a home setting?
- How do we extend individual health activities to an entire community?
- What are some of the social and collaborative tools that are most effective in promoting wellness and prevention plans and activities?
- Does the layout of a kitchen affect food choices?
- What are some of the planning and motivational techniques that can help achieve health outcomes at low cost?
- What is the optimal tool kit of health oriented apps, methods, and education that produces the maximum effect with the minimum financial and time impact?
- Does ambient health monitoring in CHF provide a capability that is similar to that of current remote monitoring capabilities through standalone equipment OR done through manual reporting of self-collected monitoring data?
- Does ambient health monitoring provide a Quality of Life benefit that is statistically better than the same achieved through other traditional means (remote monitoring or self-monitoring) in CHF patients?
- Does ambient health monitoring lead to long-term health care outcomes related to lowered disease burden, improved quality of life, and lowered cost of care at the individual and system levels in CHF management within a community setting?
- What criteria can be used to identify an engaged patient and delivery system/care team that define the greatest likelihood of success for ambient health monitoring in CHF?

Example Opportunities

In CHF, the success of the care plan in a community setting can be defined by the following:

1. Quality of life – the ability of a member to engage in activities they enjoy without limiting factors caused by CHF
2. Compliance to care plan
3. Physical abilities in Activities of Daily Living
4. Affordability of care
5. Delaying transition to assisted living
6. Reduction in interruptions caused by ER visits/hospital admissions

The experience in the living laboratory allows us to test different hypotheses as well create different case control experiments that test out the interdependence of various controllable variables, such as:

- Impact of physical activity
- Impact on health habit formation
- Impact of nutritional interventions related to changes in calories, sodium, eating times as well diet types
- Impact of monitoring vitals as well as morbidity indicators that can provide just-in-time patient controlled actionable interventions, as well its long term impact on health outcome
- Understanding the outcomes in engaged patients (or Activated patients) in comparison to those who are not
- Systems-based interactions for family members and technologies
- Social effects of health behaviors among family members

Future Themes/Events

As you can see from the prior sections on background evidence and future opportunities for collaboration, the Lake Nona Institute team would welcome other partners who wish to conduct studies, pilots, or community testing to answer some of the many research questions presented herein.

Preparation has already begun for the HIMSS '14 Annual Conference and Exposition and the Intelligent Health Association Symposium, both scheduled for the week of February 23 in Orlando. We also welcome attendance and contact at future events like J&J Ignite and next year's Lake Nona Impact Forum.

Contact Our Members:

- For inquiries related to HIMSS, please contact Dr. David Metcalf (dmetcalf@ist.ucf.edu)
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