XAVIER UNIVERSITY
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# Impact and Cost of Smart Home Technology on Adults with Developmental Disabilities

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**Abstract**

This longitudinal repeated measures study aimed to describe the impact of technology-assisted care on performance and satisfaction with selected daily living tasks and the cost of providing technology-assisted care for adults with developmental disabilities in a technology supported living residence and . Participants were 4 adult male residents with developmental disabilities. In Year 1, participants had previous living arrangements before moving into the technology supported living residence in Year 2 . Data were collected using the Canadian Occupational Performance Measure (COPM) and the Caregiver Level of Assistance Logs. The cost of the technology will be provided by the agency in Year 3. Participants reported increased performance and satisfaction scores for most selected daily living tasks in Year 2 compared to Year 1. COPM scores were clinically significant and demonstrated that technology-assisted care can potentially aid adults with developmental disabilities in daily living tasks. It's important that occupational therapists assist adults with developmental disabilities find the appropriate technology to fit their needs.

*Keywords:* developmental disabilities, caregivers, technology, cost, smart home

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## Section I: The Problem

### Introduction

In the last year, Ohio budgeted $3.27 billion to care for over 90,000 individuals with developmental disabilities. The budget is set to increase in the next year due to the increase in budget initiatives, including the rising cost of caring for these individuals (Ohio Department of Developmental Disabilities (ODODD, 2019, p. 1). Additionally, adults with developmental disabilities are living longer (Byram, 2018). Many adults with developmental disabilities desire independence for completing activities in the home but mainly live with paid or familial caregivers who provide around the clock supervision, often resulting in emotional and financial caregiver burden (Bialon & Coke, 2012; Byram, 2018; Gentry, 2009; Lindahl et al., 2018). A technology-supported living residence offers adults with developmental disabilities features to assist with daily living tasks and potentially decrease caregiving hours (Gentry, 2009; Gentry, 2017; Hoenig et al., 2003; Kellems et., 2018).

### Purpose of the Study

The purpose of this research study was to describe the cost of providing technology-assisted care to adults with developmental disabilities in a technology-supported living residence and investigate the impact of technology-assisted care on performance and satisfaction with selected daily living tasks.

### Questions

This study addressed the following questions:

1. What is the cost of providing technology-assisted care to adults with developmental disabilities in a technology supported living residence?
2. For adults with developmental disabilities in a technology supported living residence, does the provision of technology-assisted care:

a) Increase performance of selected daily living tasks as measured by the Canadian Occupational Performance Measure (COPM) and Caregiver Assistance Log?
b) Increase satisfaction with performance of selected daily living tasks as measured by the COPM?
c) Reduce the hours of direct caregiver assistance provided to each residence per week as measured by the Caregiver Assistance Log?

**Statement of the Problem**

Some adults with developmental disabilities experience limitations affecting their daily living tasks and require direct caregiving (Byram, 2018). However, caregiving is time-consuming, diminishes the independence of adults with developmental disabilities, and has significant financial implications (Byram, 2018). For example, the Ohio budget for supporting adults with developmental disabilities is expected to increase in 2021 due to initiatives including an increase in wages for direct support professionals (ODODD, 2019). Adults with developmental disabilities need a cost-effective alternative to aid in independent performance of daily living tasks.

**Rationale**

There is potential for technology-assisted care and the provision of occupational therapy services to increase autonomy and independence of an individual by reducing constant caregiver support (Gentry, 2009; Hoenig et al., 2003; Beyer & Perry, 2013). Rather than relying on caregivers with high caregiver costs, adults with developmental disabilities can gain independence by using technology-assisted care to complete daily living tasks (Gentry, 2009). With an elderly population, Goodacre et al. (2008) found that technology-assisted care is a cost-effective substitute for direct caregivers; this finding provides a promising foundation for adults

with developmental disabilities to use technology-assisted care for independent living. The results of this study will inform occupational therapists regarding the impact, costs, and types of technology that can promote performance and satisfaction in daily living tasks.

**Scope**

This longitudinal, descriptive study was conducted by two groups of graduate student researchers from a university in the Midwest. Year 1 data were collected from 2019-2020 and year two data were collected from Fall of 2019 through Fall of 2021. The researchers used the COPM (Appendix A), Caregiver Log (Appendix B), and demographic information (Appendix C) to collect data from four adult residents with developmental disabilities and their caregivers. The residents all received services from an agency that encourages the independence of adults with developmental disabilities in a large Midwest city. Data were collected before, and directly after moving into a new technology enhanced residence. The study only addressed technology-assisted care present in the technology supported living residence, not all assistive devices.

**Assumptions**

The researchers assumed the residents will need time to be trained and practice how to use technology-assisted care. Additionally, the researchers assumed the technology-assisted care provided in the home will be appropriate for the goals the residents previously identified. Lastly, the researchers assumed the caregiver will accurately complete the Caregiver Log (Appendix B) and correctly document the performance of each participant.

**Operational Definition of Terms**

Technology-assisted care refers to technology and devices that aid in participation in desired daily activities and include mobile devices, sensory monitoring systems, and software applications. Examples include tablets, fall alarms, medicine dispensers, video-monitoring

applications, and applications for cues and prompts (Golisz et al., 2018; Kellems et al., 2018; Nauha et al., 2016). A caregiver is a professional or family member who provides the primary care and daily assistance to the resident. A technology supported living residence refers to a home that is equipped with smart technology used to assist in daily living tasks (Gentry, 2009). Daily living tasks are activities that a person wants or needs to do such as bathing, banking, and home management. Developmental disabilities are "a group of conditions due to an impairment in physical, learning, language, or behavior areas" (CDC, 2019).

## Section II: Literature Review

### Introduction

Studies have shown technology-assisted care can help many adults with developmental disabilities achieve their goal of independence in addition to decreasing the need for constant caregiver support (Agree, 2014; Beyer & Perry, 2013; Gentry, 2009; Mortenson et al., 2018; Peek et al., 2015; Wagner & Tassé, 2019). Additionally, technology-assisted care has the potential to combat the costs of direct caregiving (Anderson & Wiener, 2013; Goodacre et al., 2008). There are opportunities to use technology in the home or with mobile devices to assist with daily living tasks, such as dressing (Czarnuch & Mihailidis, 2011; Golisz et al., 2018), and there are multiple ways to fund it (Douglas et al. 2012; Gentry & Wallace, 2011).

### Adults with Developmental Disabilities

Adults with developmental disabilities are an aging population who rightfully desire independence but often require constant care due to limitations affecting their ability to perform daily living tasks (Byram, 2018; Gentry, 2009). Limitations in adaptive skills, cognitive function, and social skills cause difficulties with independent completion of a wide variety of daily living tasks including money and home management, self-care, and healthy eating (Anderson & Wiener, 2013; Byram, 2018; Cumella & Heslam, 2013; Kellems et al., 2018; Scott et al., 2013).

Adults with developmental disabilities often rely on their caregivers or parents to complete daily living tasks but now live longer and often outlive their parents (Byram, 2018).

**Caregivers and Technology-Assisted Care**

Funding for caregiving can be overwhelming for families of adults with developmental disabilities (Byram, 2018). The cost of caring for individuals with developmental disabilities is expected to rise; one of the reasons the 2021 budget is increasing is due to an increase in direct support professional wages (ODODD, 2019). Additionally, family caregivers experience financial strain because they spend nearly 20% of their income on caregiving activities (AARP, 2016). Being a family caregiver requires extensive time, limits their social participation, causes isolation (Byram, 2018), and leads to role conflict (Bialon & Coke, 2012). Technology-assisted care has the potential to decrease caregiver hours (Anderson & Wiener, 2013; Gentry, 2009; Hoenig et al. 2003). In a study including adults with intellectual disabilities, direct staff hours decreased by 23% when participants used telecare services consisting of home monitoring and sensors (Perry et al., 2012 p. 65). Therefore, a decrease in caregiver hours can be achieved by shifting responsibility from a caregiver to a device (Beyer & Perry, 2013). The initial cost of technology-assisted care devices can eventually outweigh the monthly cost of direct caregiving (Goodacre, 2008). Additionally, there is limited research and conflicting results on the impact of technology-assisted care when implemented among individuals with learning disabilities and older adults (Beyer & Perry, 2013; Marasinghe, 2016). For example, Marasinghe (2016) found some technology decreased caregiver burden; however, technology increased the pressure to constantly check on their family members using the monitoring systems in the homes.

## Technology-Assisted Care

### *Technology-Assisted Care for the Home*

Technology-assisted care devices can increase safe participation and guide a healthy lifestyle in the home (Yu et al., 2019; El-Basioni et al., 2014; Agree & Freedman, 2011). Adults with a memory disorder and their caregivers found using fall alarms and a calendar clock facilitated the role of a caregiver by aiding in safety and organization (Nauha et al., 2018). Also, remote support can address safety issues for adults with intellectual or developmental disabilities (Wagner et al., 2019). Tassé et al. (2020) conducted a study with adults with intellectual and developmental disabilities and found that they reported greater independence using remote support services without needing direct care staff in the home. However, there is conflicting research concerning home monitoring systems because of the potential for the system to breach privacy (Beyer & Perry, 2013). Home modifications, such as an enhanced lighting system, contributed to home mobility and safety, helping adults with developmental disabilities as they aged (Hutching et al., 2008). Additionally, a verbal personal assistant such as Google Home can be used for personal appointment reminders, recipes, and nutrition with individuals with disabilities (Noda, 2018).

### *Mobile Devices Support Participation*

Mobile devices, such as smartphones and tablets, have a variety of apps that support participation and independence in daily living tasks while also remaining socially acceptable (Cullen & Alber-Morgan, 2015; Douglas et al., 2012; Gentry et al. 2015; Kellems et al., 2018; Ramsten et al., 2019; Shinohara & Wobbrock, 2011). Mobile devices have applications that can support cooking, social participation (Ramsten et al., 2019), health and wellness (Uphold et al., 2016), leisure activities (Chan et al., 2013; Chan et al., 2014), and community access (Stock et

al., 2011). For example, an individual with Down syndrome independently accessed community destinations using smartphone apps with icons and prompts, and it promoted his self-determination because he learned to use a device to travel without supervision (Stock et al., 2011). Cueing strategies on mobile devices such as pictorial instructions (Lancioni et al., 2016) and video prompting support engagement in daily living tasks such as cleaning, employment, dressing, grooming, cooking, as well as health and money management (Cullen, Simmons-Reed, & Weaver, 2017; Cullen et al., 2017; Douglas et al., 2012; Johnson, 2014; Kellems et al., 2017; Scott et al., 2013). In one study including adults with intellectual disabilities, video prompting assisted participants with independently dressing and brushing teeth. They appeared more focused and less anxious when using cues from technology rather than a support worker (Golisz et al., 2018).

### *Cost of Technology-Assisted Care*

For those paying out of pocket, technology-assisted care can range anywhere from under $100 for a verbal personal assistant (Noda, 2018) to an average of $23,000 for more advanced home monitoring systems (Friedman & Rizzolo, 2017). Studies on participants with intellectual disabilities (Boot et al., 2018) and hearing and ambulatory disabilities (Borg & Östergren, 2014) both reported that cost was a barrier to assistive technologies. Additionally, time and money need to be allocated to train professionals to match the right technology to each user and demonstrate its use (Scherer, n.d.). The availability of service providers to train users in technology-assisted care devices is limited due to funding restrictions (Taherian & Davies, 2018). Despite high costs, many users with a variety of disabilities believe the benefits of assistive technology are worth the cost (Lenker et al., 2013; Simpson et al., 2017). Medicaid funds technology-assisted care through waivers (Renda & Lape, 2018); however, restrictions delineate which assistive technology

products are funded and the maximum amount a person can receive for technology-assisted care (Gentry & Wallace, 2011; Ohio Department of Medicaid, 2020). The recipient's age, income, and level of care determine the funds received from Medicaid (Ohio Department of Medicaid, 2020).

### Summary

Rather than relying on caregivers, adults with developmental disabilities can gain independence by using smart home technology, mobile devices, and remote monitoring systems to complete daily living tasks such as leisure, dressing, financial management, cooking, and health management. Although there are funding limitations for technology-assisted care, these devices offer a potentially worthwhile investment compared to the expense of caregivers. The results of this study will inform occupational therapists regarding the use of technology-assisted care with clients to enable performance of daily living tasks and promote self-efficacy. This study will address the cost as well as the impact of technology-assisted care on the performance and satisfaction with selected daily living tasks.

## Section III: Methods and Procedures

### Research Design

This descriptive three-year study used a longitudinal repeated-measures design to investigate the effect of technology-assisted care on performance and satisfaction of adults with developmental disabilities. The independent variable was the technology-assisted care such as motion detector lights and a smart refrigerator. The dependent variables included the level of performance and satisfaction in which the resident was able to complete a self-identified task related to their goal, the level of caregiver assistance required to complete the task, and the costs of the technology-assisted care. Data were collected in Fall 2019 (Year 1) and Fall 2020 (Year 2). See the study flow diagram for more details (Appendix E).

**Sample**

In Fall of 2019, a large Midwest agency selected four individuals to live in the technology-assisted living residence. Four adult males with a developmental disability were included in the study. To be included, the participants had to be residents of the technology-assisted living residence. Individuals not served by the Midwest Agency and who were not selected to live in this residence were excluded from the sample.

**Instrumentation**

This study uses 4 data collection tools: The COPM (Appendix A), Cost of Technology Provided Form (Appendix B), Caregiver Level of Assistance Log (Appendix D), and Data Collection Form (Appendix C). The COPM is a valid, standardized semi-structured interview with moderate reliability (Eyssen et al., 2005) used to identify problems related to daily living tasks and rate performance and satisfaction levels for those tasks (McColl et al., 2000). Dedding et al. (2004) found the COPM to have convergent and divergent validity when used among a population with multiple conditions such as hand injuries, central neurological disorders, and neuromuscular diseases. There are three different task categories: self-care, productivity, and leisure which are rated based on an importance scale from 1 (not important at all) to 10 (extremely important). Performance is rated using a scale ranging from 1 (not able to do it) to 10 (able to do it extremely well) for each task. Next, satisfaction of performance is rated on a scale from 1 (not satisfied at all) to 10 (extremely satisfied) for each task. Mean performance scores and satisfaction scores are calculated. The change score is calculated by subtracting the average score of Year 1 from Year 2. The Cost of Technology Provided Form (Appendix B) contains 5 open-ended questions related to the description and cost of the technology and caregiver services used in the home. On the Caregiver Level of Assistance Log (Appendix D), the amount of time,

in minutes, and assist level, on a scale from 1 (dependent) to 6 (independent), required for each resident to complete their 3 self-identified tasks is documented. The Data Collection Form contains 3 parts. Part A includes 6 questions regarding resident demographics, current employment or education, and assistive devices used throughout the day. Part B includes 6 questions about caregiver demographics and questions related to caregiving. In Part C, COPM scores and identified occupational tasks are documented.

**Methods and Procedures**

This study received Institutional Review Board (IRB) approval on October 7th, 2019. In this 3 year study, Year 1 phase data was collected in Fall 2019, Year 2 data was collected in Fall 2020, and Year 3 data will be collected in Fall 2021 (Appendix E). During Year 1 and Year 2 phase, participants were recruited using the recruitment script (Appendix F) and gave informed consent (Appendix G) and assent (Appendix H). The faculty tutor trained student researchers in COPM administration and data collection prior to obtaining data. Researchers filled out the demographic form with the participants and administered the COPM. The researchers documented three important daily living tasks identified by the residents. Researchers gave the key caregiver a Caregiver Level of Assistance Log (Appendix D) for each resident.

Intervention began in Fall 2020 when residents moved into the home and started to learn how to use the smart home technology. A variety of technology-assisted care was included throughout the technology supported living residence such as a remote support system, motion-controlled fall prevention lighting, door sensors, a video intercom/doorbell, a verbal digital assistant (Amazon Alexa), and touchscreen monitors in each room. Kitchen devices included a smart fridge, induction cooktop, a smart range, and an automated touch faucet.

During Year 2, the clinical tutor and researchers scheduled an appointment to meet with each resident at the technology supported living residence and obtained re-consent (Appendix I) and re-assent (Appendix J). One or two student researchers and the clinical tutor attended each meeting and asked residents questions 5 & 6 from the Data Collection Form (Appendix F) and administered the COPM (Appendix A). The researchers reminded residents of the three tasks they identified one year ago and asked them to re-rate their performance and satisfaction with each task. The key caregiver received one binder per resident with copies of the Caregiver Level of Assistance Log (Appendix D). Researchers instructed the caregiver on how to complete the log daily for two weeks. Additionally, researchers contacted the Midwest Agency to obtain financial data from their records using the Cost of Technology Provided Form (Appendix B). During Year 3, researchers will repeat the same procedures as Year 1 and Year 2 (Appendix E).

### Data Analysis

Descriptive statistics were calculated for all variables. Scale data including cost of technology devices and services were analyzed using descriptive statistics including mean, median, and range. Nominal and categorical data, including how many days a task was completed, were analyzed using frequencies and percentages. The number of hours of direct assistance provided and level of assistance provided were analyzed using mean values. COPM performance and satisfaction change scores were compared from Year 1 to Year 2; a difference of 2 or more is clinically significant (COPM, 2020). COPM analysis will be repeated in Year 3.

## Section IV: Results

### Caregiver Demographics

In Year 1, Resident 1 was cared for by his unpaid 60-year-old mother. He had a total of two caregivers. Resident 2 was cared for by a 28-year-old male caregiver who was present 40 hours per week and was not a family member. He also had an additional 3-4 caregivers. Resident

3 was cared for by his unpaid 54-year-old mother. Resident 4 had a paid caregiver who was a 33-year-old male. He additionally had 7 other caregivers. Caregiver log Year I data was collected by the aforementioned caregivers (Table 1-6).

In Year 2, new caregivers were present in the technology-supported living residence; thus, they were interviewed and provided demographic information. Caregiver 1 is a 33-year-old male. He is present approximately 8 hours a day for 3 days each week. Caregiver 2 is a 30-year-old male and is present via GrandCare remote system approximately 23 hours each week over 3 days. Caregiver 3 is a 33-year-old female. She is present 8 hours a day, 5 days a week. None of the aforementioned caregivers are related to the residents and all are financially compensated. Caregiver log Year 2 data was collected by the aforementioned caregivers (Table 1-6).

**Resident 1**

Resident 1 is a 22-year-old Caucasian male with Down syndrome. He is employed at a catering business where he does cleaning tasks and sets up for private events. He uses technology including his iPhone, Alexa, an induction stove, a smart fridge, a Surface tablet, a Fitbit, a CPAP cleaner, and GrandCare Systems touch screen. His iPhone has various apps that support him in meal preparation and community mobility. Alexa is used to aid in searching for healthy recipes and playing music.

In Year 1, Resident 1 lived at home. He identified the following as tasks to improve: (1) cook more food and read recipes, (2) be more responsible with schedule and turning off electronics at night, (3) be more responsible with food control and maintain a healthy diet. See Figure 1 for COPM scores. The change in COPM performance score from Year 1 to Year 2 was 2.33. The change in COPM satisfaction score from Year 1 to Year 2 was 3.34.

Overall, Resident 1 had a caregiver available for 14 hours per day during the two-week caregiver log data collection in Year 1. During Year 2, Resident 1 received direct assistance for an average of 1.67 hours per day and an average of 16.57 hours of indirect care/remote monitoring per day. Table 1 contains the level of assistance for each task provided by the caregiver. Table 2 details the number of minutes of assistance for each task. Table 3 contains how many days each task was completed during the 14 days.

**Resident 2**

Resident 2 is a 35-year-old Caucasian male. He is legally blind, has hydrocephalus and epilepsy. He works at a community organization where he works on a computer and creates PowerPoints. He uses a desktop, GrandCare Systems touch screen, music in the sensory room, smartphone, and smartwatch.

In Year 1, Resident 2 did not live at home with family members. He identified the following as tasks to improve: (1) cook more and use stovetop, (2) use more smart technology such as iPhone, Siri, and Alexa for bus schedules and recipes, (3) be able to cut food without assistance, plan with a calendar, and video chat to problem solve. See Figure 2 for COPM scores. The change in COPM performance score from Year 1 to Year 2 was 2.37. The change in COPM satisfaction score from Year 1 to Year 2 was 3.33. During Year 1 caregiver log collection, Resident 2 received an average of 0.50 hours of assistance per day. In Year 2, he received 3.82 hours per day of direct assistance and an average of 19.96 hours per day of indirect care/remote monitoring. Table 1 contains the level of assistance each task provided by the caregiver. Table 1 details the number of minutes of required assistance for each task. His Year 1 data only spans 12 days instead of 14 days (Table 4).

**Resident 3**

Resident 3 is a 21-year-old Caucasian male with Down syndrome. He works at a restaurant where he is a busser, food runner, and greeter. He uses Alexa to check the weather, GrandCare Systems touch screen for his daily schedule and reminders. He also uses an iPhone 8 plus, smart fridge, and induction stove for cooking tasks.

Resident 3 lived at home in Year 1. In Year 1, Resident 3 identified the following as tasks to improve: (1) do laundry using My-Cycle, (2) use stovetop, oven, and iPad to watch videos and make recipes, (3) use the metro app and Uber for transportation to and from home. See Figure 3 for COPM scores. The change in COPM performance score from Year 1 to Year 2 was 3.67. The change in COPM satisfaction score from Year 1 to Year 2 was 3.33. During the two-week caregiver log collection in Year 1, Resident 3 received an average of 18.5 hours of direct assistance per day. In Year 2, Resident 3 received 1.67 hours per day of direct assistance and an average of 17.5 hours per day of indirect care/remote monitoring. Table 1 contains the level of assistance for each task provided by the caregiver. Table 2 contains the number of minutes of assistance provided for each task. Table 5 contains the frequency of task completion during the 14 days.

**Resident 4**

Resident 4 is a 31-year-old Caucasian male with moderate cognitive limitations who is also hard of hearing and nonverbal. He is not currently employed but participates in an inclusive art program at a local studio daily. He uses his iPad and GrandCare Systems touch screen to view his schedule as well as touch commands on Alexa. When he receives a notification, a red lamp turns on in each room of the house to signal him.

In Year 1, Resident 4 lived in a facility with paid caregivers. Resident 4 identified the following as tasks to improve: (1) budgeting with groceries and leisure, (2) scheduling, planning, and time management, (3) planning and cooking healthy meals. See Figure 4 for COPM scores. The change in COPM performance score from Year 1 to Year 2 was 0.67. The change in COPM satisfaction score from Year 1 to Year 2 was 3.33.

Over two weeks, Resident 4 received an average of 1.08 hours of assistance per day in Year 1. In Year 2, he received 5.18 hours per day of direct assistance and 18.05 hours per day of indirect care/remote monitoring. Table 1 contains the level of assistance for each task provided by the caregiver. Table 2 details the number of minutes of assistance provided. Table 6 contains the frequency of task completion during the two weeks.

### Costs of Technology-Supported Living Residence

Cost data will be collected during Year 3.

## Section V: Discussion

This quantitative study's findings answer some of the research questions while other questions remain unanswered. The study answered the following questions: For adults with developmental disabilities in a technology-supported living residence, does the provision of technology-assisted care: 1). Increase performance of selected daily living tasks as measured by the Canadian Occupational Performance Measure (COPM) and Caregiver Assistance Log? 2). Increase satisfaction with performance of selected daily living tasks as measured by the COPM? The following question was not answered: What is the cost of providing technology-assisted care to adults with developmental disabilities in a technology-supported living residence? The following question was partially answered: For adults with developmental disabilities in a technology-supported living residence, does the provision of technology-assisted care reduce the

hours of direct caregiver assistance provided to each residence per week as measured by the Caregiver Assistance Log.

**COPM**

Most residents reported higher performance COPM scores for each task in Year II compared to Year I. Likewise, most residents reported higher satisfaction COPM scores for each task in Year II compared to Year I. Therefore, there was an increase in performance and satisfaction of selected daily living tasks based on the COPM data. With the exception of indicating that technology assisted care may increase satisfaction with and performance of daily living tasks for individuals with developmental disabilities, this data demonstrate the influence of the technology-assisted care. Similarly, adults with developmental and intellectual disabilities reported greater satisfaction and independence when using remote support services (Tassé et al., 2020). The technology-assisted living residence and technology-assisted care, including remote monitoring, positively impacted the residents' daily lives based on their reported COPM satisfaction and performance scores in Year 2.

Technology supported the independence and participation of adults with developmental disabilities (Golisz et al., 2018; Jamwal et al., 2020). Furthermore, the impact of the user's perception of technology-assisted care must be explored. Adults with disabilities describe using smart speakers and home automation technology as "helpful'" and "handy" tools (Morris & Thompson, 2020). This kind of technology enhanced self-perceived agency, control, and independence (Smith et al., 2020). The COPM scores indicated technology-assisted care may have supported the residents' performance and satisfaction.

## Caregiver Log Data

### *Level of Assistance*

From Year 1 caregiver log data, some residents required a high level of assistance for most tasks. In comparison of Year 1 to Year 2, two of the residents required less caregiver assistance for tasks. On the other hand, Resident 4 required more caregiver assistance for most tasks in Year 2 and required more minutes of caregiver assistance with each task despite the presence of technology-assisted care. It is possible that the caregiver automatically provided assistance rather than allowing Resident 4 to attempt the task independently. Literature reports caregivers believed that technology-assisted care supported and facilitated participation in cooking, communication, and shopping, and it decreased assistance with reminders and prompts (Ramsten et al., 2019). Year 2 caregiver assistance data from Resident 1 and Resident 3 confirms that technology-assisted care supported participation in selected daily living tasks.

### *Minutes of Assistance Provided*

For Resident 1, the minutes of caregiver assistance provided for tasks decreased significantly in Year 2. For Resident 3, the minutes of caregiver assistance provided increased and decreased from Year 1 to Year 2, depending on the task. Data from these residents support current literature that reports technology-assisted care can decrease the amount of caregiver hours and decrease the cost of caregiving for adults with developmental disabilities (Anderson & Wiener, 2013; Gentry, 2009). The minutes of caregiver assistance provided for each task increased from Year 1 to Year 2 for Resident 4. Data from this resident contradicts the literature's findings (Anderson & Wiener, 2013; Gentry, 2009).

**Cost of Caregivers and Technology-Assisted Care**

The cost of direct caregiving can be expensive. The state of Ohio alone is projected to spend over $3 billion in the fiscal year 2021 supporting adults with developmental disabilities (ODODD, 2019, p.1). Just under $87 million of this budget is allocated to the pay increase of direct support professionals, making their minimum wage $12.38 as of January 1, 2021 (ODODD, 2019, p. 3). With at least 98 hours of care from direct support professionals each week, this cost adds up quickly. Additionally, the Council on Aging (2019, p. 5, 15) reports spending $45,624,153 to provide community-based in-home services to approximately 26,100 elderly individuals and adults with disabilities. The use of various technologies and home monitoring systems may offer an alternative solution to direct caregiving.

GrandCare Systems are touch screens that include the key feature of remote monitoring. The technology-assisted living residence had 5-7 GrandCare System screens. Organizations who care for multiple individuals pay $495 per screen in addition to a monthly service charge of $25-$30 (S. Feldstein, personal communication, March 1, 2021). Additionally, personal assistant speaker devices such as Alexa are cost-effective solutions and offer value and independence when completing tasks (Smith et al., 2020). Technology-assisted care is a potential way to decrease direct caregiving; however, limited data exist to support the supplementation of caregivers with technology-assisted care for individuals with developmental disabilities.

**Limitations**

This was a pilot study with four participants; therefore, the results are not generalizable to the entire population of adults with developmental disabilities. Before the move-in date, researchers were unaware of the types of technology in the home, making it difficult to help residents establish goals. Year 2 data collection occurred during the COVID-19 pandemic, and

the residents only spent approximately 2 months in the home before data was collected due to a delayed move-in date. Additionally, COVID-19 limited the practice of tasks such as transportation and leisure. The self-report measure and the abstract rating scale on COPM with adults with developmental disabilities may have impacted the results. Moreover, the caregiver logs were completed by different caregivers and some of the data were not included.

**Practice Implications**

Technology-assisted care is a potentially useful tool to help individuals with developmental disabilities live independently, and it can be recommended by occupational therapists. Clinically significant COPM change scores show technology-assisted care can improve the performance and satisfaction with daily living tasks. As clinicians, occupational therapists can match the technology to individual clients based on their function and goals to support their success. Additionally, occupational therapists can teach adults with developmental disabilities how to use their assistive technology by giving proper training. This research makes it possible for agencies with a similar mission to promote independence for adults with developmental disabilities can use the results of this study to help develop homes equipped with technology-assisted care.

**Recommendations**

This study provides foundational knowledge about how technology-assisted care can impact the independence of adults with developmental disabilities living in a technology-assisted living residence. A larger participant group with a wider range of disabilities is warranted in future research to make the results more generalizable. Additionally, it is recommended researchers implement a standardized training procedure each year for filling out the caregiver log to promote inter-rater reliability. Collecting usage data from the technology can be used to

supplement caregiver logs. Finally, it is recommended residents receive more training before collecting data to give them time to become familiar with the technology and how it is used.

## Section VI: Conclusion

This quantitative study suggests the provision of technology-assisted care increased the performance and satisfaction of selected daily living tasks based on the COPM data. Findings do not include the costs of a technology-supported living residence. Additionally, it cannot be confirmed whether technology-assisted care can reduce direct caregiver assistance provided to each resident because the caregiver log data varies across participants. Clinically significant COPM performance and satisfaction change scores indicate a technology-assisted living residence can potentially support adults with developmental disabilities in the completion of their daily tasks such as laundry, cooking, and time-management. Occupational therapists need to be a part of the implementation of smart home technologies to ensure residents have training and establish the devices within a daily routine to participate in daily living tasks. This study is an important contribution to the limited literature related to the impact of a technology-assisted living residence for adults with developmental disabilities. This study will continue for one more year to further determine the impact of the technology-assisted care on the residents.

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**Table 1**

*Level of Assistance Provided for Task 1-3*

| Caregiver Log Data | Resident 1 | | Resident 2 | | Resident 3 | | Resident 4 | |
|---|---|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 |
| Assist Level (1-6) | | | | | | | | |
| Task 1 | 2.64 | 5.66 | | 4.13 | 4.29 | 5.67 | 4.50 | 2.67 |
| Task 2 | 4.00 | 6.00 | | 6.00 | 2.67 | 6.00 | 3.83 | 2.77 |
| Task 3 | 1.43 | 6.00 | | 5.20 | 1.00 | | 2.83 | 3.14 |

**Table 2**

*Time Spent Assisting Each Resident in Task 1-3*

| Caregiver Log Data | Resident 1 | | Resident 2 | | Resident 3 | | Resident 4 | |
|---|---|---|---|---|---|---|---|---|
| | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 | Year 1 | Year 2 |
| Time (min) | | | | | | | | |
| Task 1 | 120.00 | 21.00 | | 42.00 | 28.00 | 30 | 10.00 | 60.00 |
| Task 2 | 25.00 | 1.25 | | | 37.50 | | 16.15 | 69.23 |
| Task 3 | 60.00 | 1.36 | | 45.00 | 57.31 | | 51.66 | 55.00 |

**Table 3**

*Resident 1 Frequency of Task Completion for Tasks 1-3*

| Task | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| | Days Completed (1-14) | Total Days (1-14) | Days Completed (1-14) | Total Days (1-14) | Days Completed (1-14) | Total Days (1-14) |
| Year 1 | 2 | 13 | 7 | 8 | 0 | 7 |
| Year 2 | 5 | 14 | 12 | 14 | 11 | 14 |

**Table 4**

*Resident 2 Frequency of Task Completion for Tasks 1-3*

| Task | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| | Days Completed (1-14) | Total Days (1-14) | Days Completed (1-14) | Total Days (1-14) | Days Completed (1-14) | Total Days (1-14) |
| Year 1 | 0 | 12 | 0 | 12 | 0 | 12 |
| Year 2 | 8 | 14 | 2 | 14 | 5 | 14 |

**Table 5**

*Resident 3 Frequency of Task Completion for Tasks 1-3*

| Task | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| | Days Completed (1-14) | Total Days (1-14) | Days Completed (1-14) | Total Days (1-14) | Days Completed (1-14) | Total Days (1-14) |
| Year 1 | 7 | 13 | 6 | 12 | 10 | 13 |
| Year 2 | 2 | 14 | 10 | 14 | 0 | 14 |

**Table 6**

*Resident 4 Frequency of Task Completion for Tasks 1-3*

| Task | 1 | | 2 | | 3 | |
|---|---|---|---|---|---|---|
| | Days Completed (1-14) | Total Days (1-14) | Days Completed (1-14) | Total Days (1-14) | Days Completed (1-14) | Total Days (1-14) |
| Year 1 | 3 | 9 | 13 | 14 | 12 | 13 |
| Year 2 | 3 | 14 | 13 | 14 | 7 | 14 |

**Table 7**

*Participant Demographics*

| Participant | Age | Gender | Race | Primary Diagnosis | Living Situation Y1 | Living Situation Y2 | Technology Used |
|---|---|---|---|---|---|---|---|
| 1 | 22 | Male | Caucasian | Down syndrome | Home with parents | Tech-assisted living residence | iPhone, Alexa, induction stove, smart fridge, Surface tablet, Fitbit, CPAP cleaner, GrandCare Systems touch screen |
| 2 | 35 | Male | Caucasian | Hydrocephalus | Assisted living | Tech-assisted living residence | Desktop computer, music in sensory room, smartphone, smartwatch, GrandCare Systems touch screen |
| 3 | 21 | Male | Caucasian | Down syndrome | Home with parents | Tech-assisted living residence | Alexa, iPhone 8 Plus, smart fridge, induction stove, GrandCare Systems touch screen |
| 4 | 31 | Male | Caucasian | Moderate cognitive limitations | Assisted living | Tech-assisted living residence | iPad, touch commands on Alexa, light notifications, GrandCare Systems touch screen |

**Figure 1**

*Resident 1 COPM Data*

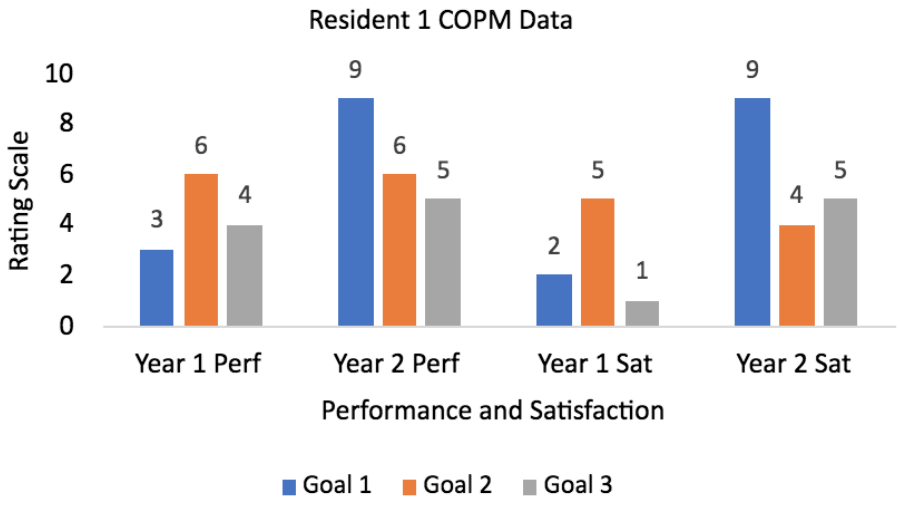

**Figure 2**

*Resident 2 COPM Data*

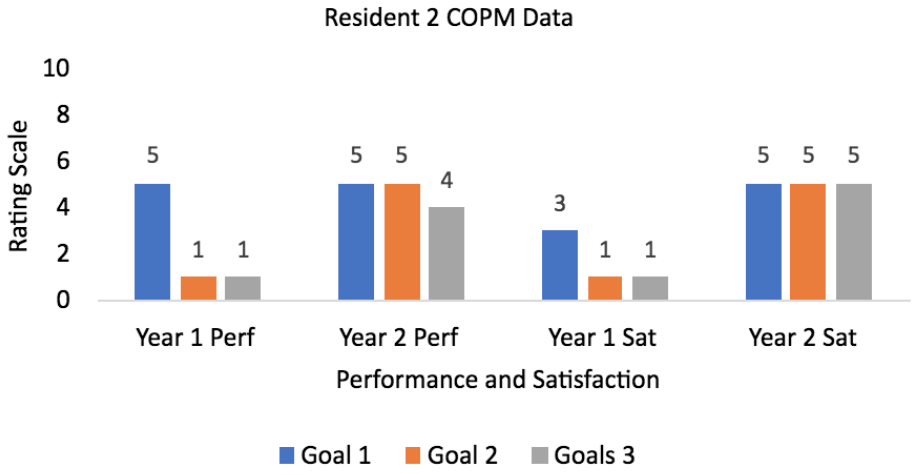

**Figure 3**

*Resident 3 COPM Data*

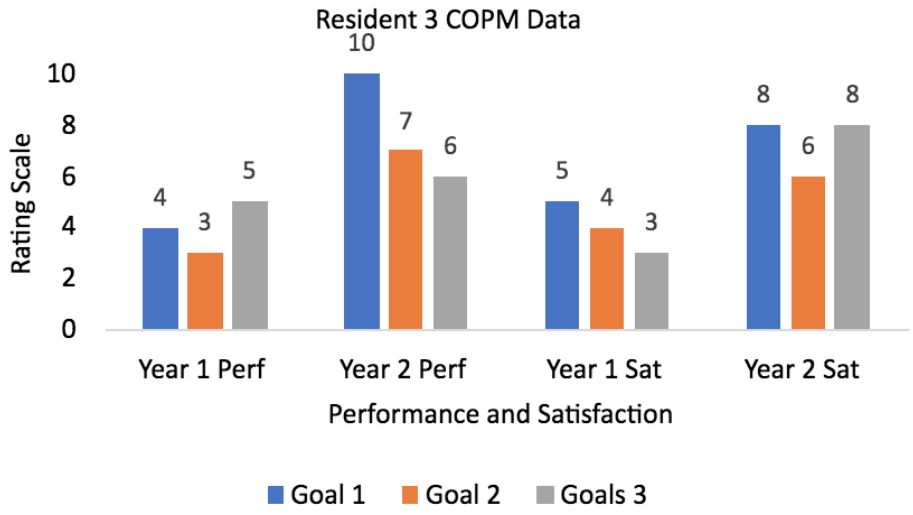

**Figure 4**

*Resident 4 COPM Data*

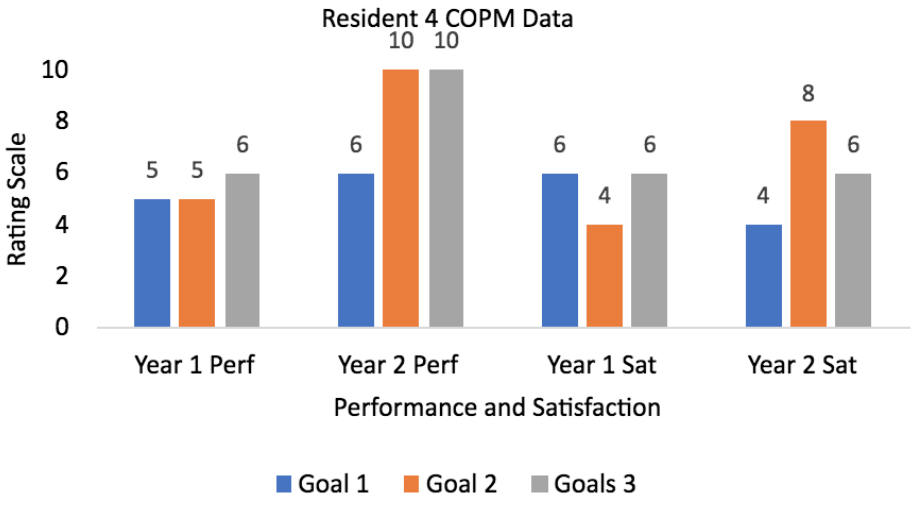

**Figure 5**

*COPM Mean Change for Performance and Satisfaction*

## Appendix A: COPM

# CANADIAN OCCUPATIONAL PERFORMANCE MEASURE

Authors:
Mary Law, Sue Baptiste, Anne Carswell,
Mary Ann McColl, Helene Polatajko, Nancy Pollock

The Canadian Occupational Performance Measure (COPM) is an individualized measure designed for use by occupational therapists to detect self-perceived change in occupational performance problems over time.

| | | |
|---|---|---|
| Client Name: | | |
| Age: | Gender: | ID#: |
| Respondent (if not client): | | |
| Date of Assessment: | Planned Date of Reassessment: | Date of Reassessment: |

| |
|---|
| Therapist: |
| Facility/Agency: |
| Program: |

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## Appendix B: Cost of Technology Provided Form

Cost of Technology Provided

- Pretest phase: no data will be collected regarding costs
- Year 1 & Year 2: The following cost-related data will be obtained from LADD data records.
    - Description & cost of the technological devices used in the home:

      _____
      _____
      _____
      _____
    - Description & cost of installation and maintenance of the devices:

      _____
      _____
      _____
      _____
    - Description & cost of training to teach resident and caregiver to use the technology:

      _____
      _____
      _____
      _____
    - Description & cost of support services (such as remote monitoring):

      _____
      _____
      _____
      _____
    - Description & cost of direct caregiving/supervision provided per week in the home:

      _____
      _____
      _____
      _____
    - Other:

      _____
      _____
      _____
      _____
      _____
      _____

## Appendix C: Data Collection Form

| | |
|---|---|
| Participant Code: | _____ |
| Date Administered: | _____ |
| Researcher Initials: | _____ |

A member of the research team will facilitate a face-to-face semi-structured interview to complete Parts A, B, and C of the data collection form with the resident and their caregiver present. The data collection form has been written in simple language for residents with cognitive impairments to fully understand. However, researchers will adapt their language to match the cognitive level of the resident.

**Part A: Resident Information** (Administer Questions 1-4 at Pretest; Administer Question 5& 6 at Pretest, Year 1 & Year 2)

*Researcher will begin Part A by stating the following to the resident: "We would like to ask you questions about you and the things you use to help you do things everyday. We will not tell other people what you say, and we will not use your name."*

1. How old are you? _____ years
2. Do you see yourself as a man or woman? ❑ M ❑ F ❑ Other answer
3. Do you know what your diagnosis is?

   _____
4. Which of the following best describes your race or ethnic group:

   ❑ Caucasian
   ❑ Hispanic/Latino
   ❑ Asian
   ❑ African American
   ❑ Native American
   ❑ Other:_____ Specify
5. Do you work or attend school? ❑ Y ❑ N If yes, describe _____

   _____
6. Can you tell us what things you use to help you during the day, like a wheelchair, an iPad, anything special to help you eat or bathe, or something to help you talk? (record all technology, assistive devices and/or any technology-related support or monitoring currently used)

   _____

   _____

   _____

## Appendix D: Caregiver Level of Assistance Log

Caregiver Level of Assistance Log

*For Caregiver Use Only*:
Date & Time: _____
Resident Name:

NOTE: residents name will be blacked out prior to transportation to Xavier University

*For Researcher Use Only*:
Participant Code: _____
Date:

Total number of hours of direct assistance and/or supervision provided for all activities and tasks in this 24 hour period: _____ hours

At the end of each shift, or 24-hour period, select whether or not (resident name) completed the following tasks. If the task was not completed during your shift, select "no" in the first box. If (name) did complete the task during your shift, select "yes" and rate level of assistance provided for each task using the 6-point scale (i.e: if (resident name) required Moderate assistance for Task 1, record assist level 3 in the Task 1 row). Then record the total time you spent assisting the resident with each task in minutes.
**This form will be completed daily for 2 weeks.**

*Please record the amount of assistance you provided (resident's name) with each task:*

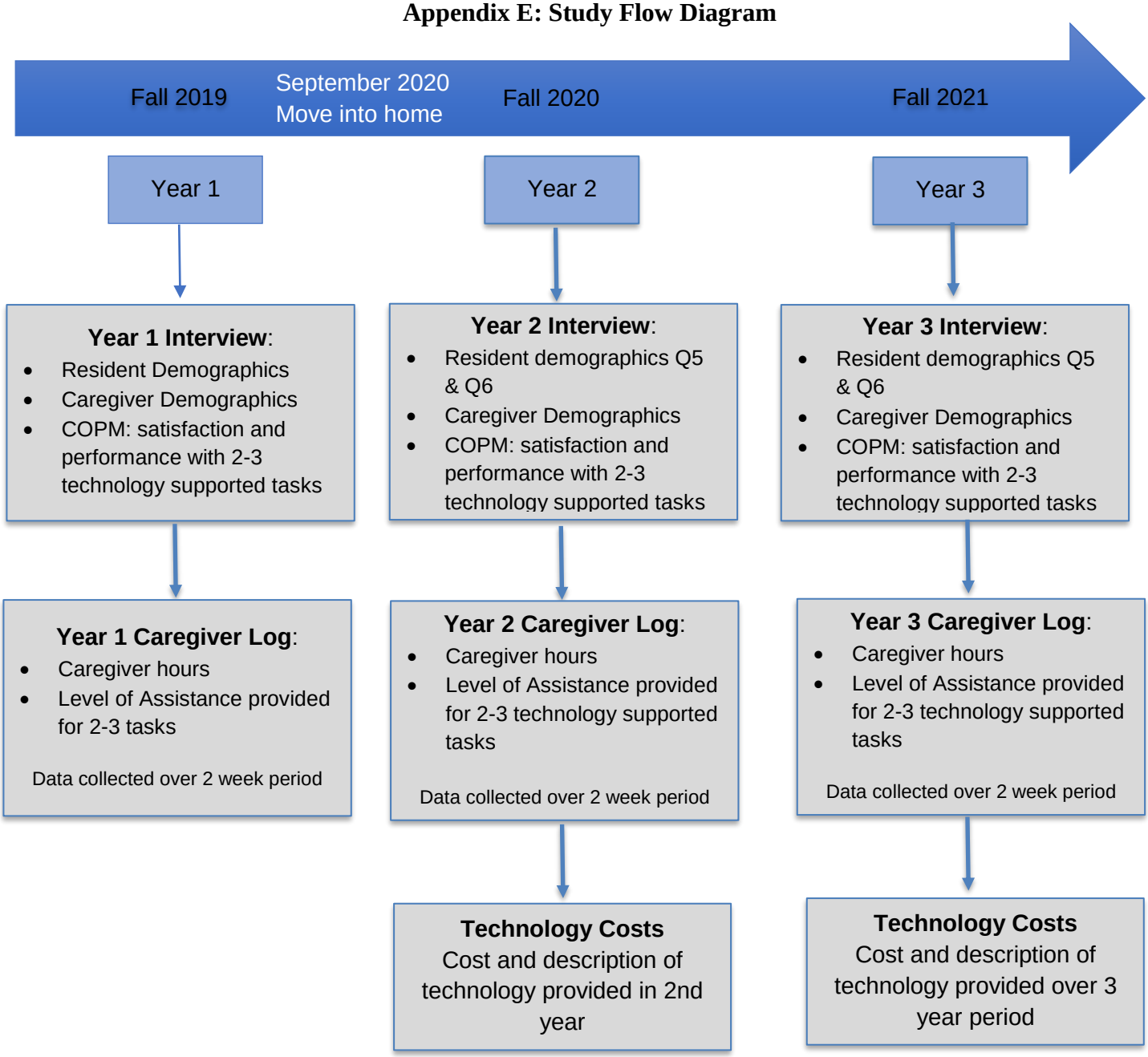
6. Independent - no assistance needed from helper.
5. Setup or Cleanup Assistance - helper only assists before or after task.
4. Supervision or Touching Assistance - helper provides verbal cues or steadying assistance.
3. Moderate Assistance - helper does less than half of the effort.
2. Maximal Assistance - helper does more than half of the effort.
1. Dependent - helper does all the effort.

| Task/Description | Completed? | Assist level (1-6) | Time (# of minutes you spent assisting client with this task) |
|---|---|---|---|
| Task 1: | ❑ Yes<br>❑ No | | |

| | | | |
|---|---|---|---|
| Task 2: | ❑ Yes<br>❑ No | | |
| Task 3: | ❑ Yes<br>❑ No | | |

*Scale modified from the Inpatient Rehabilitation Facility - Patient Assessment Instrument (IRF-PAI) (CMS, 2019)

## Appendix E: Study Flow Diagram



## Appendix F: Recruitment Script

Recruitment Scripts A, B, & C

| Guardian/Adult without Cognitive Disability | Adult with Cognitive/Developmental Disability | Caregiver of Adult with Cognitive/Developmental Disability |
|---|---|---|
| **Initial Contact Script A**<br><br>**Introduction**<br>- Provide Name<br>- Job title and affiliation<br>- Reason for contact: "I am contacting you because you are an adult with a disability and are moving into the Forever Home through LADD."<br>**Purpose**<br>- Provide purpose of research: "The goals of this study are to describe the cost of providing technology for adults with disabilities in a supported living home and to show the impact of technology care on the ability and happiness with selected activities."<br>**Participants & Inclusion/Exclusion Criteria**<br>- State the inclusion criteria: "I am looking for adults with a disability who are moving into the Forever Home."<br>- Ask permission to continue: "In order to see if you qualify for this study I am going to ask you some private questions. You are free to answer only the questions you feel comfortable answering. Do I have your permission to proceed?"<br>- 18 years of age or older<br>- Do you have a disability | **Initial Contact Script B**<br><br>**Introduction:**<br>- "Hi, my name is Kate. I'm talking to you because you are a person who is moving into the LADD Forever Home. I want to see if you want to help me with a research project"?<br>**Purpose:**<br>- "I'm doing this project to find out if your new home will make you happier. I'm also trying to find out if it will make the things you do every day easier."<br>**Participants & Inclusion/Exclusion Criteria:**<br>- State the inclusion criteria: "I'm looking for people who have a disability and who are moving into the Forever Home."<br>- Ask permission to continue: "To see if you can help with the study, I am going to ask you some private questions about you. You can only answer the questions you want to. Can I keep going now?"<br>- 18 years of age or older<br>- Do you have a disability<br>- Are you going to move into the Forever Home<br>**Overview of Study:** | **Initial Contact Script C**<br><br>**Introduction**<br>- Provide Name<br>- Job title and affiliation<br>- Reason for contact: "I am contacting you because you are a caregiver of an adult with a disability who is moving into the Forever Home through LADD."<br>**Purpose**<br>- Provide purpose of research: "The goals of this study are to describe the cost of providing technology for adults with disabilities in a supported living home and to show the impact of technology assisted care on the ability and happiness with selected activities."<br>**Participants & Inclusion/Exclusion Criteria**<br>- State the inclusion criteria: "I am looking caregivers for adults with a disability who are moving into the Forever Home."<br>- Ask permission to continue: "In order to see if you qualify for this study I am going to ask you some private questions. You are free to answer only the questions you feel comfortable answering. Do I have your permission to proceed?"<br>- 18 years of age or older |

## Appendix G: Informed Consent Form

Informed Consent Form: Legal Guardian

My name is _____ and your ward is being given the opportunity to volunteer to participate in a project with Xavier University and the Living Arrangements for the Developmentally Disabled (LADD). The purpose of this study is to look at the cost of providing technological care for adults with disabilities in a supported living home and to describe the impact of technology care on the performance of and satisfaction with some daily tasks. Participants in this study will be asked to provide demographic information, complete an interview regarding their performance and satisfaction of everyday tasks, and to give permission for their caregivers to share information regarding the care they provide. The study will continue over three years and each year the interview will take about 45 minutes to one hour to complete, allowing for individual differences as needed. Benefits to participating in the study include improving your dependent's skills with technology devices and services, lowering his/her need for help, and lowering caregiving costs. This study presents minimal risks related to time and inconvenience for your dependent and his/her caregiver. No compensation for participation in the study will be given.

**What Will Happen**

Your ward will be asked to be a part of semi-structured interviews looking at daily tasks and use of technology. The interviews will be 30-45 minutes and will happen between September and November 2019. They will be done in a private space near Xavier University. Additionally, your ward's permission will be requested to allow researchers to talk with their caregiver(s). This process will be repeated next year (year one) and the following year (year Font Size tal of three years. By signing this document you are giving consent for your dependent to participate in this study for three years. You will be reminded of what you are consenting to each year, and your dependent may stop participating in the study at any time over the course of the three years.

**Why Your Ward was Invited to Take Part**

Your ward is asked to take part as an adult with a disability who will live in a home that has technology devices and services.

**Study Requirements**

Your ward will participate in one 45 minute to one hour interview. This interview will include questions relating to their performance and satisfaction with daily tasks, how much care they receive from their caregivers, and general information about them. We will also ask his/her caregiver to tell us how much assistance they give your ward for 2-3 selected daily tasks. This will happen once per year for three years.

**What are the Bad Things That can Happen**

This study presents minimal risks related to time and inconvenience for your ward and his/her caregiver.

**What are the Good Things That can Happen**
Benefits are helping your ward's skill with technology devices and services, lowering his/her need for help, and lowering caregiving costs. No payment for his/her participation will be given.

**How will Information About your Ward be Kept Private**
Steps will be taken to keep confidentiality including de-identifying information, storing consent forms in a locked cabinet in a faculty office in a different location than the data, and destroying all data three years after the study.

**Will it Cost your Ward Anything to be in the Study and Will your Ward be Paid**
No payment for their participation will be given, and no cost is associated with participating in the study.

Not participating in this study will NOT EFFECT ON ANY FUTURE SERVICES your ward may be given by Xavier University and LADD. Your ward is FREE TO STOP PARTICIPATING IN THE STUDY AT ANYTIME WITHOUT HARM. Sign the line below if you want your ward want to take part. You will be given a copy of this form to keep.

If you have questions, ask Maddie Doyle at doylem10@xavier.edu or Claire Morress at morress@xavier.edu (513) 745-3266. Questions about your rights as a research participant go to Xavier University's Institutional Review Board at (513) 745-2870.

I have been given information about this study, its risks and benefits, and have asked any questions I had. I give my consent for my ward to be in this study.

Name of Ward (printed): _____

Name of Legal Guardian (printed) _____

_____ _____
Signature of Legal Guardian Date

THE DATE APPROVAL STAMP ON THIS CONSENT FORM INDICATES THAT THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY XAVIER UNIVERSITY'S INSTITUTIONAL REVIEW BOARD.

## Appendix H: Assent Form

Appendix H

Assent Form

I, _____ [participant name] know that [caregiver name] said I could be in this study conducted by Xavier students and teachers. If I say I want to be in the study, people will ask me about the things I do every day. They will ask me about how happy I feel about how well I can do things at home. If I say no, they will not ask me anything. If I say no, nothing bad will happen. I am doing this because I want to. The people who are asking me questions can also talk to [caregiver name]. I know nothing bad will happen to me if I don't want to answer the questions anymore. I know the study will last for three years and the Xavier students will ask me every year if I still want to be in the study.

Name (printed):_____

_____ _____
Signature Date

_____ _____
Witness (someone other than parent/guardian) Date

THE DATE APPROVAL STAMP ON THIS CONSENT FORM INDICATES THAT THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY XAVIER UNIVERSITY'S INSTITUTIONAL REVIEW BOARD.

## Appendix I: Informed Re-Consent Form

Re-Consent Form: Legal Guardian

I _____ agree to continue allowing my dependent _____ to participate in this project with Xavier University and LADD. I understand that he/she will be asked to answer questions about his/her performance and satisfaction with a few everyday tasks, and that this will take approximately 45 minutes of his/her time. I understand that my ward's caregiver will also be asked to rate how much assistance he/she provides my ward with these tasks. I understand that my ward is free to stop participating in this study at any time. If you have questions Claire Morress at morress@xavier.edu (513) 745-3266. Questions about your dependent's rights as a participant go to Xavier University's Institutional Review Board at (513) 745-2870.

_____ _____

Signature Date

THE DATE APPROVAL STAMP ON THIS CONSENT FORM INDICATED THAT THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY XAVIER UNIVERSITY'S INSTITUTIONAL REVIEW BOARD.

## Appendix J: Re-assent Form

Re-Assent Form

I, _____ know that [caregiver name] said I can continue to be in this study conducted by Xavier students and faculty. I know nothing bad will happen to me if I don't want to answer the questions anymore. If you have questions, ask Claire Morress at morress@xavier.edu or (513) 745-3266. Questions about your rights as a participant go to Xavier University's Institutional Review Board at (513) 745-2870

_____ _____

Signature Date

THE DATE APPROVAL STAMP ON THIS CONSENT FORM INDICATES THAT THIS PROJECT HAS BEEN REVIEWED AND APPROVED BY XAVIER UNIVERSITY'S INSTITUTIONAL REVIEW BOARD.