Weeks et al., Gerontechnology (2024) 23:1
https://doi.org/10.4017/gt.2024.23.1.1049.08

Family and friend caregiver satisfaction and utility of passive remote monitoring technology utilized by frail home care clients

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Abstract

Background: Passive remote monitoring technologies (RMT) utilize information gathered from sensors that is transmitted to a caregiver to alert them to a possible incident. There are gaps in our knowledge about the level of satisfaction with passive RMT from the perspective of those who have actual experience using this technology, including family and friend caregivers. This knowledge is important as caregivers are instrumental in determining whether passive RMT will be adopted and utilized over time. In addition, technologies designed for older adults and their caregivers are both helpful and user-friendly.
Objective: The aim of this research was to identify the level of satisfaction and utility of passive RMT from the perspective of family and friend caregivers of frail older adults who utilized the technology for a minimum of 90 days.
Method: Questionnaire data was collected through interviews with family and friend caregivers of frail home care clients who utilized passive RMT for at least 90 days. Participants could choose from an array of passive RMT sensors that met their needs (e.g., technologies that monitored falls, eating, sleeping, movement/lack of movement, washroom patterns, taking medications, and video cameras). Data reported included closed-ended questionnaires the type of sensors utilized, level of satisfaction with the type of sensor, usability, and satisfaction with passive RMT.
Results: Of the 80 participants, most participants were over age 60, female, lived with the home care client, and reported high levels of caregiver burden. Sensors to detect wandering were frequently utilized. The level of satisfaction across the various types of sensors ranged from a mean low of 4 for medication sensors (i.e., somewhat satisfied) with the rest scoring at least a mean of 4.5, indicating between somewhat satisfied and satisfied. The participants indicated a high level of utility of the technology, ranging from 3.4 to 5.5 with 6 indicating strongly agree.
Conclusion: The results of this research contribute to our scant knowledge about the high level of satisfaction and utility of passive RMT from those with real-life experience using this technology. Mechanisms should be investigated to support the implementation of passive RMT for caregivers of frail older adults.

Keywords: sensors, community-dwelling, approval, value

Introduction

The World Health Organization (WHO) has identified the importance of supporting family caregivers with appropriate resources and technologies to allow the people they provide care for to age-in-place in their homes and communities and to reduce stress and health problems for caregivers (World Health Organization, 2017). Remote monitoring technologies (RMT) are one form of support designed to assist older adults and their family caregivers.

Passive RMT acts by sending notifications from sensors (e.g., motion sensors, cameras, medication administration sensors) to a recipient. A recent scoping review on the use of passive RMT in the homes of community-dwelling older adults identified that the most frequently used passive RMT sensors were motion sensors to detect activity or lack of activity, bed sensors, and cameras

(Read et al., 2023). Passive RMT uses sensors that do not require any action by the individual for the system to work, as opposed to active RMT which requires individual participation, such as pushing a button (Berridge, 2019; Tokunaga et al., 2014). Recipients can include a healthcare professional, the client being monitored, or family or friend caregivers (van Hoof et al., 2011). With passive RMT, information gathered from the sensors can be transmitted directly to a recipient (e.g., cell phone notification) to alert them to a possible incident (e.g., a fall, wandering outside the home, failure to take medication) (Berridge, 2019). A major benefit of passive RMT is that this technology avoids concerns with adherence identified with active RMT, such as not wearing a device or turning it off (French et al., 2023).

While there continues to be relatively little research focused on this passive RMT, (Berridge, 2019; Read et al., 2023), there have been many positive aspects of passive RMT identified, including supporting aging-in-place, improving the health and safety of those utilizing this technology, and beneficial outcomes for family and friend caregivers such as a reduction in the burden of care (Weeks et al., 2022). Most prior research has examined the impact of passive RMT on client outcomes, with far fewer studies examining the impact of this technology on family and friend caregivers (Read et al., 2023). In a recent qualitative study, passive RMT has been identified as particularly beneficial for caregivers who do not live with the care recipient as they can be kept aware of any concerns that arise (Weeks et al., 2021).

There is a small body of knowledge about the extent to which family caregivers are satisfied with utilizing various forms of technology to support the older adults they provide care for (Chi & Demiris, 2015). In one quantitative study conducted in 2009, researchers identified that family caregivers were very satisfied (i.e., usability, ease of use) with a particular type of night monitoring system for people with dementia (Rowe et al., 2009). In a more recent qualitative study, researchers examined family caregiver acceptability of a live video-feed home monitoring system (Comiskey et al., 2018). The participants in this study did not have actual experience utilizing the technology, but they indicated a willingness to accept live video monitoring of the person they cared for as long as the privacy and dignity of the person was protected. In a small qualitative study published in 2013 focused on passive RMT supporting the nighttime needs of people with dementia living in the community, most family caregivers indicated a high level of user acceptance of the technology, such as identifying that it helped them to monitor the person they cared for from a distance and the technology was easy to navigate (Martin et al., 2013).

From our review of the literature, we identified gaps in our knowledge about the level of satisfaction with passive RMT from the perspective of those who have actual experience using this technology, including family caregivers (Read et al., 2023). As technologies are continually advancing, additional current knowledge about satisfaction with this technology is necessary from family caregivers as they are instrumental in determining whether passive RMT will be adopted and utilized over time. As technology that is difficult to use has been found to be a barrier for some older adults with cognitive (e.g., dementia) or physical limitations (Ienca et al., 2018), it is imperative that any technologies designed for older adults and their caregivers are user-friendly. In addition, many caregivers are older adults, especially those caring for a spouse or partner. It is necessary to develop technologies that are perceived by the users as both helpful and easy to utilize.

The aim of this research was to identify the level of satisfaction and utility of passive RMT from the perspective of family and friend caregivers of frail older adults who utilized the technology for a minimum of 90 days.

Methods

Ethical considerations

After the receipt of ethics certificates, informed consent was obtained from participants either verbally or in writing. Ethics certificates were received from the Nova Scotia Health Research Ethics Board (File #1022203) and Western University Health Sciences Research Ethics Board (File #108406). Data were recorded by paper and pencil by trained interviewers and then entered into a spreadsheet by research staff. Paper copies were securely stored in locked cabinets in research offices. Electronic data were stored using a participant ID number on secure password-protected and encrypted computer servers at Dalhousie University and Western University.

Study context and design

This research is a component of a pragmatic unblinded randomized controlled trial with 2 parallel groups in the provinces of Ontario and Nova Scotia, Canada, titled "The Caring Near and Far Study: A Multi-province Investigation of Remote Monitoring Technologies Connecting Community-based Older Adults and their Care Team." We conceptualize passive RMT as an important form of quaternary prevention, which is a form of technology that could prevent or delay the need for additional medical intervention (Norman & Tesser, 2019). One overarching objective of the Caring Near and Far Study is examining whether passive RMT can reduce the need for higher levels of healthcare (e.g., nursing home admission or acute care utilization). From 2017-

2021, we collected evidence about the effectiveness of passive RMT for frail older adults receiving home care services who were at high risk of requiring higher levels of care, defined as being likely to be admitted to a nursing home within the next 12 months. For additional details on our study methodology and study context, please see previously published articles from this research (Donelle et al., 2020; Weeks et al., 2022).

The passive RMT was provided at no cost to the study participants by our study partner, an RMT provider. Those randomized into the intervention arm had the opportunity to choose from an array of passive RMT sensors that met their needs (e.g., technologies that monitored falls, eating, sleeping, movement/lack of movement, washroom patterns, taking medications, and video cameras). The ability to select the monitoring devices according to personal needs and preferences is an important aspect of remote monitoring (Tokunaga et al., 2014). Technicians hired by the RMT provider reviewed each of the types of sensors and the participants could choose any or all of them to be installed, including input from both the family and friend caregivers and home care clients. The technicians installed the technology, and as part of our partnership arrangement, provided full service/support at no cost to the users for 1 year for those randomized into the intervention arm.

Notifications from the sensors were sent directly to family and friend caregivers via email, text message, or phone call. Quantitative and qualitative data were collected from dyads of home care clients and their family and friend caregivers who received the notifications from the passive RMT sensors. In this article, we report on quantitative data collected from family and friend caregivers.

Participants and procedures

The inclusion criteria for the RCT were family and friend caregivers of people aged 65 and older who utilized publicly funded home care and were at risk of needing a higher level of care (i.e., residential long-term care). Each home care recipient was required to have a family or friend caregiver who was willing to receive notifications from the passive RMT sensors. In the current article, we only report data collected from family and friend caregivers in the intervention arm of the RCT as they were asked questions about technology satisfaction and utility.

We analyzed data collected from 80 family and friend caregivers in the intervention arm in the Canadian provinces of Nova Scotia and Ontario who utilized passive RMT for at least 90 days. Any participants who utilized the RMT for at least 90 days from installation to the time of the interview were included in the analysis. If participants had more than one interview, the last data point was used. Family and friend caregivers were excluded if (1) they were randomized to the control group, or (2) were randomized to the intervention group but did not utilize passive RMT for at least 90 days. There were a total of 121 participants at baseline, and 66% (n=80) of participants met the inclusion criteria for this analysis.

In both provinces, research staff worked with their respective health authorities to identify home care clients who met the inclusion criteria utilizing interRAI assessment system (interRAI.org) data and/or the judgment of care coordinators. Once potential participants were identified, information about the study was sent to them via mail by the health authority, and two reminders were sent. Participants contacted the research staff if they were interested in participating. Data were collected both from older adults and their family or friend caregivers.

Statistical analysis

Various demographic characteristics were collected (e.g., age, gender, education, employment, marital status, income). We also reported additional characteristics about the clients and caregivers to provide an understanding of the care needs of the home care clients in this study. The caregiving experience including whether the caregiver lives with the client and the time Caregiver burden was assessed using the 12-item Zarit caregiver burden interview (Bédard et al., 2001). Scores range from 0-48. Scores of 17 or higher indicate a high caregiver burden. The Hospital Admission Risk Profile (HARP) tool (Sager et al., 1996) was used to indicate a higher risk for elevated levels of care by assessing Instrumental Activities of Daily Living (IADL). The results of this tool range from 0-7, with lower scores indicating a higher risk for elevated levels of care.

We examined data on satisfaction with RMT from the perspective of family and friend caregivers due to their important role in the utilization of the passive RMT as they were the ones receiving notifications (e.g., cell phone notification) from the various sensors. Notifications were sent in response to atypical behaviour of the older adult for whom they provided care; that is, notifications were only sent if the behaviours were outside of their normal daily pattern that had been previously established by the family and friend caregivers with the assistance of a technician who worked for the RMT provider. Participants identified which type of RMT sensors they utilized in their homes. We then asked them to indicate their level of satisfaction on a Likert scale developed by the researchers

Table 1. Participant characteristics

Characteristic	Nova Scotia (n=36)	Ontario (n=44)	Total (n=80)
Age (mean±SD, range) (n=79)	60.3±10.7, 42-81	64.5±13.3, 31-87	62.6±12.3, 31-87
Gender: Female (n=79)	26 (72%)	36 (84%)	62 (78%)
Completed college or higher than college (n=79)	21 (58%)	23 (53%)	44 (56%)
Employment status (n=79)			
Employed			
Full time (35+ hrs/week)	12 (33%)	11 (25%)	23 (29%)
Part time (<35 hrs/week)	6 (17%)	4 (9%)	10 (13%)
Leave of absence	1 (3%)	1 (2%)	2 (3%)
Retired	10 (28%)	26 (59%)	36 (46%)
Not employed	7 (19%)	2 (5%)	9 (11%)
Marital status (n=79)*			
Married	21 (58%)	31(70%)	52(65%)
Widowed	1 (3%)	3 (7%)	4 (5%)
Separated	2 (6%)	2 (5%)	4 (5%)
Living together	3 (8%)	2 (5%)	5 (6%)
Divorced	3 (8%)	1 (2%)	4 (5%)
Single	6 (17%)	5 (11%)	11(14%)
Annual household income (n=64)*			
<$20,000	5 (15%)	3 (7%)	8 (10%)
$20,000-$49,999	10 (30%)	10 (23%)	20 (26%
$50,000-$99,999	6 (18%)	16 (36%)	22 (29%)
≥$100,000	7 (21%)	7 (16%)	14 (18%)
Refused to answer or did not know	5 (15%)	8 (18%	13 (17%)
Household income satisfaction (n=79)*			
Very well	6 (17%)	15 (35%)	21(27%)
Adequately	15 (42%)	22 (51%)	37 (47%)
With some difficulty	10 (28%)	1 (2%)	11(14%)
Not very well	4 (11%)	4 (9%)	8 (10%)
Totally inadequate	1 (3%)	1 (2%)	2 (3%)
Spouse or partner of client (n=79)*	9 (25%)*	26 (60%)	35 (44%)
Live with client (n=79)*	17 (47%)	34 (77%)	51(65%)
Self-reported weekly time spent providing care (mean±SD, range) (n=80)	68.0±69.9, 3-168	94.8±70.0, 1-168	82.8±70.8, 1-168
Number of IADLs need help with (mean±SD, range) (n=80)	1.6±1.7, 0-5	1.2±1.5, 0-6	1.4±1.6, 0-6
0	14 (39%)	19 (43%)	33 (41%)
1	6 (17%)	12 (27%)	18 (23%)
2	5 14%)	6 (14%)	11 (14%)
3	5 (14%)	2 (5%)	7 (9%)
4	3(8%)	4 (9%)	7 (9%)
5	3 (8%)	0 (0%)	3 (4%)
6	0 (0%)	1 (2%)	1 (1%)
Zarit Caregiver Burden Interview (mean±SD, range)	16.7±9.3, 0-38	17.8±10.4, 0-41	17.3±9.9, 0-41
Considered moving client to institution	24 (67%)	23 (52%)	47 (59%)
Number of days between installation and interview (mean±SD, range)	304.1±90.9, 102-457	295.6±74.1, 99-441	299.4±81.6, 99-457

* Statistically significant difference between provinces, p<.05

(1=strongly unsatisfied to 6=strongly satisfied) for each form of technology they utilized. In addition, participants were asked fifteen questions about the usability and satisfaction with the passive RMT technology utilized (1=strongly disagree to 6=strongly agree). These items were developed based on a review of available self-report questionnaires to assess patient, caregiver, and healthcare providers' satisfaction with home care services, telehealth services, and in-home monitoring technologies. Five items were adapted from a questionnaire developed to assess patient satisfaction with home care services including telehealth services (Grant et al., 2015). The remaining 10 items were developed by the research team based on our expertise.

Descriptive statistics (i.e., percentages, means, standard deviations) were used to describe the data. Demographic data collected from Nova Scotia and Ontario were compared to identify any provincial differences. Chi-square tests, or Fisher's Exact test, were used for categorical variables and the Mann-Whitney U test was used for the non-parametric continuous variables.

Results

Participant characteristics

See *Table 1* for further details on the characteristics of the 80 family and friend caregivers.

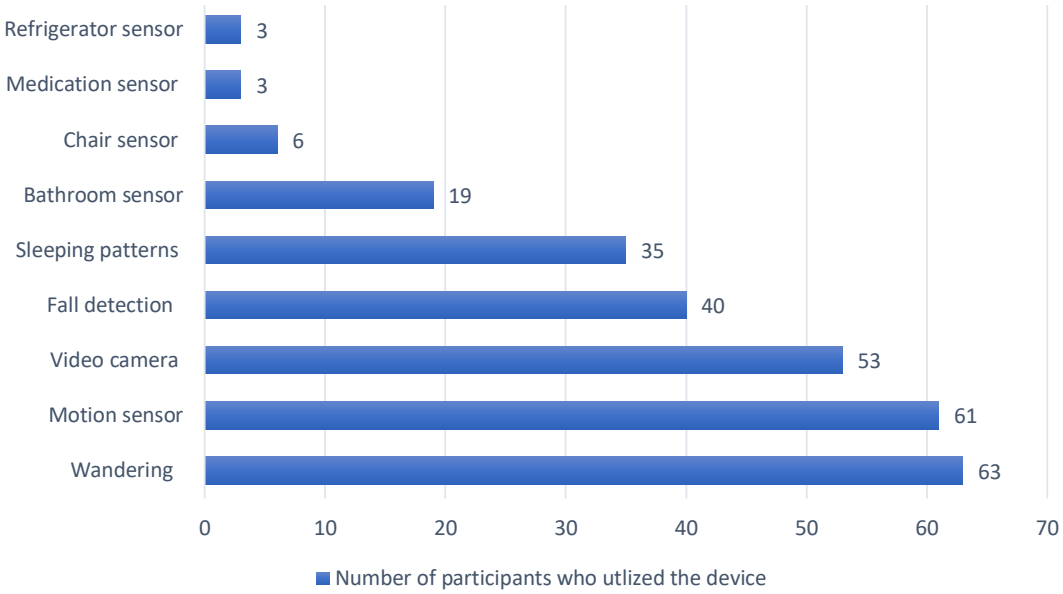

Figure 1. Passive RMT sensors utilized

Forty-five percent of the sample were from Nova Scotia (NS) and 55% from Ontario. They ranged in age from 31-87 (mean=62.6, SD= 12.3), included 78% females, and 71% were married or lived with a partner. A total of 65% lived with the home care client and 42% were employed full or part-time. Fifty-six percent had completed college or beyond and 27% reported some difficulty having enough financial resources to meet their household's needs.

The mean hours of weekly care provided was 82.8 (SD=70.8), and 59% considered moving the home care client to a nursing home. The mean IADL score was 1.4 (range = 0-6, SD=1.6) indicating a high risk of requiring elevated care (e.g., nursing home). The Zarit Caregiver Burden Interview mean was 17.3 (range=0-41, SD 9.9) indicating high levels of caregiver burden.

Comparisons between the samples from Nova Scotia and Ontario showed significant differences between marital status (fewer in NS married or living with a partner), income levels and income satisfaction (NS lower), relationship to the person caring for (NS less likely to be a spouse or partner), live in the same home (NS lower). These significant differences were largely attributed to the significantly smaller proportion of spouse caregivers in the NS sample.

Types of sensors utilized and satisfaction by sensor type

See *Figure 1* for the results of which passive RMT sensors the study participants chose to utilize. As the older adults and their caregivers collaborated to tailor the sensors to meet their unique needs, there was variation in the number and type of sensors utilized. Sensors to detect wandering were the most frequently utilized, and these sensors could be installed on any door (e.g., door to the outside, bedroom doors). Video cameras were also utilized frequently. Sensors to detect falls were selected by half the sample. Few participants selected sensors on refrigerators, chairs, and to monitor medications.

See *Figure 2* for results of satisfaction of the participants by type of sensors. Overall, there was a high level of satisfaction across the various types of sensors. The results ranged from a mean low of 4 for medication sensors (i.e., somewhat satisfied) with the rest scoring at least a mean of 4.5, indicating between somewhat satisfied and satisfied, and satisfaction with chair sensors approached a mean of 6, indicating strongly satisfied.

Utility of the passive RMT system

The results of the utility of the passive RMT system are included in *Figure 3*. Note that the first four items at the top of the figure were asked in reverse order, with lower scores indicating higher levels of utility. In general, the participants indicated that the passive RMT system had very positive utility for themselves as caregivers (e.g., peace of mind), for the person they cared for (e.g., keeping them safe in their home), and potentially for the health system (e.g., the early identification of emergencies, accidents, or unexpected events). Importantly, the participants did not identify that the system had a negative impact on privacy or interfered with their day-to-day life and they indicated that it was easy to use. The mean rating for overall satisfaction with

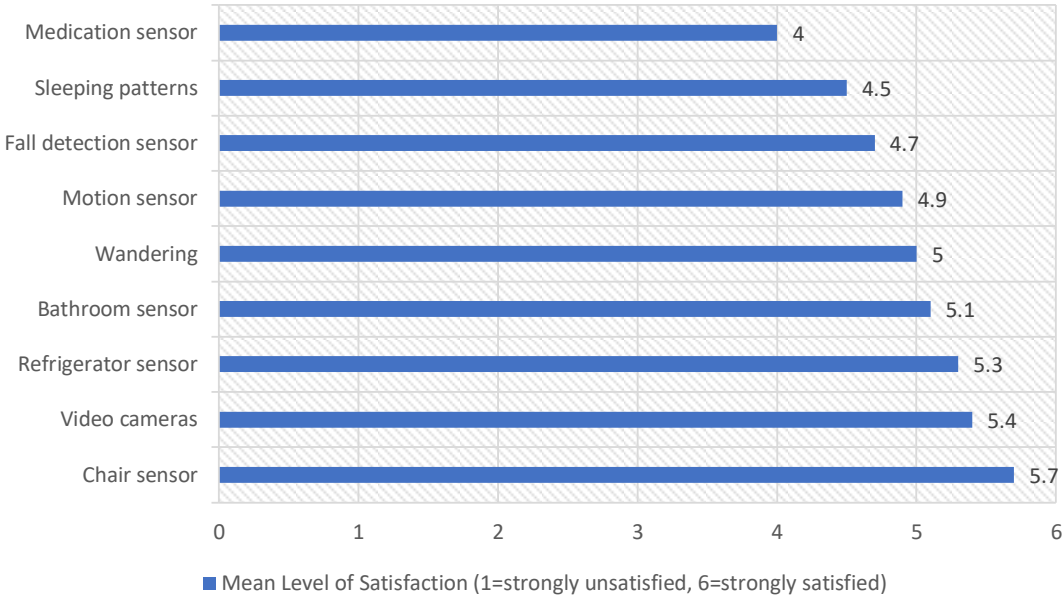

Figure 2. Satisfaction by type of passive RMT sensors utilized

the system was quite high.

Discussion

The results of this research contribute to our scant knowledge about the level of satisfaction and utility of passive RMT from those with real-life experience using this technology (Comiskey et al., 2018; Read et al., 2023). Our research has contributed knowledge from the perspective of family and friend caregivers with experience utilizing this technology. While the inclusion criteria required having experience using the passive RMT system for a minimum of 90 days, the mean was almost 10 months. This length of time using the technology afforded the family and friend caregivers the considerable opportunity to form meaningful assessments of their level of satisfaction and the utility of the passive RMT system.

Overall, our results indicate very high levels of satisfaction and utility of many aspects of passive RMT technology from the perspective of family and friend caregivers of frail older adults living in community settings. The sensors most utilized allowed family and friend caregivers to detect unusual movement patterns in general and ensure overall safety. These were utilized more frequently than sensors with very specific purposes (e.g., monitoring medication administration). Various forms of passive RMT sensors are included in other studies but in general, motion sensors and contact sensors to detect doors opening and closing are the most frequently examined, and some studies examine one or a small number of sensors (Read et al., 2023). That the passive RMT system we utilized had a range of sensors to choose from, with a high level of customization, may have contributed to our highly positive results related to satisfaction and utility.

It is interesting that many chose to utilize video cameras, with a subsequent high level of satisfaction for this component of the passive RMT system. While some researchers have identified concerns about privacy related to video cameras, others have noted that this is not a large concern as long as the privacy and dignity of the person are protected (Berridge et al., 2019; Bowman et al., 2013; Comiskey et al., 2018). Video cameras were the one form of sensor in our research that required a high-speed internet connection, which may have limited the utility of the system for those without access to this technology due to cost or remote location. Thus, enhancing access to reliable high-speed internet services for those who live in rural and remote areas will support the video capacity of passive RMT technologies. As prior studies tend to focus on urban populations (Read et al., 2023) examining the feasibility of incorporating passive RMT, especially those reliant on stable internet connectivity, in rural and remote places is needed.

As there was a high level of agreement that passive RMT can help keep frail older adults safe in their homes, our results contribute evidence to existing knowledge that there may be a preventive aspect of passive RMT systems (Read et al., 2022; Weeks et al., 2022). Passive RMT could be an important component of quaternary prevention (Norman & Tesser, 2019). for this population who are already managing significant physical and/or mental health challenges and are at risk of needing higher levels of healthcare (e.g.,

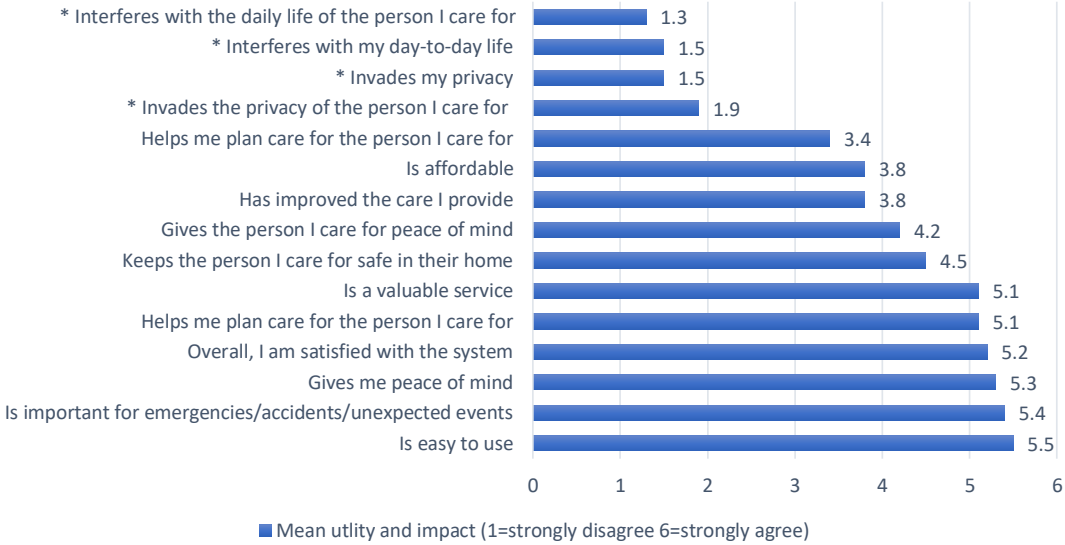

Figure 3. Utility of passive RMT (For these items, lower scores indicate higher levels of utility)*

nursing home admission, and acute care utilization). However, quantitative evidence is needed across multiple jurisdictions in order to more fully understand the relationship between passive RMT and aging-in-place (Read et al., 2022). When the health system utilization data from our randomized controlled trial are available, this will contribute to this knowledge (Donelle et al., 2020). In addition, in the future, researchers should examine the impact of implementing passive RMT using an upstream preventive approach, such as incorporating this technology for pre-frail older adults.

The issue of affordability of passive RMT is a very important one. Many of the caregivers who participated in this research, had relatively low incomes and identified challenges related to income satisfaction. Most agreed that passive RMT is affordable, however, the issue of affordability may have been difficult for the participants to assess accurately as they did not pay for the passive RMT system during this study. There are some examples in Canada of passive RMT being subsidized or fully paid for by the publicly funded healthcare system. For example, in New Brunswick, passive RMT is part of the suite of publicly funded home support services provided by the Department of Social Development (Read et al., 2022). Little is known about the level of access family and friend caregivers have to publicly funded passive RMT. Documentation about this in Canada and elsewhere would be advantageous. In addition to the cost of the passive RMT, an additional barrier could be purchasing internet services if a video camera is utilized (Read et al., 2022).

In our study, frail older adults had to have a family or friend caregiver willing to receive the notifications from the sensors. Clearly, not all older adults have a family or friend caregiver available who is able to serve in this capacity. In the future, it would be useful to examine how home care agencies, or other health service providers, could be involved in monitoring sensors from clients. In the United States, there is a relatively recent expansion of Medicaid programs to include coverage of technologies to monitor home and community-based services clients to maintain safety within the context of a lack of human resources. (Berridge, 2019) Additional research is needed to examine the effect of passive RMT on the role of paid care providers (Read et al., 2023).

Various factors affected participant recruitment, including the capacity of our health system partners to devote resources to this study during the COVID-19 pandemic. However, through the results presented in the current article, we were able to provide important insights into the level of satisfaction, and the utility and impact to contribute to the scant knowledge about passive RMT. Our knowledge of the factors that affect family caregiver satisfaction with passive RMT is largely unknown. There is some qualitative evidence that the cultural values and beliefs of caregivers impact passive RMT acceptance (Berridge et al., 2019). Given the lack of cultural diversity of the sample in our study, we were not able to contribute to this important topic, and additional research is warranted that focuses on satisfaction and utility for specific groups.

We recognize some additional limitations of this research. The tools used to assess passive RMT satisfaction and utility were developed by the research team. Conducting psychometric testing of the tools utilized is warranted to sup-

port further research. We collected data in two Canadian provinces which limits the generalizability of the results to other settings or contexts that may differ in the health and social supports available to support frail older adults to remain in their homes longer. Finally, the technology was provided at no cost to study participants, and this may have contributed to positive ratings of satisfaction and utility.

Conclusions

Family and friend caregivers with experience using passive RMT indicated a high level of satisfaction and very positive utility for themselves as caregivers and for the person they cared for. Mechanisms should be investigated to support the implementation of passive RMT, such as funding the costs of implementing the technology for those unable to afford to purchase it and ensuring that infrastructure is available to support the technology (e.g., internet and cell phone coverage).

Acknowledgments

This work was funded by the Canadian Institutes of Health Research, eHealth Innovation Partnership Program-Seniors with Complex Care Needs [EH2-143561].

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