How does passive remote monitoring technology affect perceived outcomes for older adults, their family and friend caregivers, and the healthcare system?

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Abstract

Background: Most people who receive home care services also rely extensively on support provided by family and friend caregivers. The utilization of technology such as help from remote monitoring technologies (RMT) that send notifications from sensors (e.g., motion sensors, cameras, medication administration monitoring) to a recipient (e.g., family or friend caregiver, healthcare professional) can help to support care provision. Passive RMT uses sensors that do not require any action by the individual for the system to work.
Objective: This study is a qualitative component of a pragmatic randomized controlled trial. Our objective is to report qualitative findings from the perspective of family and friend caregivers to examine: How does providing passive RMT to older home care recipients affect perceived outcomes for recipients, their family and friend caregivers, and the healthcare system?
Method: We analyzed transcripts from qualitative semi-structured interviews with 15 family and friend caregivers. They provided support for frail older adults receiving home care services, were at risk of requiring higher levels of care, and utilized a passive RMT system for 12 months. We utilized thematic analysis to identify perceived outcomes of passive RMT.
Results: Supporting aging in place emerged as an overarching theme as participants clearly discussed how passive RMT supports frail older adults to remain living in their homes longer or potentially eliminate the need for higher levels of care. Participants identified many ways that passive RMT supports the health and well-being of home care clients. A key theme focused on the perceived positive impact of the passive RMT on the overall well-being of family and friend caregivers.
Conclusion: This study contributed important qualitative insights into the perceived impact of passive RMT. The participants clearly articulated that passive RMT has a great capacity to support the overall well-being of family and friend caregivers and can support aging in place for frail older adults.

Keywords: older adult, frail, family and friend caregivers, passive remote monitoring, Canada

INTRODUCTION

With the global population aging, there is a growing need for home-based care to address the health needs of older adults. Home care services involve a range of public and privately funded organizations that provide chronic, rehabilitative, and palliative care (Innovation, Science, and Economic Development Canada, 2022). It is estimated that 3 million Canadians receive some form of care at home (Government of Canada, 2020). According to the most recent Canadian Community Health Survey, 6.4% of Canadian households received home care services in the past year provided by the healthcare system

(Gilmour, 2018). Those over age 65 represent the largest proportion of home care recipients and 89% of people receiving home care also report receiving care from family members or friends (Government of Canada, 2020). In Canada, about half of home care services are paid for by government sources, 27% are paid for solely out-of-pocket, and the remainder is paid for by other sources, such as insurance companies (Statistics Canada, 2018). There are variations in service delivery and funding models for home-based services between provincial/territorial jurisdictions in Canada, and in this article, we focus on data collected in the province of Nova Scotia.

In Canada, the highest rate of home care usage is in the province of Nova Scotia at 7.8% of households (Gilmour, 2018). Home care services in Nova Scotia are funded and organized provincially by the Department of Health and Wellness (i.e., governing public health policy) and Nova Scotia Health (i.e., governing the delivery of health services and programs), and are delivered locally through Nova Scotia Health and Continuing Care Coordinators that work with contracted agencies to provide home care services (Nova Scotia Department of Health and Wellness, 2020). There are no out-of-pocket costs for receiving skilled nursing home care services, however, fees for home support (e.g., light housekeeping, laundry, meal preparation) are based on income and family size, and additional support for family and friend caregivers may include costs such as specialized equipment loans (Nova Scotia Department of Health and Wellness, 2020).

Most people receiving home care services also rely extensively on support provided by family, friends, and caregivers. The interconnections between care provided by family and friend caregivers and care provided by home care workers have been identified and research results highlight the important contributions of both in meeting the needs of older adults living in the community (Sims-Gould & Martin-Matthews, 2010). A recent integrative review identified that relationship building with home care workers, negotiating the care that will be provided, and knowledge sharing are important aspects of the involvement of family and friend caregivers working together with home care workers to meet the needs of older adults (Ris et al., 2019).

With an aging population, the need to support family and friend caregivers of older adults is imperative, especially as there is an increasing number of caregivers supporting those with their health and functional limitations (National Alliance for Caregiving and AARP, 2020). Various forms of technology can be utilized to support older adults living in their own homes in the community which can reduce the need for in-person assistance (Berridge, 2019). The utilization of technology can help to support family and friend caregivers of older adults receiving home care services. In a systematic review of the literature, Khosravi and Ghapanchi (2016) identified that assistive technologies can focus on a variety of problems that older adults experience, such as chronic disease, dementia, depression, fall risk, dependent living, medication management, and poor well-being. These technologies can include videoconferencing, telephone calls or text messaging, web-based information, and remote monitoring using sensor technology (Chi & Demiris, 2015; Khosravi & Ghapanchi, 2016).

Remote monitoring technologies (RMT) act by sending notifications from sensors (e.g., motion sensors, cameras, medication administration monitoring) to a recipient. Recipients can include a healthcare professional, the client being monitored, or a family or friend caregiver (van Hoof et al., 2011). 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). There are some examples of passive RMT in which the sensor data is transmitted to healthcare providers (e.g., Rantz et al., 2013, Rantz et al., 2015). Other researchers have utilized passive RMT video cameras to evaluate gait measurements of older adults that ultimately were designed to reduce falls by providing the sensor data to nurses or care providers (Stone & Skubic, 2013).

While most studies focus on the role of various technology-mediated interventions on the care recipients or patients (Tsertsidis et al., 2019; van Hoof et al., 2011), there is a lack of attention paid to the effect of passive RMT on family and friend caregivers and how these technologies support their needs (Chi & Demiris, 2015; Reder et al., 2010). As a technology that is difficult to use is a barrier for some older adults with cognitive (e.g., dementia) or physical limitations (Ienca et al., 2018), the utilization of passive RMT may be particularly useful for many older adults and their family and friend caregivers. Information gathered from the sensors can be transmitted directly to a family or friend caregiver (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).

An early example of passive RMT showed a promising positive impact on older adults and their family and friend caregivers, but the technology was not able to provide emergency alerts or warnings (Reder et al., 2010). A systematic review of various forms of telehealth technologies to support family caregivers (Chi & Demiris, 2015) identified just 1 study focused on the impact of passive RMT on family caregivers of older adults living in their own homes (Chou et al., 2012). In this pilot study conducted in Taiwan, data were collected from family caregivers after utilizing the EverCare TMSS system (Yorkshire, UK) for 6 months (Chou et al., 2012). The system provided data from various sensors (e.g., property exit sensors, bed occupancy sensors) to a response centre in a hospital where decisions were made about care or medical support. Family or friend caregivers also received a daily phone call from the hospital to check on them. While the family or friend caregivers did not personally receive notifications from the technology, they

felt comforted that the system was able to detect round-the-clock changes in the recipient's condition, and the system helped share the burden of providing care.

A recent qualitative Canadian study examined various stakeholder perspectives (i.e., home care clients, family and friend caregivers, case managers, and decision-makers) of passive RMT to support aging in place in the Canadian province of New Brunswick (Read et al., 2021). While passive RMT is currently available as a publicly funded home support service in that province, there are quite low levels of utilization of the technology. Thus, those interviewed in that study had very limited experience with passive RMT. Key findings included the perception that passive RMT supports home care clients living at home longer, and this technology can reduce the burden of providing care for family and friend caregivers.

From our review of the literature, we identified that little is currently known about the impact of passive RMT on older adults, their family and friend caregivers, and the healthcare system from the perspective of those who have direct experience utilizing this technology. This form of technology is rapidly advancing but our knowledge base about appropriate and ethical use is lacking (Berridge, 2014, 2019). In this article, we report qualitative results from the perspective of family and friend caregivers who have direct experience utilizing passive RMT to examine: How does providing passive RMT to older home care recipients in Nova Scotia, Canada, affect perceived outcomes for older adults, their family and friend caregivers, and the healthcare system?

METHODS
Study context and design
This research was conducted as a component of a pragmatic unblinded randomized controlled trial with 2 parallel groups in Ontario and Nova Scotia, Canada, titled "Caring near and far: A multi-province investigation of remote monitoring technologies connecting community-based older adults and their care team." For additional details on our study methodology, please see the published protocol (Donelle et al., 2020). We examined the effectiveness of passive remote monitoring technologies (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.

In this eHealth partnership study funded by the Canadian Institutes of Health Research, the passive RMT was provided by our study partner, CareLink Advantage (carelinkadvantage.ca). Those randomized into the intervention arm had the opportunity to choose from an array of passive RMT options that met their needs (e.g., technologies that monitor 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). CareLink Advantage technicians installed the technology, and as part of our partnership arrangement, provided the technology at no cost for 1 year for those randomized into the intervention arm. Notifications from the sensors (e.g., missed medications, atypical length of time in bed) were sent directly to family and friend caregivers via email, text message, or phone call. After 1 year, the clients and their family and friend caregivers had the option of having the system removed at no cost or keeping the system and incurring the costs directly. 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 at 3-time points: baseline; 6 months; and 12 months.

In the current study, we only included qualitative data collected in Nova Scotia at the 12-month time point for family and friend caregivers in the intervention arm, that is those with direct experience utilizing passive RMT as they received the notifications from passive RMT sensors. The randomized controlled trial component of this research primarily gathered quantitative data using a range of tools. While this data provides important insights, the inclusion of an interpretative qualitative (Elliott & Timulak, 2021) component provided our research team with the opportunity to gain additional insights from family and friend caregivers. Their experience has the potential to add important insights into the perceived outcomes of passive RMT, especially given that our trial was initiated prior to the COVID-19 pandemic and data collection continued throughout 2020 and into 2021. We measured the impact of passive RMT on the utilization of higher levels of care, such as nursing home admissions. With many outbreaks of COVID-19 documented in nursing homes and deaths in this setting due to COVID-19, this may have provided an impetus for older adults to choose not to move to a nursing home (Hsu et al., 2020; Thompson et al., 2020; Weeks et al., 2021). Thus, the qualitative component of our study provided unique advantages that contribute to exploring the complex experiences of utilizing passive RMT and perceptions of the outcomes of this technology on multiple stakeholders.

Ethical considerations
An ethics certificate was received from the Nova Scotia Health Research Ethics Board (File

\# 1022203). Prior to each interview, informed consent was obtained either verbally or in writing. Audio-recorded interviews were saved using a study ID number on a secure password-protected and encrypted computer server at Dalhousie University. Participants were advised not to disclose any identifying information, but if identifying information was disclosed, it was not included in the interview transcript. A confidentiality agreement was signed by anyone who had access to the data, including a professional transcriber. Quotes from participants are identified by their interview number only.

Participants and procedures
For the data reported in this article, we focused on interviews with family and friend caregivers of the home care clients who received the passive RMT intervention for 1 year in Nova Scotia. Many of the home care clients were quite frail and unable to participate meaningfully in discussions about the impact of the technology due to cognitive impairment. Their family and friend caregivers played an important role in the utilization of the passive RMT as they received notifications (e.g., cell phone notifications) from the various sensors. Notifications were sent in response to atypical behaviour of older adult home care clients; that is notifications to family and friend caregivers were only sent if older adult behaviours were outside of their normal daily pattern.

The family and friend caregivers who chose to participate in the interview were asked about: their overall passive RMT experience; the impact of passive RMT on physical health, mental health, stress, and daily activities for themselves and the client; the impact of passive RMT on the healthcare system; ways to improve the passive RMT; and if they were willing to pay for the technology. Each participant was given the opportunity to make additional comments at the end of the interview. Five interviews were conducted prior to March 2020. The remainder of the interviews were conducted after the province implemented public health restrictions due to the pandemic. The interviews ranged from 9-52 minutes (mean=24).

In the randomized controlled trial, a total of 53 home care clients in Nova Scotia were in the intervention arm. We invited 23 of their family or friend caregivers to participate in a semi-structured interview, and a total of 15 agreed (i.e., 68% response rate and 28% of those in the intervention arm). There were no significant differences (t-test or chi-square analysis) between those interviewed and those not interviewed for demographics and living situation, financial status and caregiver stress, and time spent in care (*Table 1*). Documented reasons for declining to participate in an interview included that the family or friend caregiver was not involved in the research from the beginning of the randomized controlled trial and thus had little experience with the technology, the home care client had moved to a nursing home, or the home care client died.

The 15 family and friend caregivers interviewed ranged in age from 47-81 (mean=63.4, SD=10.4) and included 11 females (n=7 daughters, 3 wives, 1 sister) and 4 males (n=1 husband, 1 son, 1 brother-in-law, 1 friend). A total of 9 lived with the home care client and 8 were employed full or part-time. Seven had completed college or beyond and 6 reported some difficulty having enough financial resources to meet their household's needs. The mean hours of weekly care provided were 62.9, and 5 considered moving the home care client to a nursing home. See Table 1 for further details on the characteristics of the family and friend caregivers interviewed.

Data analysis
The interviews were audio recorded and transcribed verbatim. The transcriptions were then validated for accuracy by the researcher who originally conducted the interview by listening to the recording and reading the transcript. Any discrepancies or inaccuracies in the written transcript were changed by the researcher to ensure accuracy. The transcripts were uploaded into NVivo12, a computer program that aids in organizing and analyzing qualitative data. Guided by our research question, we first conducted deductive analysis followed by allowing themes to emerge from the data using inductive coding (Fereday & Muir Cochrane, 2006).

First, 2 research team members independently coded all 15 interviews into 3 predetermined deductive categories of perceived outcomes of passive RMT 1) older adults utilizing the technology; 2) their family and friend caregivers, and 3) the healthcare system. The 2 researchers then met to discuss any differences and come to a consensus on the final coding of the text into these categories. Random transcripts were reviewed by 2 additional team members, further verifying coding reliability.

After the deductive analysis process was complete, where we coded perceived outcomes into the 3 categories, data was then analyzed inductively for emergent themes within each category. We utilized thematic analysis, a form of pattern recognition that allows for inductive coding (Fereday & Muir-Cochrane, 2006) and is particularly useful in understanding influences and motivations related to how people respond to events or situations (Luborsky, 1994). The data coding process involved generating initial codes through reading the transcripts, search-

Table 1. Comparison of participants interviewed to the total sample in RCT intervention arm

	Interviewed (n=15)	Not interviewed (n=38)	Total sample (n=53)	Missing data	T(p) or χ²
Age: mean±SD (range)	63.4±10.4 (47-81)	58.6±13.6 (28-87)	59.9±12.9 (28-87)	0	1.52 (.22)
Sex: Female	11 (73.3)	27 (71.1)	38 (71.7)	0	0.28 (.87)
Spouse of client	4 (26.7)	11 (28.9)	15(28.3)	0	0.28 (.87)
Live with client	9 (60.0)	24 (63.2)	33 (62.3)	0	0.05 (.83)
Education: Completed college or higher than college	7 (46.7)	21 (55.3)	28 (52.8)	0	0.32 (.57)
Employment status					
Employed	8 (53.3)	17 (44.7)	25 (47.2)	1	0.64 (.73)
Full time (35+ hrs/week)	5 (33.3)	8 (21.6)	13 (25.0)	1	1.69 (.79)
Part time (<35 hrs/week)	3 (20.0)	8 (21.6)	11 (21.2)		
Leave of absence	0 (0)	1 (2.7)	1 (1.9)		
Retired	3 (20.0)	12 (32.4)	15 (28.8)		
Not employed	4 (26.7)	8 (21.6)	12 (23.1)		
Marital status					
Married	8 (25.0)	24 (63.2)	32 (60.4)	0	3.06 (.55)
Separated	1 (6.7)	2 (5.3)	3 (5.7)		
Living together	2 (13.3)	3 (7.9)	5 (9.4)		
Divorced	2 (13.3)	1 (2.6)	3 (5.7)		
Single	2 (13.3)	8 (21.1)	10 (18.9)		
Annual household income					
<$20,000	1 (6.7)	7 (18.4)	8 (15.1)	0	2.23 (.70)
$20,000-$49,999	6 (40.0)	12 (31.6)	18 (34.0)		
$49,999-$99,999	2 (13.3)	5 (13.2)	7 (13.2)		
≥$100,000	4 (26.7)	6 (15.8)	10 (18.9)		
Decline to answer	2 (20.0)	8 (21.1)	10 (18.9)		
Household income satisfaction					
Very well	3 (20.0)	5 (13.5)	8 (15.4)	1	5.70 (.23)
Adequately	6 (40.0)	14 (37.8)	20 (38.5)		
With some difficulty	6 (40.0)	8 (21.6)	14 (26.9)		
Not very well	0 (0)	8 (21.6)	8 (15.4)		
Totally inadequate	0 (0)	2 (5.4)	2 (3.8)		
Self-reported weekly time spent providing care (mean±SD, range)	62.9±68.9 (1-168)	83.0±71.9 (1-168)	77.3±71.0 (1-168)	0	0.86 (.36)
Zarit Burden Interview (mean±SD, range)	17.5±10.2 (0-36)	19.0±13.0 (1-42)	18.6±12.2 (0-42)	7	0.13 (.72)
Considered moving client to institution	5 (35.7)	12 (31.6)	17 (32.7)	0	0.08 (.78)

ing for themes, reviewing themes, and defining and naming themes (Braun & Clarke, 2006). This process resulted in thematic codes representing patterned responses within the data set. The first author developed the codes and the first 2 authors then coded 6 of the 15 (40%) interviews independently and then compared codes. Adjustments were made to the codes to increase clarity and reduce the overlap of the codes. The first author then coded the remaining transcripts independently. This process exceeds the recommendation to have multiple team members independently code 10-25% of the data units (e.g., interviews) (O'Connor & Joffe, 2020). Re-reading our transcripts across successive interpretations provided a check that our thematic groupings continued to reflect the original interviews and were the essential process for developing a constitutive overarching theme (Pieranunzi, 1997).

RESULTS

A summary of the relationship between the categories, themes, and overarching themes identified is included in *Table 2*. In this results section, we begin by presenting our overarching theme "Supporting Aging in Place" followed by results of themes identified within each of the categories of perceived outcomes of passive RMT for home care clients, family and friend caregivers, and the healthcare system.

Overarching theme: Supporting aging in place

The vast majority (n=13) of the participants clearly discussed how passive RMT supports aging in place, that is supporting frail older adults to remain living in their homes longer, and thus potentially eliminating the need for a move to a higher level of care. This represents an overarching theme from our analysis as it contains interconnected perceived outcomes for home care

Table 2. Summary of themes

Categories	Themes	Overarching Theme
Perceived Outcomes for Home Care Clients	Negative experience or impact	
	Neutral experiences	
	Improved overall wellbeing	
	Improved physical health	
Perceived Outcomes for Family and Friend Caregivers	Negative experiences or impact	Supporting Aging in Place
	Neutral	
	Improved overall wellbeing	
	Improved physical health	
	Can monitor people coming into the home	
Perceived Outcomes for the Healthcare System	Nursing home usage	
	Acute care usage	
	Home care usage	
	New costs to fund or partially fund passive RMT	

clients, family and friend caregivers, and the healthcare system. From the perspective of the family and friend caregivers interviewed, passive RMT supports home care clients by reducing the stressors of living at home. For family and friend caregivers, passive RMT can support the overall well-being and physical health that can contribute to being able to provide care longer. This can contribute to potentially reducing the need for more costly forms of care, such as assisted living facilities or nursing homes.

Additional text and data in the sections that follow further illustrate elements of this overarching theme, and the quotes below highlight the perceived interconnected and multifaceted perceived outcomes of passive RMT on aging in place for older adults, their family and friend caregivers, and the healthcare system. Overwhelmingly, participants described the impact of passive RMT on supporting older adults' desire to remain at home which is reflected in the quote below:
"I think that this technology [passive RMT], if she has it continued, is going to help her stay in her home… she's pretty independent but she's starting to get to the point where she needs assistance. And we cannot hire somebody to live with her… I think that she will end up in a nursing home if she doesn't have it. Because we're not going to be able to keep visiting. Like we're not going to be able to stay with her as much as she's going to need us to. But if we're able to watch her and communicate with her that way and get messages back that she's safe or not safe, that's going to make a big difference." (P5)

Participants' awareness of the interconnected perceived outcomes for older adult home care clients supported, in part, by passive RMT is articulated in the following statement.
"I would think that it would be cost effective for the province to foster somebody aging in place.

It would be good for everybody, including the budget of the province. So, yes, I think under a lot of circumstances, this would be economical, practical, and health promoting for the whole family. Instead of moving somebody into institutional care or trying to fit somebody who loves being at home and loves their neighbours and so on, but they're just, they're frail, and the family's concerned, this kind of monitoring would allow that person to age in place quite likely and would be very cost effective for the province." (P15)

Perceived outcomes for home care clients
Negative experiences or impact
While participants were specifically asked about any negative perceived impact the technology had on the home care recipient, for those who were cognitively aware of the technology, very few family and friend caregivers indicated that the technology had a negative perceived impact, such as any concerns about privacy. One caregiver chose to not include video cameras because the home care client was cognitively alert and very independent.
"I didn't think it was necessary. And that to me was a bit too intrusive because he is very independent. And so, I didn't want him to feel he was being spied on, that kind of thing." (P12)

Two home care clients were initially not comfortable with the passive RMT in their homes, but they grew accustomed to it over time.
"At first it kind of freaked him out. He said, "What! These cameras are watching me. What's happening in the bathroom?" [laughs] So at first he was uncomfortable about it, and then he just forgot about it." (P15)

Neutral experiences
While it may appear to be adverse that many family and friend caregivers indicated that the passive RMT had no perceived negative impact or had a

neutral impact, this generally referred to the seamless integration of passive RMT within the home setting and the inconspicuousness of the technology among home care recipients. Participants reported that older adult home care recipients were not bothered by or even aware of the technology operating in their homes. Whereas some home care recipients had various dementia diagnoses that resulted in a lack of awareness of the technology or forgetting that it is there.

"It didn't have any impact on him because he doesn't really… He didn't really pay much attention. Like I guess it's just not in his thought process right now. Like he has Alzheimer's and Parkinson's… And you know, he had no problem with it. It's just I don't think he even realized, you know, the camera was there." (P3)

Improved overall wellbeing
Eight of the participants perceived that the passive RMT improved the overall well-being of the home care clients in various ways such as reducing their level of stress, improving their confidence, having a greater sense of comfort and security.

"But she wants to have it [passive RMT] hooked up fully in her house so that it's on all the time for security reasons, for protection …to be able to have somebody there with her but that's not there… She has the outlook on it that she feels secure. She feels at ease and at peace with it because of the protection that it gives her." (P6)

One participant identified that the technology would be especially advantageous for home care clients who lived alone but received comfort from not feeling isolated.

"Because it's a great comfort to an elderly person that is living alone. That's where it comes into the best…it would do the best service to someone living alone – an elderly person." (P1)

Improved physical health
Seven of the participants identified ways that the passive RMT positively affected the physical health of the home care clients. This included various aspects of physical health such as utilizing the medication monitoring sensor to ensure that the home care client was receiving their medications properly.

"So, it was helpful to me if I couldn't reach her, that I could look and see if she was still in bed at an abnormal time … Or if I didn't get a message that she had taken her medication off the monitor at 9:00 in the morning then I could call." (P5)

The participants provided details about situations in which the passive RMT reduced potentially physically hazardous situations. A caregiver was able to prevent the home care recipient from being exposed to odors and scents that she is very allergic to by checking on her status re-

motely versus in person. Also, the passive RMT provided early identification and prevention of physical harm including falls, wandering outside the home, and fire.

"She's fallen asleep with a cigarette in her hand. She's a real fire hazard… And just for me to be able to check in on her. I check in on her before I go to sleep, and I check in on her every time I get up to go to the bathroom through the night." (P10)

In addition, 3 participants who did not live with the home care client identified how the technology provided the ability to monitor their family member or friend without increasing their risk of exposure to COVID-19.

"But with this system, they can actually see what's going on and they can actually help the person in that way. And it makes it more safe. It's like a security system, it's like it puts people at ease. It's just it makes it so that the people themselves, they don't have to worry about the COVID-19. They don't have to worry about viruses." (P6)

Perceived outcomes for family and friend caregivers
Negative experience or Impact
There were a few challenges identified by the study participants that rendered the passive RMT to be less advantageous for the caregivers in certain situations. For example, while monitors outside the home were available, the people involved in these interviews only utilized monitors inside the client's home. One participant felt that monitors outside the home would be useful. Two participants identified that the system does not relay notifications when there are power outages. One participant whose mother had physical declines due to dementia during the study found the passive RMT more beneficial when her mother was more mobile. While the notifications could be tailored to the preferences of the caregivers, some may not have made full use of this tailoring process. Some caregivers found that receiving the notifications caused them some level of annoyance, stress, or anxiety, such as getting notifications at times they did not want to receive them, such as at nighttime or while at work.

"I think it heightened my anxiety, if you will, because if I happened to look at it or I got a prompt that the door had opened at 11:00 at night, well, that's useful information and I wanted it. Obviously, I became anxious about why that had happened. And so, you know, if I didn't have that technology and hadn't been prompted, I wouldn't have had that anxiety. So, I suppose I would be the one impact that it had on me… So, it definitely was still useful, even though the heightened stress was there." (P12)

Interestingly, despite participants' accounts that passive RMT had little or no impact, or in some

contexts had a negative impact on their lives, 14 of the 15 participants enthusiastically and un-equivocally stated they would recommend the passive RMT to other family and friend caregivers when asked about this by the researchers.

"Absolutely. Absolutely, no question about it." (P5)
"Highly recommend it." (P7)

One additional participant appeared less enthusiastic about recommending the technology, but they would recommend that others should investigate to see if it would meet their needs.

"I would mention that it's out there, and that they could do their own research and see whether they felt it met their needs or not." (P2)

Neutral experience

Two of the 15 family and friend caregivers perceived that the passive RMT had little or no impact on their own lives. In 1 instance, the caregiver had challenges with utilizing the technology.

"Because I am not a computer person. I'm very limited in what I do on the computer. So this is very overwhelming for me. It was at the beginning, and then I just had to put it out of my head because there's nothing I can do. Like I can't do it, you know." (P13)

In the other instance, the caregiver did not use the video cameras that would likely have been useful in supporting his brother-in-law.

"Not very much. No, I don't think it… If you're asking me if it made me feel more secure about what…the safety or [brother-in-law]'s safety in his apartment, I honestly…I don't know. Because you know, if he gets up in the middle of the night and he goes and watches TV for some time, or he gets up in the middle of the night and he falls, I can't tell the difference." (P2)

Improved overall wellbeing

The 1 subtheme identified in 14 of the participants that resulted in the largest amount of text focused on the perceived positive impact of the passive RMT on the overall wellbeing of 14 of the family and friend caregivers. This theme encompassed a variety of related issues that resulted from the ability to have information about the status of the person they provided care for. This resulted in less stress and greater peace of mind for the caregiver.

"Stress in that it's lower because now I can…if something does happen, i.e., the door is opening or something like that, then yeah, I can take action right away. I don't have to, you know, hear about it after the fact, after the police have arrived, kind of thing." (P9)

Several participants mentioned that the passive RMT provided them with greater freedom as they did not always have to be physically present to know if the home care recipient was safe and secure or to determine if any action needed to be taken.

"Like say I was away, and even if her fall button went on or something like that, I would have been able to go in and check the video itself to see where she was and everything." (P11)

The passive RMT gave family and friend caregivers the ability to do the things they wanted and needed to do. This included family and friend caregivers being able to go to their own medical appointments, obtain necessary supplies, or do other errands while also ensuring that their family member or friend was safe.

"I could take appointments for my health, knowing that they were outside of the allotted hours for care for [wife]. And I would be able to monitor her remotely. The stress level was lowered. And I've had lots of stress level during the last year." (P8)

"For a little while, I used the camera when I could leave him for a short time. I could use the remote camera to check that he was still standing or sitting… It just meant I could run to the drugstore or run to the grocery store and leave him for half an hour." (P14)

Improved physical health

The participants identified a few additional examples of how the passive RMT can have a perceived positive influence on the physical health of family and friend caregivers. One daughter living with her mother found that the technology allowed her to not have to physically move between different floors of the home as frequently to check on her mother's status.

"I didn't have to go up and down… Well, I have to go downstairs so many times a day anyway. But I could at least look at her on the video. If I could see that she was still sleeping in bed then I didn't have to go down and physically check because I could actually look and see.

Also, 2 participants identified that the passive RMT allowed them to get much-needed sleep.

"I used the monitor in his bedroom because he got up at night. And it was so that I could get some sleep and not have to rely on hearing him. My phone would ring when he got up. That alerted me." (P14)

The passive RMT system also could help protect family and friend caregivers from exposure to COVID-19.

"The cameras placed in [sister]'s apartment have been very helpful, especially with the COVID, because I don't like going into that building during COVID. So being able to keep an eye on her without going into the building physically has been a great help." (P10)

Can monitor people coming into the home
An interesting application of the technology identified as a benefit by 9 of the family and friend caregivers was that they could monitor additional people coming into the home for various reasons. If they utilized video cameras, they could identify specific people such as home care workers, paramedics, and visitors. Even if the video cameras were not used, they could identify when people came and left through notifications from the outside door sensor. The family and friend caregivers did not identify that this was a privacy concern for the home care clients.
"I knew if the VON nurses were there. You know, I knew what time that they were there. If I didn't get a notification, I knew that, you know, I had to call up and see where they were, right. That sort of thing. So it was just less of a stress that way." (P4)

Perceived outcomes for the healthcare system
Nursing home usage
A total of 13 (87%) participants clearly specified that passive RMT can have an impact on the need for nursing home care through extending the length of time that frail older adults can live in their own homes or potentially eliminating the need for relocation to a nursing home and thus reduce public expenditures. This quote is a further illustration of the potential cost savings of passive RMT for the healthcare system.
"I would assume that by using this, 1 more person stays at home. Which is one 1 person who's not under the government healthcare system." (P7)

Acute care usage
Family and friend caregivers were specifically asked about how passive RMT affected the amount and type of other forms of healthcare utilized, such as acute care. Several participants could not identify specific ways in which the technology had an impact on acute care usage. Given that they utilized the passive RMT for one year in the intervention arm of the randomized controlled trial, some participants qualified that it may have a more noticeable impact if they used it for a longer time.
"Well, it probably hasn't had any yet, or very little. But I think over the long term, I think it will have a huge impact." (P5)

Several other participants identified potential ways in which passive RMT could impact the usage of acute care, including the emergency department and hospital admissions. One participant recognized the potential of passive RMT in supporting the care of older adults' early discharge from the hospital to home.
"I have a relative who is getting out of the hospital, and he's sick and he wants…he would rather be at home than in hospital. So, I think there's potential in this technology." (P2)

The potential impact of passive RMT includes the ability to proactively respond to older adults' health care needs. Another participant described the importance of having ease of access to information about a friend's health status to prevent their health from deteriorating. Early intervention from paramedics successfully resolved the health situation instead of requiring hospital admission.
"The monitoring system [passive RMT] allowed me to see what was happening, for me to be able to go up there [to the friend's home] and be able to talk to her, and to be able to notify the ambulance, the EHS, and for them to come over. And for them to be able to administer some drugs and stuff like that for her. And to be able to keep her at home instead of her having to go to the hospital. Because if it had been that it had lingered on, she would have probably wound up having to go to the hospital." (P6)

Home care usage
A requirement for participation in our randomized controlled trial was that frail older adults were currently receiving home care. A few of the family and friend caregiver participants had some interesting insights about how passive RMT can impact home care services. One daughter reported that her mother would have needed additional hours of homecare services if the passive RMT was not in place. Another participant also explained that she reduced the amount of homecare utilized for her parent because of the technology.
"So, I need the people to come in and stay with mom for hours at a time. But on Mondays, they come for 1 hour to give her a shower. So, it was easy enough for me to say today, no, I don't want someone I don't know coming in here today. I will forgo that hour. And the fact that I have the cameras allows me to sit here and keep my eye on mom." (P7)

New costs to fund or partially fund passive RMT
Each participant provided their thoughts on whether passive RMT should become a service that is publicly funded by the provincial healthcare system. While 8 participants felt that the service should be co-paid by the provincial government, or a sliding scale utilized, an additional 5 participants felt that it should be fully funded by the provincial government.
"Oh, yes. Yeah, because, you know, a lot of seniors don't have the money to do it. And my parents are, you know, from the generation that you don't get these extras. Like to them it's not needed, sort of thing. And it is keeping them in their home longer. So, I mean that's saving a lot of money on nursing homes. And with my mom and dad right now, if they weren't here, they would both be in a nursing home." (P3)

The remaining 2 participants did not give a clear response about if the passive RMT should be

publicly funded. Thus, most participants felt that while passive RMT would save money for the healthcare system in the long-term (e.g., reduced nursing home costs), they felt that in general, there should be a new public investment to either partially or fully cover the costs of the technology.

DISCUSSION

It was clear that from the perspective of family and friend caregivers who utilized the passive RMT for 1 year, a key finding was that having the ability to monitor remotely at any time had perceived positive impacts on overall wellbeing. This technology has a clear role in the early identification and prevention of negative situations and health events. Importantly, while the family and friend caregivers identified some challenges with utilizing the technology, almost all would recommend it to other family and friend caregivers. This adds to the very small body of knowledge about the positive perceived impact of passive RMT on family and friend caregivers (Chou et al., 2012; Crevani et al., 2020; Read et al., 2021), and importantly from those who have actual experience utilizing the technology, as this is lacking in the current literature (Tsertsidis et al., 2019).

This research contributes importantly to our knowledge as we qualitatively examined multiple perceived outcomes of passive RMT from the perspective of the family and friend caregivers with experience using this technology for one year. A qualitative approach provides insights into perceived outcomes that may be difficult to assess using quantitative measures. Our qualitative approach was especially helpful to understand some nuances about not wanting to utilize other health services (e.g., nursing homes, acute care, primary care) during the COVID-19 global pandemic for fear of contracting the virus (Weeks et al., 2021). In particular, there were many COVID-19 outbreaks and deaths in nursing homes during the early phases of the pandemic (Hsu et al., 2020; Thompson et al., 2020). This may have provided the impetus for older adults to not access other health services in person unless absolutely necessary during the COVID-19 global pandemic.

Supporting aging in place is a key reason why passive RMTs are utilized with older adults. Previous researchers identified that passive RMT sensor data transmitted to health care providers can positively contribute to aging in place (Khosravi & Ghapanchi, 2016; Rantz et al, 2015). The qualitative evidence from the family and friend caregivers in this study indicated that they perceived that passive RMT sensor data transmitted to them can also contribute to supporting aging in place. Economic evidence is needed to determine more clearly any short and long-term cost savings associated with the implementation of passive RMT with family and friend caregivers. The quantitative results of our randomized controlled trial (Donelle et al., 2020), when available, will provide important evidence related to the impacts of passive RMT on health system usage and costs. As some participants felt that the impact of passive RMT on the health system may not have been able to be detected after 1 year, in the future, researchers should consider expanding the amount of time that the passive RMT intervention is received.

The ability of family and friend caregivers to have access to the status of an older adult they care for virtually at any time or place had clear perceived positive outcomes, such as the freedom to go where they needed and wanted to go. However, the utilization of passive RMT by family and friend caregivers can create tension between the benefits and challenges of having access to information 24-7. We identified that some participants were concerned about the impact of always having access to information about the older adult and always being on call. This is similar to other research findings that older adults expressed concern about the physical and emotional burden of receiving constant information (Bowman et al., 2013). This suggests that not all family and friend caregivers want to have constant access to notifications and data from sensors. Thus, while the RMTs provide peace of mind to caregivers by way of information about their loved one's well-being, it is important that caregivers may need help from others to monitor the RMT notifications so that they can maintain their own health and well-being (Plöthner et al., 2019). They also may need to work with the service provider to ensure that they customize their notification preferences to meet their needs (Tokunaga et al., 2014), such as not receiving notifications at certain times.

While not all participants chose to utilize video cameras, it was clear that for many participants, video cameras were a key form of passive RMT. This technology provides an efficient way to identify potential concerns about the health or safety of the older adult and to monitor people coming into the home (e.g., home care workers, and visitors) (Read et al., 2021). While issues about the ethical use of remotely accessible video cameras, such as privacy, could be a factor in choosing to utilize this form of technology (Berridge, 2019), we found little evidence that family and friend caregivers perceived older adults would have privacy concerns related to cameras monitoring their activity. Others have also found that having a 24-hour monitoring system, including video cameras, was not a large privacy concern for older adults (Bowman et al., 2013; Read et al., 2021). For anyone with such concerns, it can be

prudent for cameras to be placed in such a way that they protect autonomy and privacy (Berridge, 2014), such as being placed near the floor in sensitive areas, such as bathrooms, or fixed to only provide a view of specific areas of concern in the home such as the entries/exits or the kitchen.

In this article, we only included the perspectives of family and friend caregivers. It would also be advantageous to include the voices of the older adults themselves and their experiences of utilizing passive RMT. In this study, eligibility criteria included frail home care clients at risk of needing higher levels of care (e.g., nursing home) and thus, many were not able to participate in in-depth interviews. In future research, it would be advantageous to include the diverse perspective of those utilizing passive RMT in their own homes (e.g., younger adults experiencing disabilities; those utilizing passive RMT living in remote locations). Thus, the results may also differ for those who do not currently receive home care services. It would be advantageous in the future to examine if there is any form of interaction or a cumulative effect of utilizing passive RMT along with other forms of care and support for the older adult and their family and friend caregivers.

In this article, we report evidence from 1 Canadian province. While it can be advantageous to focus on 1 province as the health system in Canada is provincially administered, comparative research among provinces/territories and internationally is warranted. Our results confirm many findings identified from a qualitative study in the neighboring province of New Brunswick (Reid et al., in press). There are only a few provinces in Canada that currently fully or partially fund passive RMT, and it is not currently publicly funded in Nova Scotia. An interesting finding was that most of the family and friend caregivers in this study felt that passive RMT should be at least partially funded by the provincial government, indicating that many felt that users should pay some of the cost (e.g., a sliding scale based on income). Further research into the impact of public funding of passive RMT on older adults, their family and friend caregivers, and the healthcare system is warranted.

Conclusions

This study contributed important qualitative insights to a scant body of knowledge about the perceived impact of passive RMT on frail older adults living in their own homes, their family and friend caregiver, and the healthcare system. The presentation of family and friend caregivers' perspectives on perceived outcomes after utilizing the technology for one year was a strength of this research. The participants clearly articulated that passive RMT has a great perceived capacity to support the overall wellbeing of family and friend caregivers and to support frail older adults to age in place.

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