Clinicians' Perspectives on Procedures for Implementing Wearable Movement Sensors into Primary Care

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Abstract

Canada's 24-hour Movement Guidelines (24hrMG) are underutilized in health care. This study explored what type of wearable movement sensor (WMS) information would be best utilized by physicians, and what 24hrMG variables could be best integrated into primary care. Canadian physicians were included in this study (*n*=5). This study utilized a phenomenological approach to guide the research process. Virtual semi-structured interviews (~30 min) were conducted following an interview guide with 11 questions. Reflexive journalling was used throughout this study to record the principal investigator's thoughts and decision making. The research supervisors acted as critical friends, providing feedback to improve trustworthiness. A thematic analysis of the data revealed three main themes: *Benefits of WMS in Patient Care, Integration Considerations* and *Data Logistics*. *Benefits of WMS in Patient Care* highlights the various benefits, presented as subthemes, that physicians believed WMS could provide to their patients in overall patient care. The subthemes of this theme include 24Hr MG, Target Population, Type of Monitoring, Pharmacare, and Empowerment. *Integration Considerations* considers the facilitators and barriers regarding WMS implementation into primary care from a physician's perspective. The subthemes of facilitators of integration considerations include Current Use of RPM, Timeline and Lifestyle Management. The subthemes contributing to the barriers of WMS integration into primary care include Access, Education, and Lifestyle Management. *Data Logistics* encompasses the logistical aspect of obtaining WMS data from the perspective of a physician, with subthemes including Data Intake, Data Summary, Most Important Data, and Workload. In conclusion, for interested physicians, WMS provide an opportunity to enhance patient primary care with the 24hr MG mainly through objectively monitored time spent in moderate-to-vigorous intensity physical activity.

Introduction

Physical activity (PA) and adherence to Canada's 24-hour Movement Guidelines (24hrMG) can reduce the impact of chronic disease and substantially improve quality of life for Canadians of all ages through prevention and treatment of primary disease (i.e., developed on its own and independent of other illnesses) and secondary disease (i.e., developed as a result of prior disease or illness) (Anderson & Durstine, 2019). Currently, the Canadian 24hrMG for adults advises 150 minutes or more of moderate to vigorous physical activity (MVPA) per week, less than 8 hours of sedentary time per day and a sleep duration of 7 to 9 hours per night for adults 18-64, and 7-8 hours of sleep per night for adults older than 65 (Rollo et al., 2022). Despite the known physiologic and psychologic advantages of attaining the 24hrMG (i.e., increased PA, reduced sedentary behaviours (SB), and consistent sleep) as treatment for chronic disease are underutilized in health care (Rollo et al., 2022). A contributing reason for this underuse may be that clinicians lack the technologic tools in the clinical environment to objectively assess and track their patients' lifestyle movement behaviours. A potential solution to this problem may be the implementation of WMS into primary health care; the frontline of the Canadian health care system. The introduction of WMS may allow primary health care to have a more involved role in the prevention of primary and secondary diseases and therefore, help to reduce the strain on the Canadian healthcare system. Moreover, WMS may provide a greater opportunity to not only prescribe the 24hrMG to patients, but also allow for specific modifications to be made for patients following review of their data to improve quality of life.

Literature Review

Canada's 24-Hour Movement Guidelines

Rollo et al.'s (2022) study analyzed the responses of 8297 adults aged 18-79, from cycles 1 to 3 of the Canadian Health Measures Survey. This study's purpose was to examine whether meeting the Canadian 24hrMG alongside different combinations of PA, sedentary time, and sleep were associated with health indicators. Through a combination of self-reported and device-based (i.e., objective) measures, all participants were classified into one of two groups: meeting each of the 24hrMG or not meeting the 24hrMG. Despite the national recommendations, Rollo et al. (2022) found that only 7.1 % of Canadians met all three of these requirements, 29.8 % met two of the requirements, 43.9% met only one of the requirements, and 19.1% met none of the requirements. A noteworthy finding was that meeting the MVPA recommendation in isolation of the other guidelines was consistently associated with the most favourable health benefits. Overall, this study found that individuals who adhered to the 24hrMG had more favourable health indicators such as body mass index (BMI), waist circumference, aerobic fitness, as well as triglyceride, insulin, C-reactive protein, and serum glucose levels. Thus supporting the 24hrMG recommendations to improve overall health, thereby augmenting quality of life (Rollo et al., 2022).

Current Models of Remote Monitoring in Healthcare

The use of WMS (i.e., smartwatches) for preventative care would not be the inaugural example of remote monitoring devices in the health system. Remote patient monitoring has previously been implemented in the specialty of Cardiology through ambulatory blood pressure monitoring (ABPM) systems and portable electrocardiograms (i.e., heart rhythms), such as ECG patches and ECG Holter monitors. Holter monitor devices have been used in healthcare since the 1960s, followed by the introduction of ABPM in the 1980s; both of which have undergone extensive technological advancements to arrive at the current models used today (Kennedy, 2006).

Remote monitoring has also been implemented in Endocrinology through continuous glucose monitors (CGM) to assist individuals diagnosed with both type 1 and type 2 diabetes. The first CGM system was introduced in 1999, consisting of a sensor that was connected to a receiver through a cable, with the ability to measure a patient's glucose levels over a period of three days (Didyuk et al., 2021). In 2004, CGM systems progressed to allow for a wireless transmission of data from sensor to receiver, and in 2007 CGM systems were improved so patients could continuously monitor their glucose levels for a period of seven days (Didyuk et al., 2021). Lastly, in 2018, flash glucose monitoring was introduced to the realm of CGM, in which patients simply scan the receiver over their sensor to seamlessly monitor real-time glucose levels (Didyuk et al., 2021).

This integration of remote monitoring and advancements in these devices in different realms of healthcare portrays the importance and effectiveness of remote patient monitoring. Through remote patient monitoring, health professionals are provided with a more comprehensive viewpoint of how their patients' lifestyle behaviours impact their health. Compared to the limited information received from office visits and yearly check-ups, the information provided by remote patient monitoring may help clinicians make better informed treatment plans for their patients.

Self- Applied Wearable Electrocardiogram (ECG)

A study by Steinbuhl et al. (2018), investigated the effects of a self-applied wearable electrocardiogram (ECG) patch in detecting atrial fibrillation (AF; i.e., irregular heart rhythms) in a broad at-risk population of participants for AF. The purpose of this study was to determine the effectiveness of a self-applied wearable ECG patch to detect AF, as well as the associated clinical outcomes (Steinhubl et al., 2018). The participant pool of 2659 (38.6 % women) from a large health insurance plan's members in the United States (Aetna Fully Insured Commercial and

Medicare Advantage) included individuals aged 75 years or older, or a male older than 55 years or a female older than 65 years with at least one comorbidity for AF (Steinhubl et al., 2018). Successful participants were randomly placed into one of the study's two cohorts and then matched with a participant of the other cohort, therefore, utilizing a direct-to-participant randomized clinical trial and prospective matched observational cohort design (Steinhubl et al., 2018). The participants were then divided further into an immediate group, in which the ECG patch was received within two weeks, or the delayed group who did not receive their patch until 4 months after selection. Despite differences in receival of the ECG patch, participants in both groups received two patches to be worn for a duration of two weeks. Participants were instructed to wear the second patch three months after the first; to provide insight regarding potential benefits from a longer period of monitoring. Steinhbul et al. (2018), concluded that among all participants at risk for AF, the group that received immediate monitoring with their home-based wearable ECG patch had a higher rate of AF diagnosis after four months, compared to those in the delayed monitoring group. Further, individuals that were monitored compared to those that were not monitored had a greater rate of AF diagnosis, which allowed for an earlier treatment intervention through anticoagulants and other procedures, as well as an increased use of health care resources (Steinhbul et al., 2018). Overall, this study provided support for the benefits of remote monitoring for increased rates of diagnoses and more prompt prognoses for individuals at-risk for AF.

Holter ECG Monitor

Likewise, Halimi et al. (2023) examined the use of wearable technology to remotely detect AF in high-risk patients, however using a Holter ECG monitor instead of an ECG patch. The aim of this study was to determine the prevalence, and then management of AF diagnosed in patients at a high cardiovascular risk who had non-documented clinical palpitations through systematic 14-

day continuous monitoring with a Holter ECG device (Halimi et al., 2023). To be eligible for this study, participants had to adhere to the inclusion criteria of a CHA_2DS_2VASCs score – used to determine an individual with AF's risk for a stroke from seven clinical risk descriptors – of ≥2 in males and ≥ 3 in females and have experienced clinical palpitations without being diagnosed with AF (Halimi et al., 2023). Once selected, participants (n = 336, 39% male), were given a Holter monitor (AFT1000 recorder) to wear continuously for 14 days to monitor their heart rhythms (Halimi et al., 2023). Following the 14 days of monitoring, Halimi et al. (2023) found that on average, AF was detected 110 hours (SD = 103) after the Holter-ECG recording began. Overall, the Holter-ECG monitoring provided the opportunity for undiagnosed AF to be diagnosed in 14% of participants, with 11 diagnoses in the first 24 hours of the Holter ECG monitoring and 36 diagnoses after 24 hours (Halimi et al., 2023). This allowed for an intervention treatment to be provided to participants diagnosed with AF more promptly, as 90 % of participants diagnosed were prescribed anticoagulation and antiarrhythmic medications, and 13% underwent a catheter ablation procedure (Halimi et al., 2023). This study demonstrates that longer term monitoring in a patient's free-living environment can lead to a more accurate understanding of the individual's health status to allow for a more clearly defined and successful treatment plan.

Ambulatory Blood Pressure Monitoring (ABPM)

In addition to wearable technology for monitoring cardiac rhythms to improve the rate of diagnoses and interventions, Mohammed et al. (2022) utilized ambulatory blood pressure monitoring (ABPM) to monitor variations in patient's blood pressure. The purpose of this study was to determine the effectiveness of office blood pressure (BP) monitoring compared to ABPM using a prospective cohort of 561 patients (n = 333 male and n = 228 female), with the mean age of 46.98 years (Mohammad et al., 2022). Patients diagnosed with hypertension (i.e., high blood

pressure) receiving pharmacological treatment, in which at least one accepted office blood pressure measurement had been recorded were included in this study (Mohammed et al., 2022). To record ABPM, all participants were given a portable BP measuring device (Meditech ABPM-05) to wear on their non-dominant arm for 24 hours with BP measurements taken every 15 minutes during the day, and every 30 minutes overnight (Mohammad et al., 2022). Following data collection, all measurements were downloaded to a computer and a variety of analyses were completed to provide an adequate comparison to the office BP data (Mohammad et al., 2022). A Pearson correlation was completed to compare parameters from ABPM data and office BP data, in which a weak correlation was found; therefore, leading researchers to conclude that office BP data was a poor predictor of daily changes in BP for patients diagnosed with hypertension (Mohammad et al., 2022). This finding highlights the value of using ABPM in addition to office BP, to confirm hypertension diagnoses and provide more information on a patient's overall condition; thus allowing clinicians to serve their patients more comprehensively and effectively.

Novel ABPM Model

Building upon the effectiveness of ABPM to confirm diagnoses of hypertension, Yenurkar et al. (2024) created a model that overcomes limitations of previously employed BP monitoring systems to highlight the potential of ABPM when treating individuals with chronic heart disease (CHD). This model was developed with the aim of improving patient outcomes and quality of life while also reducing the strain on healthcare because of CHD (Yenurkar et al., 2024). The novel component of this model by Yenurkar et al. (2024) in ABPM is an "Internet of Things" based ABPM (IABPM) system that would be used to continuously monitor BP as with current ABPM; however, the data from the IABPM would be uploaded immediately to the cloud (i.e., online data storage system). The immediate uploading and availability of data to the cloud also provides the

opportunity for data to be easily integrated into a patient's electronic medical record (EMR), therefore allowing healthcare providers to have heightened accessibility and monitoring of their patients' BP. This immediate access to a patient's data would provide healthcare professionals with the opportunity for real-time analysis and intervention and more personalized treatment plans. Further, Yenurkar et al. (2024), anticipate that this model will advance the realm of virtual care by providing a method in which physicians can receive accurate data in a timely manner to better inform their virtual consultations and management of patients with chronic diseases. This study also notes the positive contribution that this resource poses for managing patients living in rural areas who face many barriers regarding access to health care services.

The technology included in this model developed by Yenurkar et al. (2024) includes many novel specifications that create the framework for a more efficient and technological realm of health care. One of the primary specifications of this model's technology is its algorithms' superiority to all current techniques with respect to accuracy, precision, recall, and F1 measure (Yenurkar et al., 2024). Another specification of this technology is the option for physicians to pre-set measurement intervals and label them regarding the level of health that would be associated with a recording of specific data levels (Yenurkar et al., 2024). Along with the pre-set measurements, the IABPM algorithm can generate early warning scores (WES), thus providing an additional method to identify and predict chronic illnesses and health emergencies of patients, with the aim to reduce adverse patient outcomes (Yenurkar et al., 2024). As a result of the high-precision sensors and advanced technology within the IABPM system, precise and reliable systolic, diastolic and pulse rate measurements would be registered, in which Yenurkar et al. (2024) presume will assist patients to be proactive when managing their condition, resulting in a greater compliance rate. Moreover, the system is designed to check the accuracy of readings and if an

error is identified, the system is programmed to restart and repeat the data measurements before uploading to the online cloud "Internet of Things" based platform (Yenurkar et al., 2024). Furthermore, Yenurkar et al. (2024) believe that this model can be expanded to include a broader range of chronic illnesses to improve patient care for those diagnosed with other chronic illnesses, as well as to assist in decreasing the strain on the healthcare system.

Overall, Yenurkar et al. (2024)'s IABPM system presents an innovative medical monitoring system that has the potential to have a significant impact on the future of not only BP monitoring and CHD prevention, but for many other domains of health and conditions that could also benefit from the same real-time monitoring technology and associated specifications.

Continuous Blood Glucose Monitoring (CGM)

Remote blood glucose monitoring presents another method in which wearable technology assists in the management of chronic disease. A study by Beck et al. (Beck, Riddlesworth, Ruedy, Ahmann, Bergenstal, et al., 2017) investigated the use of CGM for individuals with type 1 diabetes who manage and treat this disease with insulin injections. The study consisted of a randomized clinical trial methodology in which 158 adults aged 26-73 (44% women) diagnosed with type 1 diabetes for at least one year with a hemoglobin A_{1c} (HbA_{1c}) baseline of 7.5%-10% were randomly assigned to the CGM group (n = 102) and control group (n = 53) (Beck, Riddlesworth, Ruedy, Ahmann, Bergenstal, et al., 2017). The CGM group was provided with a CGM system (Dexcom G4 Platinum) that measures glucose concentrations from the user's interstitial fluid every 5 minutes for up to 7 days. Meanwhile, the control group was instructed to continue their home blood glucose monitoring, with specifications to perform monitoring at least 4 times daily. Both treatment groups received follow-up visits after 4, 12, and 24 weeks in which their HbA_{1c} was measured. The primary finding of this study was the greater decrease in HbA_{1c} levels during 24 weeks in

individuals using CGM compared to individuals maintaining usual care, demonstrating improved management of their chronic disease (Beck, Riddlesworth, Ruedy, Ahmann, Bergenstal, et al., 2017). Moreover, at 24 weeks, the satisfaction of participants in the CGM was measured using a Likert scale CGM Satisfaction Survey, in which the results demonstrated high satisfaction with the use of a CGM to manage their diabetes (Beck, Riddlesworth, Ruedy, Ahmann, Bergenstal, et al., 2017) .

Likewise, Beck, Riddlesworth, Ruedy, Ahmann, Haller, et al. (2017) completed a similar study on the benefits of CGM for individuals diagnosed with type 2 diabetes compared to the prior study in which the participant population included individuals with type 1 diabetes. This study also used a randomized control trial however a 1:1 ratio of CGM monitoring to control group was used, with a total of 158 participants and 79 in each group. The objective of this study was to determine the effectiveness of CGM in adults with type 2 diabetes using insulin injections to manage their condition, through a change in HbA_{1c} levels from baseline over a 24-week period (Beck, Riddlesworth, Ruedy, Ahmann, Haller, et al., 2017). The rationale for the recreation of this study with people with type 2 diabetes was due to the conception that they may have less advanced skills (e.g., carbohydrate counting, insulin sensitivity factors, correction timing) to manage their diabetes and that they may also have less patient autonomy that could hinder their use of CGM to improve the management of their condition. This study included participants aged at least 25 years, being diagnosed with type 2 diabetes, using multiple insulin injections as daily management for at least one year, and HbA_{1c} levels between 7.5%-10.0 %. Both groups were given a Contour Next USB meter and test strips, to measure blood glucose, while individuals in the CGM group were also given a CGM system (Dexcom G4 Platinum) that measured their glucose concentrations from their interstitial fluid every 5 minutes (Beck, Riddlesworth, Ruedy, Ahmann, Haller, et al., 2017).

Individuals in the control group were instructed to measure their blood glucose a minimum of 4 times per day. Both groups received follow-up visits after 4, 12, and 24 weeks in which their HbA_{1c} levels were measured to compare to baseline levels. After 24 weeks HbA_{1c} levels in individuals in the CGM group had improved significantly compared to those in the control group, with a mean reduction of 0.8% and 0.5% respectively. This improvement in the HbA_{1c} levels was supported by an increase in the duration of periods where blood glucose was measured between 3.89-9.99 mmol/L, the target glucose range. The mean reduction difference of 0.3% between the treatment groups was considered as noteworthy since this reduction was achieved without pharmacological changes, therefore providing support for the effectiveness of lifestyle and behaviour monitoring to manage health conditions (Beck, Riddlesworth, Ruedy, Ahmann, Haller, et al., 2017). In addition to the reduction in HbA_{1c} levels, the use of CGM was also associated with high patient satisfaction also shown by (Beck, Riddlesworth, Ruedy, Ahmann, Bergenstal, et al., 2017) when treating type 1 diabetes. Overall, this study supports the proposition that remote patient monitoring may be beneficial for management of disease.

CGM - Impact on Quality of Life

A similarity among both CGM studies previously discussed, is the improvement in quality of life when using a CGM. This positive outcome has been investigated and supported by other researchers including Johnston et al. (2022) and Fokkert et al. (2019). Using the Freestyle Libre flash glucose monitoring system, Fokkert et al. (2019) examined the benefits of CGM, with a focus on improved glycemic control and decreased disease burden for individuals with type 1 and type 2 diabetes. Different from previous studies conducted on this topic, Fokkert et al. (2019), utilized a value based-healthcare approach, by considering quality of life factors such as absence rate from work, number of diabetes related hospitalizations, reduced daily functioning and reduced sport

performance. The history of these factors was recorded for a duration of 6 months prior to the study (i.e., no use of CGM) to create a baseline, and then compared to occurrences at 6 months and 12 months throughout the study in which individuals used a CGM (Fokkert et al., 2019). The primary findings from this study were the overall improvement in participants' health-related quality of life and the reduction in disease burden when using a CGM compared to finger-prick based self-monitoring (Fokkert et al., 2019). Additionally, participants noted a more active role in the management and treatment of their condition when using CGM. Johnston et al. (2022) noted similar findings in their study on the perceived impact of CGM on quality of life and self-care for patients with type 2 diabetes. However, a novel finding in this study was the increase in the self-care behaviours such as improved nutrition and exercise, along with an increase in support factors such as improved diabetes knowledge and health self-efficacy following the use of a CGM (Johnston et al., 2022). Further, as shown in Fokkert et al. (2019)'s study, patients in Johnston et al. (2022)'s study also reported improved confidence in their ability to take quality care of their health condition as well as more confidence in their ability to avoid significant health-related problems in the future. Together, these findings highlight the positive benefits of stepping outside one's comfort zone by exploring health-related technological tools, as they have been shown to improve both quality of life and autonomy in many ways.

Wearable Movement Sensors

As shown in the studies regarding Holter monitors, ECG patches, ABPMs, and CGMs, remote wearable monitors can be an impactful tool in the diagnosis, monitoring, and prevention of chronic diseases and have provided health professionals the opportunity for more prompt diagnoses and impactful interventions with their patients. Moreover, these tools have provided

patients with a greater sense of control and self-efficacy in managing their conditions, therefore contributing to improved quality of life (Johnston et al., 2022).

Since the introduction of WMS such as Fitbits and Apple watches in 2012 and 2015 respectively, there has been an ongoing increase in the global wearable movement sensor/smartwatch commercial market. In 2014, there was an estimated 19 million of these monitors being used worldwide, and it was estimated that there could be as many as 60 million in use by 2018 (James, 2014). By 2023, there were 360.6 million users worldwide, far exceeding previous estimates, and this is forecasted to increase to 524.9 million users by 2029 (Abdelhamid, 2021; Hunter, 2024; Statista, 2024). The continued increase in the WMS market demonstrates the widespread usage of these tools in our society. The rapid adoption of these personal monitors may be an opportunity for improved patient care, providing access to longitudinal, objective health data, without additional costs (e.g., purchasing and maintaining the monitor) to the national health care system. As a result, it is hypothesized that WMS could be used in a similar manner to current remote patient monitoring models to assess patients' adherence to the Canadian 24hrMG. Through access to this objective, longitudinal data, health professionals may be better equipped to make informed recommendations to a patient's movement behaviours and perhaps motivate patients to take on a greater role in the improvement of their own health.

Historically, outside of interviewing techniques, clinicians have relied on questionnaires to assess patients' adherence to recommendations regarding PA, SB, and sleep, however questionnaires lack validity due to their subjective nature (Ummels et al., 2021). Moreover, individuals face many difficulties when estimating their adherence to PA, SB, and sleep recommendations, with the primary problem being overestimation (Ummels et al., 2021). Further, Ummels et al. (2021) found that questionnaires' practicability has also been reduced due to the

associated aspects of storage, and time-consuming nature of manually reviewing and analyzing their results. Surveys sent to patients by email to be completed before office visits, combined with the automated computation of results have removed some of these barriers. However, the issue of overestimation which may be attributable to the intentional misrepresentation of habits to gain favour with health professionals persists. Further, a lack of knowledge about movement intensities and classification may also contribute to overestimation errors in surveys.

WMS and digital health applications present a solution to the limitations of subjective assessment, as they provide clinicians with an objective measurement for PA, SB, and sleep (Ummels et al., 2021). The electronic storage and analysis of the data provide a time and space efficient method for the physicians to determine and prescribe appropriate lifestyle behaviour modifications. Recent studies involving the incorporation of WMS into the healthcare system have presented many positive impacts on patient care including increased engagement with patients in their treatment and improved accuracy regarding physician's treatment interventions (Ummels et al., 2021).

Ferguson et al. 's (2022) study provides a comprehensive review regarding the impact of wearable monitors on physical activity levels and overall health. The purpose of this study was to investigate the effectiveness of activity monitors to improve physical activity and related physiological and psychosocial factors (Ferguson et al., 2022). This study utilized a systematic review methodology in which systematic reviews and meta-analyses of both clinical and non-clinical populations were reviewed using seven databases (Ferguson et al., 2022). This review included primary studies that used activity monitors as an intervention method for recording PA, physiological and psychosocial factors, resulting in the inclusion of 39 systematic reviews of experimental studies (Ferguson et al., 2022). Following this systematic review, Ferguson et al.

(2022) concluded that activity monitors have a favourable impact on physical activity through various metrics such as step count, minutes of MVPA, minutes of light physical activity, energy expenditure, blood pressure, and emotional well-being. More specifically, this review concluded that wearable activity monitors resulted in an average increase of 1800 steps per day, an increase of 40 minutes of walking, and a daily increase of 6 minutes of MVPA (Ferguson et al., 2022). These results were clinically significant as they adhere to the public health affirmation that a daily increase of 5-10 minutes of MVPA is meaningful. Overall, this study provides support for the recommendation of utilizing activity monitors to improve physical activity and health (Ferguson et al., 2022).

Electronic Medical Records (EMRs)

As portrayed in the previous studies discussed, there are many benefits to remote monitoring in healthcare. These benefits of remote monitoring would not be possible without advancements in technology which are becoming more prevalent in healthcare, and more specifically in primary care, for example, through the introduction of electronic medical records (EMR). The use of EMRs in Canadian primary care has increased significantly with 73% in 2015, 86% in 2019, and 93% in 2022, of primary care physicians reporting EMR use in their practice (Canadian Institution for Health Information, 2022). The combination of the increased use of activity monitors and increased prevalence of EMRs, demonstrates that the integration of technology into society's everyday life is greater than ever before. Accordingly, society is more familiar with and proficient in a wide variety of technological devices and the interconnectivity of data, including cloud-based health data.

The use of EMRs presents many advantages to the practice of primary care such as increased accessibility to patients test results, improved efficiency when searching patient's

medical history and automated reminders for appointments to assist in preventative care (Rahal et al., 2019; Rahal et al., 2021). Moreover, (Barbazza et al. (2021) identified additional advantages to the use of EMRs in primary health care including the ability for real-time data extraction, chronic disease management, medication management, and prevention/screening of various conditions such as cancer screenings, smoking, overweight/obesity, immunizations, blood pressure, and socioeconomic risk factors. Further, relating to previous studies that discussed the use of remote monitoring for the management of chronic diseases, Barbazza et al. (2021) found that data from EMR was frequently used to measure the management of chronic diseases including diabetes, cardiovascular diseases, mental health, and respiratory diseases.

Though EMR usage has increased substantially in recent years, there is still room for growth and improvement regarding overall usage of EMR, as many physicians continue to face barriers, are unaware of and/or inexperienced when it comes to the advanced features of EMR which could positively affect and progress their use of EMRs in their practice (Rahal et al., 2021). Some of the reported barriers by physicians concerning the use and implementation of EMRs include cost of systems, complexity of EMRs functionality and system issues (Goetz Goldberg, 2012). Additionally, the time commitment required to learn how the system functions, alongside the disorganization of their practice during implementation, both of which contribute to loss of productivity, have also been expressed as barriers to EMRs' implementation (Goetz Goldberg, 2012). Meanwhile, some of the positive effects expressed by physicians themselves because of taking the time to learn and use more advanced features EMRs include decreased cognitive load of the physician, improved workflow of their practice, improved communication with patients, and other healthcare providers (specialists). The use of EMRs also facilitates other technological advancements in healthcare; for example, through the incorporation of artificial intelligence (AI)

technologies to assist in the efficient retrieval of patients' pertinent medical history like prescriptions and reports.

Overall, these factors have been reported to contribute to both enhanced efficiency of the physician and quality of care for patients (Rahal et al., 2021). This brief introduction concerning EMRs and their use, is only a glimpse into the possibilities/usage of technology in healthcare, and despite the initial barriers, it highlights many positive outcomes. By extension, the launch of EMRs supports the possibilities for future technological growth in many realms of healthcare, including WMS.

Existing research detailing the different types of technology models that are used in healthcare to remotely monitor health parameters provides support for the effectiveness and benefits of remote health monitoring, as well as framework for the implementation of new health monitors such as WMS. Moreover, following the exploration of numerous health monitoring devices, there appears to be two main models for this technology in the healthcare system. The first model includes Holter monitors, self-applied patches for ECG, and ABPMs for blood pressure. These devices are provided to the patient by their health professional for short-term use, with the purpose of diagnosing an at-risk patient’s condition or confirming a diagnosis. Meanwhile, the second model includes CGMs for blood (i.e., interstitial) glucose that are the property of the patient and worn longitudinally to assist in management of a pre-existing health condition (i.e., diabetes). In this model, the patient supplies the data from their device to their health professional, to receive guidance and recommendations regarding the management of their pre-existent health condition.

Purpose

The primary purpose of this study is to explore what variables related to the 24hrMG and what type of information (subjective vs. objective) would be best suited for integration into primary care. The secondary purpose of this study is to explore what aspects of the existing remote patient monitoring models would best apply to WMS.

Methods

Participants

Five physicians participated in this study. To be included, participants had to be a Primary Health Care Clinician (PHCC) such as a physician, physician assistant, or nurse practitioner, working in a Canadian healthcare institution. Retired PHCCs, residents, and students were excluded from participating in this study.

Recruitment

This study was approved by the St. Francis Xavier University Research Ethics Board (#27497). Participants were recruited through convenience and snowball sampling. An email including a link to an online survey (Qualtrics) was sent to potential participants. This survey included an Invitation to Participate (Appendix B) in the study and a consent form (Appendix C) where participants clicked "yes" to consent. Participation was voluntary, and informed consent was obtained prior to data collection. Ten PHCCs were recruited for this study. Six PHCCs completed the online consent form, and five physicians participated in the virtual interview.

Procedure and Tools

The five interviews were completed between January to March 2025. One pilot interview was conducted on January 19, 2025. The data from this interview was not included in the data analysis. Following consent, the online survey led participants through 14 questions (Appendix D). These questions included demographics (6 questions), location of practice (3 questions), knowledge of 24-hour movement guidelines (2 questions), and experiences with WMS in healthcare settings (3 questions).

Following the completion of the survey, participants were contacted via email to schedule their virtual one-on-one interview with the primary investigator. Prior to these interviews,

participants were sent a document including background information about the study's purpose and an overview of the interview questions (Appendix E). To improve confidentiality and security for the interviews, the virtual meeting was passcode protected, and a waiting room was used, in which only the primary investigator could accept participants into the interview. The duration of each interview was approximately 30-45 minutes and these interviews were audio recorded using the virtual interview platform. One interview was completed using Zoom, while the rest of the interviews were completed using Microsoft Teams. All interviews were transcribed verbatim using the Microsoft Teams transcription tool. The primary investigator engaged in note taking throughout and following each interview to provide additional comments regarding participants' responses, and to record any interesting findings from the interviews. Following the pilot interview and first interview, the interview guide (Appendix F) was updated to include additional probing questions. These probing questions were either discussed during the first interview or identified during the review of the first interview transcript to be of importance. After these initial edits, the same interview guide was used throughout the remaining interviews.

Each interview began by verbally confirming consent to participate in the study, and the participant's awareness that the interview was being audio recorded and would be transcribed, with the transcripts confirmed by the primary investigator prior to being sent to them for confirmation. The primary investigator then explained a brief 2- minute preamble (Appendix F & G) about WMS, the information these sensors provide and the two current models of remote monitoring health devices. This was done to ensure the participants were familiar with the current framework of models that WMS usage in primary care could be adapted from. After the preamble, the interview continued in a semi-structured manner with approximately 11 questions, followed by probing questions, regarding topics of the 24hrMG, patient care, feasibility, accessibility (i.e., to device

and data), storage of data, type of data parameters, confidentiality, and target population (Appendix G).

Data Analysis

Following the transcription of the interview, the primary investigator confirmed the transcripts. This provided the primary investigator with an opportunity to become familiar with the interview data, identify any errors from the transcription tool and record additional notes and impressions from the interview. The primary investigator contacted all participants for clarification or further elaboration of their transcripts; no alterations to transcripts were made by participants through this process. After repeating this procedure for the first three interviews, the primary investigator began to identify common themes among the interviews and made note of these in their journal. This process continued for the final two interviews. Initially 17 themes were identified, and relevant quotations were grouped under these themes. During weekly meetings, the primary investigator discussed their general impressions and noteworthy findings from the interviews with critical friend A. Once all interviews were completed and all transcripts were confirmed, the primary investigator created pseudonyms for all participants.

Following completion of all interviews, the primary investigator reviewed all transcripts again to ensure all relevant extracts had been identified. Then the initial 17 themes were reviewed again, and descriptions of the initial themes were created. Through creating summaries of the initial themes, similarities were noted, and many themes were then combined.

Next, the primary investigator met with critical friends A & B individually to explain and discuss their preliminary themes. Following collaboration of the primary investigator and their critical friends, the preliminary categories were organized into three overarching themes: *Benefits of WMS in Patient Care, Integration Considerations,* and *Data from WMS*. These themes were

further discussed, and subthemes were created from the preliminary categories and quotations grouped accordingly. Through collaborative discussions, among the primary investigator and both critical friends, troubleshooting of overlapping subthemes was successfully navigated. Lastly, the title of the theme *Data from WMS* was changed to *Data Logistics*, and as a result an initial subtheme was eliminated.

Design

This study utilized a phenomenological approach. The phenomenological approach explores a phenomenon through an individual's perspective as a result of their lived experience (Davidsen, 2013). Physicians are well-versed in the implementation, benefits and feasibility of novel tools in primary health care, thus their lived experiences and perspectives regarding the potential implementation of WMS was crucial for a comprehensive understanding of the subject. Since, this study was interested in the differing perspectives of physicians concerning the implementation of WMS into primary care, a thematic analysis was used to analyze the interview data. A thematic analysis is a flexible research method in which a researcher actively identifies and analyzes patterns within a data set (Braun & Clark, 2006). Therefore, following verification and clarification of the transcription from participants, a thematic analysis was used to analyze the transcripts alongside the primary investigator's supplementary notes from the interviews and reflexive journaling logs within the context of the physician's lived experiences.

Trustworthiness

Reflexive journaling was ongoing to keep a log of the principal investigator's thoughts, reflections, and decision-making throughout the study. This helped the researcher account for their subjectivity and biases in the research process (Jones, 2022). The primary investigator also engaged in reflexive journaling following every interview to record their overall thoughts. In

addition, the primary investigator's research supervisors acted as critical friends, trusted individuals who asked provocative questions, examined data through another lens, and offered critique/feedback on the analysis process (Costa & Kallick, 1993). Critical friends help increase the credibility of qualitative research (Krefting, 1991). Critical friend A and the primary investigator met weekly for 30-minutes. Meetings with critical friend B occurred less frequently, for confirming and troubleshooting discussions. Member checking, a technique for exploring the credibility of qualitative results, was also employed in this study (Jones, 2022). The transcripts from each interview were sent to participants by email following their interview (and confirmation by the primary investigator) so they could examine them for accuracy. Following confirmation from participants, the audio recordings were deleted.

Results & Discussion

Following analysis of the interview transcripts and primary investigators reflexive journalling notes, three themes were formulated. Three main themes related to the implementation of WMS into Primary Care are: “Benefits of WMS in Patient Care”, which highlights the benefits identified by physicians that WMS could provide if incorporated into their patient care; “Integration Considerations”, which includes both barriers and facilitators to WMS’s implementation into primary care and “WMS Data Logistics”, which includes the various considerations regarding type of data, receiving and storage of data.

Theme 1: Benefits of WMS in Patient Care

This theme highlights the various benefits, presented as subthemes, that physicians believed WMS could provide to their patients in overall patient care. Thus, this theme was analyzed from the perspective of benefits for a physician’s patient population based on the physicians’ lived experiences. The subthemes of this theme include 24HrMG, Target Population, Type of Monitoring, Pharmacare, and Empowerment.

Subtheme: 24HrMG

Most physicians recognized the importance of the 24hrMG for their patient's overall health and discuss the guideline parameters (i.e., PA, sleep, and SB) with their patients. PA and sleep were consistently reported as the most discussed guidelines while SB was identified as being the least discussed. Though physicians identified SB as the least counselled guideline, they recognized the importance of limiting SB for health. John expressed a possible reason for the lack of counselling concerning SB, *“I’m able to rifle off some of the more recent research that investigates exercise... whereas for sedentary time, I just yeah, I’m not familiar with the like certain systematic reviews or meta-analyses.”* This quotation presents the idea that a physician's lack of awareness

and/or education regarding the benefits of reducing SB may serve as an underlying barrier for counselling this parameter in their patient care. Conversely upon recently reading/reviewing the 24hrMG, Eric expressed, *"I definitely use sleep time and physical activity. I haven't used as much sedentary time until just recently, [after] reading an article... the actual 24 hour specific guidelines.*" Therefore, this supports that physicians are not opposed to incorporating SB in their counselling, but that an education gap concerning why reducing SB is important and how to counsel this guideline may be contributing to its reduced use in patient care.

Though physicians discussed their counselling regarding aspects of the 24hrMG, many physicians disclosed that they do not use the specific guidelines in their patient counselling and instead use more of a general encouraging approach. When asked his use of the 24hrMG in patient care, John replied *"I would say yes, they're pretty subjective … nothing actually objective. It's just like, oh, subjective, kinda activity levels. Subjective sleep that kinda thing."*

Additionally, physicians reported the WMS could be especially beneficial to their patient care by providing a way to objectively measure their patients' current movement behaviours. Eric believed that WMS would be an effective tool to provide physicians with a more comprehensive understanding of both their patients' physical and mental health. Moreover, access to a patient's objective behaviour data could allow physicians to make more personalized recommendations and treatment plans with respect to the 24hrMG, resulting in greater use of lifestyle management in patient care. This may also present the opportunity for discussions to educate patients about the 24hrMG and to reveal barriers that may be preventing an individual from achieving the them, such as pain, lack of education or access. These ideas were revealed through conversation with Emma and Thomas respectively:

> "I find that the biggest issue health related for patients is inactivity…inactivity is such a risk factor for so many of the chronic medical problems that I see. So being able to focus on just getting people moving and active and having a way to actually have them self-monitor that is really important."
>
> "We don't usually use specific parameters and more so just kind of take a narrative from the patient. Then they usually say something like, oh, well, I don't sleep very much at night because of this reason or I, you know, this is a barrier to exercise for me and we just kind of go down that rabbit hole and see if we can make any change there."

The importance of counselling patients on light physical activity was also emphasized by one physician, however they stressed the barriers including lack of education and awareness which make counselling for this guideline very difficult.

Subtheme: Pharmacare

The subtheme of pharmacare presented many positive benefits for WMS implementation that were not anticipated upon conducting this study. The main finding of this subtheme was that physicians believed the objective data from WMS could allow them to be more confident when prescribing medications as shown by Thomas:

> "I think in terms of how confident we are in starting, you know, pharmacological methods for our patients. If we knew that they had done good lifestyle management and made some changes and they still need a little bit of extra help, you know, we could be a bit more confident in prescribing things and not just feeling like, oh, you know, they didn't really give lifestyle management a chance."

Building upon this idea of being more confident in prescribing pharmaceuticals for patients was the proposition that by having the objective data from the WMS, and therefore a better

understanding of a patient's lifestyle behaviours, it could result in a greater emphasis of counselling and treating with lifestyle management to manage a condition and delay, reduce or eliminate the need for pharmaceuticals. This idea was discussed by many physicians including John through *"It might delay things…I think it would have the opportunity to change guidelines and change practice where it would be like, hey, listen until we get until you know you at least meet the movement goals, I can't start this drug."*

As discussed previously in the 24hrMG sub-theme, physicians also believed that the use of WMS could provide the opportunity for more open discussions with their patients; specifically pertaining to treatment options, such as why a specific treatment option has been chosen/ is recommended and the potential side effects of using medications in the long term.

> [If not giving a medication] "I think it would be really helpful to deliver that kind of news or information, we have a big gap here of your ask and your actual physical activity levels. The reason I care so much about this is because these drugs haven't been tested long-term, and they could carry significant side effects. Not to mention that you might be on this drug for life if we start it. I just want to make sure that we're doing all the right things to help you help you…. then I opened up like what we can do non pharmacologically." – John

More specifically Eric believed that conditions concerning anxiety and mood could be treated with lifestyle behaviour modification as opposed to solely relying on medications as shown in:

> [use lifestyle behaviours] "without using medication so, or using less medication or understanding when they are using medication. Why they're using medication, to to give people a better, you know, ability to manage stress in particular…any kind of grief and

> and things like that are are ,the biofeedback kind of treatment part of it can be more effective and and as effective and more effective than some medications."

These findings are noteworthy as they propose that the integration of WMS in primary care could lead to an alternative approach to patient care. This alternative approach could have significant benefits for not only the patients through reduced side effects of medications but for the overall healthcare system too, as it could reduce the need of additional personnel and resources to manage chronic and negative side effects from medications.

Subtheme: Target Population

Physicians identified many patient populations which they believed would experience the most benefits from WMS. To begin, physicians acknowledged the current increase in the sedentary lifestyle of society and believed that WMS could help this population to become more active. More specifically, physicians expressed the benefits of WMS for individuals who have never been active before or do not have a consistent exercise routine, to serve as a tool to help create new habits. Elderly patients, who may have misconceptions regarding their current activity level and the recommended amount of physical activity were also identified by physicians to benefit from WMS. Additionally, patients categorized as living with obesity or a psychological condition such as depression, anxiety, and poor mental health were also perceived by physicians to have additional benefits from using a WMS. When asked what patient populations would benefit most from a WMS, Emma replied:

> "The biggest group that, the group I find the most challenging is those who have never been active... Someone's been active before and then has become inactive. Then it's ,I find them easier to motivate. But for those who have really never been active and now because they have classically, you know, high blood pressure or some nuance at heart

> disease and need to be active they're the toughest…I think therefore a device would actually help them because there's some hard evidence to show them, oh, they've gone from walking 2000 steps a day to 4000 steps a day and then I that there's better feedback for both them and me."

Conversely, when asked the same question, Eric stated "*People that have/are self-reported, sedentary, obese patients, elderly... and people with psychological [conditions], you know, depression and anxiety."* Meanwhile, John commented, *"I think the ones who are less or the ones who are more sedentary, less active and elderly."*

In addition to patients with specific conditions, physicians believed that patients living in rural areas could gain many benefits from WMS. Individuals living in rural areas face additional barriers compared to their urban counterparts when it comes to obtaining quality healthcare, such as limited access to healthcare professionals, resulting in longer travel distances, transportation challenges, and financial concerns, all contributing to worse health outcomes (Kornelsen et al., 2021; Wilson et al. 2020). By combining WMS with virtual care, which has become an important component of healthcare for individuals living in rural areas, physicians believed access to quality healthcare for rural populations could be improved. By wearing a WMS, a physician could receive a patient's objective movement behaviours data, thus allowing for more accurate and personalized recommendations for a patient without having to travel to their physician.

> "I mean for me and my practice because, I'm in an urban centre, but I actually have patients that live rurally cause by the demographics in my practice are huge... A lot of those patients [rural population] its more difficult for them to get into see me. So, sometimes we rely a bit more on virtual care, so having a device where they could then send me information is useful;

I'm not actually seeing them in person, so at least there is some hard evidence rather than just a full self-report." – Emma

Moreover, physicians identified a lack of access and availability of facilities to promote PA in rural areas, contributing to a misconception regarding the amount of physical activity required to achieve guideline recommendations. However, John believed this barrier could be reduced through the use of WMS.

"There's less access to community centres or community resources where people in the city might have, you know, multiple skating rinks, clubs, gyms, indoor tracks… if they live on a farm, you know, going out to walk at night, might be walking on like a two lane road, which might be super dangerous. So, I think having that kind of information might be really handy, and telling and showing people about like how how much is 150 minutes or how much is whatever for 10,000 steps or whatever guideline you want to use."

Lastly, following the COVID-19 pandemic, there has been a substantial shift in work arrangement of many Canadians (Morissette, 2024). Pre-pandemic, most Canadians worked in an office, followed by a drastic shift to working remotely from home throughout the pandemic, to a gradual increase to in-office work post-pandemic (Morissette, 2024). However, not all employers required Canadians to return to office full time or at all following the pandemic, resulting in continued remote working (Morissette, 2024). Though working from home may pose many benefits to employers, this shift in work location during the COVID-19 pandemic resulted in decreased levels of PA and increased SB time (Wilms et al., 2022). Therefore, the continued trend of remote working may pose similar negative impacts for movement patterns post pandemic. Most physicians addressed the increase in SB of patients working from home due to a loss of activity from routines such as their daily commute, as shared by Eric:

> "The movement patterns have changed with people not going into work and not having to get there, not biking to work, not walking to work, even walking to your car in a bigger city or taking trains, you do quite a bit of movement, you get a lot more steps in than you think, so and then the, you know, hours of that you can spend in a sedentary position are worse if you're kind of in one environment, so."

Emma had a similar comment regarding the movement patterns connected to working remotely as well as discussing the associated health impacts: *"I have found there's been that a huge increase in patients being sedentary, increasing weight and worsening health problems because they are working remotely and therefore there's no, there's no movement just in their day, a lot of the movement in their day-to-day life has actually been removed."* To combat the increase in SB from working remotely, physicians believed that WMS could help these individuals reduce their SB by having a tool to measure their daily movement, thus allowing them to recognize when they have not achieved their daily movement guidelines and motivating them to move.

Conversely, some physicians were unsure of the changes in movement patterns of individuals who work remotely. These physicians did not perceive a special benefit for this population compared to the general population/ populations previously identified. John perceived an improvement in movement patterns for individuals working remotely as disclosed:

> "People who are working remotely oftentimes have a little more time because they're saving their commute... the patients who comment on these kinds of things, will often say like, oh yeah, like I'm saving so much time, like, now I can workout, or now I can do that, or now I can walk, or now I can take my dog out all all the time. I I wouldn't say like, you know, and even throughout the day, I imagine that their sedentary behaviour is a lot less because, you know, they're they're probably like, making food, they're probably doing

> laundry, they're probably, like, cleaning the house rather than just being at like stapled to their desk chair."

These differing perspectives may be a result of the different environments of physicians' practices and the different populations they serve. Nonetheless, it emphasizes the need for further inquiry into the actual movement patterns of individuals working remotely.

Subtheme: Type of Monitoring

Most physicians identified benefits for patient care with respect to the type of data monitoring that WMS could provide. Most physicians shared their preference for long-term WMS monitoring compared to short-term, as it would allow for improved accuracy when identifying changes or trends in specific movement behaviours. When discussing this topic, physicians were prompted with the LT monitoring example of CGM and the ST monitoring example of holter monitors; in which most physicians thought that WMS would follow a model like CGM.

John compared the two models, and explained why he would prefer WMS usage to be similar to a CGM model:

> "It'd have to be like a CGM …CGM is all the time and to really have a good representation it has to be all the time. Like if you only caught, say you have a holter which is a problem, so you have a holter and someone like someone's coming in with palpitations, or feelings that their heart's racing, and you only have the order for a week. But they don't have the palpitations and you're not really potentially catching the arrhythmia… Same kind of thing for the movement sensors, like if they're, if it's only on for a week, but the but it's winter or it's Christmas, or they're sick, or it's rainy outside It might not capture like a true representation of their average movement, and rather just a snapshot."

Physicians also highlighted that long-term monitoring with a WMS could assist in educating patients about movement habits and help them to stay consistent in improvements in their movement patterns.

> "I mean you know longer term is going to be better because I think that once you get a patient engaged and then they're actively engaged in ongoing monitoring that would be better in the long term. 'cause, I don't think you can change behaviour in two weeks, but if the only option was let's say I'm providing them, it's the only option is that it's a loan. Then I think 2 weeks is definitely better than no time at all." – Emma

This quotation supports the impact of LT monitoring for consistent engagement in improving movement patterns as well as identifying patients' movement pattern changes. In this quotation, Emma addresses a component of this subtheme that overlaps with the Integration Considerations subtheme of barriers, which will be discussed in a later section. However, though physicians addressed a potential barrier to access, physicians still realized the benefits of either type of WMS monitoring for patient care.

Subtheme: Empowerment

The subtheme of *Empowerment* concerning the benefits of WMS in patient care yielded much discussion among physicians through topics such as motivation, recognition of movement behaviours, and accountability of health. To begin, physicians shared the current problem of inactivity and sedentary lifestyles of their patients, as well as the lack of tools to quantify their movement patterns. By having a WMS, physicians believed that it could help their patients to recognize their current movement behaviours and empower them to make changes. Further, physicians shared that WMS could provide an opportunity for addressing gaps in patients' movement patterns and allow them to identify underlying reasons for said gaps. This could allow

physicians to use a more personalized approach in patient care and recommendations to overcome barriers for lifestyle management. For example, many physicians suggested that misconceptions regarding the type of activity intensity and duration, and other behaviours required to meet 24hr MG, and how their current behaviours compare to the guidelines, may be influencing their patients' ability to meet guidelines simply due to unawareness/ lack of education. This idea was presented by John:

> "Do you think you're doing enough activity? Let's look at the data and we could pull it up together and it'd be like, oh, you're actually only achieving, like, 30 minutes of MVPA a week. Like you have to ramp up your aerobic fitness...You have to do this... you're only lifting like heavyweights this much a week. OK, what's why not? Does it hurt? Are you unsure of what to do? Are you nervous about going into the gym? Maybe we can hook you up with a private instructor. Or maybe we can work on, you know, these YouTube workouts. Or maybe we can start gingerly with this."

Similarly, Emma said:

> "I think patients have a misperception of how active they actually are... I think that to to help engage them and motivate them to actually use that data [from WMS] would be something that there are a lot of them are already doing. So, to to use it for health and to share it would actually, would actually seem not out of the norm for them, so hopefully it would be motivating."

Building upon this idea, John proposed a way to assist patients in achieving specific intensity guidelines, as shown in:

> "If we set up targets or or, this might actually be super helpful to be honest. Like a lot of people don't really know what MVPA is, or if there was a certain zone aerobically that

they could exercise to. You know, like a Zone 2 and and you know, it's obviously like RPE is or rated of perceived exertion is. That is like a really good indicator of Zone 2 aerobic functioning. But for other people they might underestimate it."

Moreover, by having an objective way to monitor lifestyle behaviours, physicians believed that this could help patients to create a causal relationship between their behaviours and how they feel. This could then serve as a natural reinforcer to continuously improve and maintain positive changes in their lifestyle behaviours if they can develop this causal relationship. This idea was shared by Thomas with respect to sleep and activity:

> "It would be interesting to know what people's sleep patterns are. Because I think that's an area, both in physical and mental health, that people tend to neglect. And so having, like objective numbers and tracking that would be just like a sleep diary where if they had, if we could keep track of when their sleep was good and how they felt, to try to create that causal or correlation between the two for them to then feel like, OK, this is something that I actually should be doing... Then physical activity, I would say is also a good one, like in the sense that if they can again see some sort of objective measurements of what they're what they have been doing, it might encourage them to continue that habit. And then for us as well as like an accountability piece, not that we have to, you know, monitor them like a hawk or anything, but it would be good to, you know, for our diabetics. For example, if we kind of keep talking about lifestyle and lifestyle and lifestyle, it'd be good to have some sort of measure of, OK, they actually did this and did that."

As mentioned by Thomas, encouraging patients to monitor their own behaviours and lifestyle could increase a patient's accountability for their own health, and thus serve as an additional

motivator to continue those habits. This thought process was also shared by many physicians such as:

> "We can recommend stuff, but if there's really no way to track if someone's doing it …when someone's exercising and watching their, you know, their fitness level improve, their resting heart rate improve, I try to, I try to, you know, kind of use that as a as to kind of help reinforce people's activities and you know to changes in their activities." – Eric

Thomas elaborated on this idea in:

> "The main thing is that patients find some benefit from having like a 10,000 step per day goal or something that kinda keeps them honest. It hasn't been something that we've advised or or prescribed anything specific with regards to like what they should be doing with them, but it seems that it has played a positive role in many people's ability to, you know, stick with the habit essentially or create a habit."

Theme 2: Data Logistics

This theme encompasses the logistical aspect of WMS data from the perspective of a physician. Subthemes including data intake, data summary, most important data and workload were created from the interview data and will be discussed.

This theme was analyzed through the perspective of a physician as it encompasses many aspects of WMS integration in which the physician has authority. In primary care, especially those in clinical settings, the physician is the primary decision maker, thus decides protocols and procedures regarding their day-to-day operations including the integration of novel technology. Accordingly, for a comprehensive understanding of the feasibility of WMS integration into primary care, it is crucial to identify and analyze these logistical factors from the perspective of the individual in command, the physician.

Subtheme: Most Important Data

When integrating a novel piece of monitoring technology into any industry, usually one of the first questions posed by integrators is "what type of information does this device offer?", followed by the decision of whether that information is relevant or beneficial. As expected, this was a prominent question among physicians, many of which were decisive and shared similar opinions in their preferred information from a WMS.

> "Step and intensity… I still look at the other things and I ask about sleep patterns and sleep habits with people … I would just do self-reporting [on sleep] ...But the intensity of exercise and the duration of intensity and the recovery time after exercise are really, they're really helpful. You can't under report or overreport that because it's it's more measured."- Eric

As demonstrated in the quotation, physicians commonly identified a preference for two parameters in conjunction, as opposed to a singular parameter. Of these parameters, intensity, and a method to quantify an individual's amount of physical activity, whether that be through step count or active minutes were the most frequently chosen as well as sleep. Physicians conveyed the importance of having a complete understanding of a patients' movement data, perhaps supporting why more than one parameter of information was chosen. The need for more than one parameter of data, as well as the potential implications/misconceptions if only one parameter of data were to be used exclusively, was explained by Eric when asked if there was any data that he would be less likely to trust.

> "Even just the number of hours of movement, knowing that you can just move, you know 50 steps, or 100 steps and it gives you the, it gives you the hour of movement. So, I think

coupling that with the number of steps someone takes per day, and and then looking at their exercise intensity minutes, is more telling... Yeah, just looking at if someone had moved for 12 hours in a day doesn't mean that they had intensity of movement. And you could be sitting for 55 minutes and then just, you know, you can be in class all day and that's not the same as being on your feet all day, right?"

Further, physicians emphasized the importance of determining the intensity of an individual's PA and advocating for engaging in PA of varying intensities. As recommended by the 24hrMG, adults aged 18-64 should engage in at least 150 minutes of MVPA per week, at least two sessions of muscle strengthening activities for major muscle groups and several hours of light PA daily (Ross et al., 2020). Physicians recognized that, as expressed by Eric, a single parameter of data can lead to shortcomings and misinformation of whether or not a patient is meeting the 24hrMG, creating a barrier towards quality of patient care. Further, many physicians disclosed the lack of education among patients concerning the importance of different intensity PA as shared by John, *"I think there's a lot of benefit in light activity, and counselling people on that is just absolutely impossible."* Likewise, physicians reported concern with patients' self-reports of activity, highlighting problems with subjective descriptions of activity such as a "brisk walk" and what that equates to for intensity and achieving guidelines. WMS could provide a solution to these problems by providing physicians with patient's objective data to confirm their PA intensities, therefore allowing physicians to identify gaps in their current habits, provide the necessary education to reduce gaps and overall improve adherence to the 24hrMG. Sleep was also discussed as being an impactful parameter to have data about in primary care. Of all the physicians, Thomas emphasized the importance of sleep for health the most and elaborated on why sleep data would be beneficial data to have for both a patient care and educational perspective.

> "I just think sleep is very important and most people don't appreciate that. And so just having it as a data point of, you know, like if I feel crappy today like how did I sleep? Also, in terms of like drugs, alcohol, things like that, I think the quality of the sleep…. It's important thing for patients to know that, you know, being passed out is not the same as sleep. And so being able to see that I got good restful sleep for this long I think is important."

Lastly, physicians indicated concerns with the accuracy of the data provided by WMS, with the most uncertainties emerging for sleep data. Although physicians had concerns about data accuracy, many physicians expressed their interest in improving their current knowledge of WMS at a conference or through an additional learning curriculum. Based on this interest, future conferences and learning curriculums may provide an opportunity to discuss the accuracy of WMS data and may help to progress the implementation of WMS into primary care.

Subtheme: Data Intake

Discussions concerning what type of WMS data physicians viewed as the most important for primary care, created an effective transition for how physicians anticipated they could receive the WMS data as effortlessly and seamlessly as possible. Physicians noted the technological advancements of primary care, specifically through EMR, and viewed receiving the WMS data electronically through their EMR as an efficient option. Physicians noted that data from WMS to EMR could be integrated through direct upload to a patient's electronic chart or through an emailed screenshot or summary that is then uploaded to their chart. In fact, many physicians commented on how they are already receiving their patients' health data through their EMR using these methods for devices including CGM and thought that WMS data could be integrated similarly. This concept was shared by Emma:

> "What I'm already doing is if there is data, is actually having them to e- mail it to me… I am EMR, so it would be, so it comes in and then it gets actually automatically uploaded into the chart…especially for this because then, you know, I see it actually the day it comes in and then I can review it. I can check to make sure the patient has a a visit and then it's right it's easily accessible when when the visit happens."

This is noteworthy as it highlights patients' current familiarity with monitoring their own health parameters and presents the idea that monitoring with WMS may not be a large leap in health monitoring, but rather the next step. Further, the current use of technology for health monitoring reveals the existence of systems and procedures for data intake that could be modified to fit that of WMS. The benefits of WMS data intake through EMR were noted by most physicians, even those who did not currently have EMR in their practice. Despite not having EMR, physicians did not perceive this to be a barrier to WMS data intake; they instead proposed alternative methods as shared by John:

> "When they check in, they could show the secretary like, hey, like, similar to a weight. It'd be like, like, put it into the chart put, you know, mvpa colon, and then the number, and then you can trend that day over like like month over month or or, you know quarterly or something like that so that you could have a picture of how people are moving."

Lastly, physicians were asked if they perceived any issues regarding security and confidentiality associated with WMS integration. The only concerns reported were related to securely receiving the data as discussed by Emma in:

> "I guess the one thing would be when the e-mail comes in, that is not necessarily secure. So emails that go out from our office are secure, but emails that come in aren't necessary,

but they are uploaded directly into the chart. So, there may be a small risk there, but once they're actually transferred into the chart then it's it's secure."

Based on this report, further investigation into ensuring the security of data from an external source should be completed before WMS integration into primary care.

Subtheme: Data Summary

Similarly to the intake of WMS data, physicians also had suggestions regarding what level of data summarization would be most beneficial. These suggestions varied depending on the physician; however, there was a consensus of preferring a minimum of weekly data summaries/trends. Emma provided an explanation for this preference:

> "A weekly summary…first of all daily would be on a lot of data to go through… every day doesn't need to be perfect and I'm certainly not expecting patients to have, say, seven days a week of of of perfect behaviour, so to speak. So I think week would be good and I think it would be also nice to be able to compare it. I think it's more easy to compare or to see improvement. If you're looking back at a a weekly summary."

Eric elaborated on this preference for a minimum of weekly data trends compared to daily:

> "If I'm really doing lifestyle stuff with them, I see them every couple of months, so weekly is probably better…the weekly's are are more helpful for seeing how people are. If they're actually responding to what you're, if they're doing what you're asking them to do, and you know. And then the educational part, you may have a good day and a bad day, but if the overall trend is, it's really the overall trend, that's probably more important. So a weekly or monthly trend would be more beneficial."

Physicians stated that receiving daily data summaries would not be feasible as it would present a significant increase in data for physicians to read, which they do not have the time to do,

as well as a dramatic increase in their workload. Moreover, they believed that daily data summaries would make it harder to track patients' changes and progress in their movement patterns, thus reiterating their preference for weekly to monthly trends. Physicians further supported this preference in conjunction with the anticipated follow-up period of one to three months (similar to average patient follow-up period) and the common duration for being able to visualize consistent changes in patterns as expressed by John *"I'd say like every three months…for you to actually see change like all the studies, the exercise studies and the those trials are always 12 weeks at minimum."*

Some physicians shared particularly novel ideas about how the WMS data could be summarized, in addition to the duration of summary as shown in:

> "For the movement stuff, if it spits out a clean number like then that would be, that would be ideal… if the movement app spit out like a rating, which would take into account some of the major things that we just talked about, like time in Zone 2 or mvpa, sedentary time like weight lifting time…then like potentially a breakdown of the three, but that would be a really quick way of, you know, trending people's fitness levels and yeah, desire for fitness." – John
>
> Similarly, Thomas was less interested in seeing the actual WMS data and instead proposed the use of AI to summarize patients' movement patterns.
>
> "I'd be curious, like if even if you could, like if a watch could just spit out that data into like an AI platform, and then the AI can get to make a narrative of like, this is when they tend to exercise, and these are the days of the week where they tend to not and you know, so if it gives you a bit of a narrative, then you can hopefully look at that with the patient. Then they might say Oh yeah, actually because Wednesdays are busy for this and that

reason I tend to not, you know, do much exercise and then if you find out that you know if they get on a on a roll, on a positive like momentum in terms of their lifestyle changes and then you notice at the times that they relapse or are like you know it's a Wednesday that was really busy followed by a Thursday and now they've got two days where they're not really doing much exercise. You know, if AI or these WMS can pick up that kind of information, I think it would just be good for directing the conversation in terms of what can we do to, you know, help the patient back on track or stay on track."

These novel methods of summarizing the data emphasize the versatility of WMS integration into primary care. This would provide physicians with greater autonomy regarding WMS integration, allowing them to modify aspects to best fit their practice and serve their patients.

Subtheme: Workload

Through the theme of data intake, one of the reoccurring comments of physicians was to integrate WMS in a manner that did not significantly increase their workload. If data was summarized to reflect a weekly average, physicians would not be overwhelmed with excessive information, and their workload would remain manageable. Though physicians acknowledged that WMS integration would result in a slight increase in workload, as implements of any new aspect of patient care do, they perceived the slight increase in workload as worthwhile due to the improvements in patient care that it could provide. Thomas elaborated on the question of whether WMS would result in a significant increase in a physician's workload in:

"So I would say no, because I think it's part of our job. But it it would be in the same vein that, like I'm not reading a holter monitor report and going through all the numbers and and deciding you know. I'm basically pulling up the report, I see all the pages that the the person has gone through and then I'm just reading the report saying that you know this is

the rhythm that they were in and they had the Max. rate of this and the minimum rate of this blah blah blah. Reading that like you know, 2-3 line paragraph takes me really no time at all, and if that was the way that it was incorporated, then I think no. But if we were just getting, you know, reams of raw data, then I think that would not really be a feasible thing."

Related to workload, physicians predicted that uploading data through an EMR could make follow-up appointments easier for patients and physicians by not necessarily having to schedule an in-person appointment but also having objective data to discuss.

"If you're receiving the information without the patient being there then, then it would be easier to, maybe quicker even to do follow up, you know, appointments with them. Specifically, if you're talking about, if you had previously been following and having set goals for someone and then if you're getting the information but whether that's in person or whether it's virtual, I think the information is still as important to have. "– Eric

Another idea that could minimize the increase in workload from monitoring WMS data as well as improve follow-up appointment accessibility was suggested by Eric through adopting a procedure used in diabetes education centers:

"Especially with diabetes, then you know you can have a diabetes education centre, have a whole lot of patients that they're following and they can you know have things flag if they're low or if they're high and and and and you know kind of get attention faster especially if they have access to primary care is poor."

As discussed by Eric, this could minimize the increase in workload for physicians by reducing the amount of data to review. With WMS, the data could be analyzed and categorized upon uploading to the EMR as meeting 24Hr MG or not. Those who are not meeting 24Hr MG could be flagged,

resulting in a notification for the physician to follow-up on as they deem necessary. Thus, this method provides an additional opportunity for physician autonomy with WMS integration by presenting another method for data to be reviewed and received that could be easily modified depending on the physician.

Theme 3: ***Integration Considerations***

When integrating novel technology into any industry, it is important to identify perceived facilitators and barriers that may arise throughout implementation. The integration considerations theme that emerged from physician's interviews regarding WMS implementation in primary care was organized into a dichotomy of facilitators and barriers. Each division was then categorized into various subthemes. The subthemes of facilitators of integration considerations include *Current Use of RPM*, *Timeline, Lifestyle Approach* and *Tech Advancements*. Meanwhile, the subthemes contributing to the barriers of WMS integration into primary care include *Access*, *Education* and *Lifestyle Approach*. This theme was analyzed through the perspective of both physicians and patients, as both of these populations are critical in the successful implementation of WMS in primary care, therefore it is important to investigate this theme from both perspectives.

Subtheme: Facilitators - Current Use of RPM

Physicians identified many facilitators concerning the implementation of WMS into primary care, one of them being the current use of remote patient monitoring among their patients. Physicians highlighted patients of all ages' increased familiarity with technology, especially that related to monitoring health parameters through CGM, blood pressure cuffs or even their own WMS. Due to this pre-existing familiarity, physicians perceived the implementation of WMS as more practical. Some of the current uses of RPM by patients are shared by Emma and Eric.

When asked if she has noticed an uptake of WMS usage by patients Emma replied:

> "Patients love them...patients will often self-report steps like number of steps, patients seem to really like that information. And a lot of them, I guess this is outside of this, but they do love their you know like their blood pressure, pulse rate, sleep. The things you're talking about... I would say the number one thing though is that patients seem to know how many steps they have in a day."

Emma further articulated this point later in her interview through:

> "I think patients are more accepting and understanding of technology and their day-to-day life and that there has been a big uptake on using technology in regards to their own, their own health. Right, like a lot of my patients will come in with graphs, things that have been downloaded from their devices. They will quite quickly self-monitor without me even asking."

Eric expressed similar findings among his patients' use of RPM, *"There's there's a lot of people, even older people…who are and and they're more than willing to kind of follow numbers, and and try to monitor things a little more closely."* This finding provided by Eric opposes common beliefs that older individuals are less likely to be willing to use technology to monitor their health, which has been identified as a barrier in previous research for large-scale uptake of WMS into primary care (Sawler et al., 2023). This shift in willingness to use technology to monitor health may be a result of the increasing technological literacy among society. Further, because patients are already monitoring their health data, and therefore familiarity with the procedures and systems, reiterates the idea presented in *Data Intake*, that WMS's integration into primary care may not be unrealistic but rather the next advancement in RPM care.

As a result of the increased technologization of health care including EMR, receiving test results virtually, telemedicine, and RPM, physicians with many years of experience expressed

positive changes in the ways of practicing medicine since the beginning of their careers. Their increased use of technology in primary care, most specifically through current use of EMR was viewed as suitable for the integration of WMS. Moreover, the increased availability of access to and sharing of health information as well as the public's awareness and use of this information was also noted by physicians as positive. However, some also mentioned the importance of ensuring patients understanding and interpretation of information is accurate, thus emphasizing the importance of properly equipping patients with not only the tools for WMS but the proper education and resources as well.

Subtheme: Facilitators - Lifestyle Management

A unique characteristic of primary care is the autonomy that a physician has over the everyday operations of their practice, including their style and preference of patient care. This unique characteristic of primary care means that one physician's approach to treating a patient's condition may vary compared to that of another physician. This is relevant with respect to WMS integration into primary care due to varying physicians' approaches to utilizing lifestyle modification in their patient care. If a physician is very familiar with the 24hrMG and/or views lifestyle modification to be an effective approach to managing patient's conditions, then they may be more receptive to the integration of WMS into their practice. It is anticipated that these physicians would have a greater preference for an objective measure of this information which could provide many benefits to their patient care as discussed previously. Conversely, if a physician would rather treat/manage the same condition exclusively with pharmaceuticals, then they may be less or not at all interested in the implementation of WMS into their practice. Thus, the concept of a physician's approach to lifestyle management in their patient care may act as a facilitator or barrier to the large-scale uptake of WMS into primary care.

Subtheme: Facilitators - Timeline

As a result of current trends of RPM by patients, regardless of whether that is self-directed or physician directed, as well as technological advancements in primary care and physicians' approach to lifestyle management, physicians believe that these factors could allow for WMS to be integrated into primary care in the near future. The predicted timeline of implementation by physicians ranged from as soon as one year to within the next five years. The concept of implementing WMS into primary care in the new future was shared by all physicians who participated in this study such as:

> "Because I already think it's happening, I would say that to implement it more, would be. You can easily do over two to five years…Few years, that if that was a more focus of practice.. [if someone said] I'm going to really try to implement this more. I'm sure within two years, I could I could make a big change." – Emma

Eric also agreed with this implementation timeline, referencing the use of home monitoring, specifically through advancements in home blood pressure monitoring devices:

"I would love to see a big change in the next two years, would be would be great. Or sooner if possible…it's really impressive the number of people that do, that are watching things, you know with smart watches technology…people are realizing they can do home monitoring at home, you know even the blood a lot of the blood pressure cuffs are Bluetooth."

Subtheme: Barriers – Access

Though physicians were receptive to the potential implementation of WMS into primary care, many physicians disclosed factors that may be barriers to their large-scale uptake. One of the barriers identified by physicians was access to WMS, including considerations such as cost, potential coverage through insurance and availability for monitoring. As mentioned, physicians

identified the cost of WMS as a potential barrier to their implementation, primarily focusing on the question of who is buying these devices. This barrier has been identified in previous research regarding WMS implementation; thus, this study introduced the idea of physicians obtaining the data from WMS that are currently the property of their patients. By receiving the data from patient's WMS that they already own, the financial burden of purchasing WMS and the upkeep of the devices is eliminated (Sawler et al., 2022). Further, because physicians noted that some patients already have these devices, this approach to implementation was well-received by physicians and assessed as feasible. However, the question of how to ensure equitable access to WMS for those who are interested, and especially for those who physicians perceive would benefit most from their use was also discussed. Physicians reported previous experience with inaccessibility to RPM with CGM as shared by Eric:

> "Unfortunately, coverage for the glucose monitoring has been a barrier. There's a lot of people that would really benefit from knowing the information, but if they're not on insulin, their plan won't cover, cover it, and then as an out-of-pocket expense, there's not a lot of people that are willing to do it."

To navigate this barrier, physicians were asked their perspective on whether they believed WMS could be covered through insurance in the future, as is the case for some CGM. Many physicians agreed that WMS could be something potentially covered by insurance plans in the future. However, further research should investigate how WMS can be accessible to patients who do not have insurance coverage. Emma commented on how eliminating the cost of these devices would help to implement them into her practice and assist her patients' access to them.

> "I think that certainly if a third party is paying for something, it's often easier for me to get buy-in from a patient, right. And it also would depend on the cost… for some of my

patients that may not, it would be not an option for them if they were paying having to pay out of their own pocket.

If a third party was paying for it, that would be helpful… even have it where they could have it loaned to them."

Thomas elaborated on this concept and noted important implications such as standardizing the data collection and use of the data, as shown in:

"I think they'd have to be some kind of standard on how the data is collected and and what kind of use that data is actually being put to …I think there definitely could be a role, even if it's just like subsidizing…I don't know if I would believe it would be at the same level as you know, blood pressure machine or or like a a glucose monitoring machine. But yeah, I think it could be a good, good idea."

Similarly, John was very receptive to the idea of WMS being covered by insurance and shared his opinion on the importance of changing the current approach to insurance coverage in the future. He believed that coverage should be altered to include items that can reduce the occurrence of chronic diseases and co-morbidities and thought that WMS would be an integral component of this novel approach.

"So I have a really strong opinion about this. I think we wait for diseases to come up and then we spend a lot of money on treating those diseases and don't really target the disease. We just give meds a lot of docs give meds. Just to target symptoms and like target lab values... what I think would be the most important for everyone is that insurance companies cover: gym memberships, anything to promote health like a loop or a or an Apple Watch or a Garmin to track physical activity and fitness. There might have to be certain stipulations, obviously only one in three years or four years, you'd have to

> prove that you're actually using it. And I think that like food subsidies would also be a really good idea from insurance companies. I think that with these changes, there would be potentially millions or hundreds of millions of dollars saved, because of the downstream effects of not having these uncontrolled chronic diseases."

Subtheme: Barriers - Lifestyle Management

As discussed previously, a physician's approach to lifestyle management is a crucial aspect impacting the implementation of WMS into primary care. Physicians expressed how some colleagues perceive lifestyle management to be more effective for treating conditions than others and tend to utilize this approach more often than others. This led to questions regarding whether a physician who does not perceive lifestyle management to be an effective care approach would be interested in WMS. This was expressed by John, *"When I'm thinking about like wearables and all this extra data, I wonder if the average Doctor who doesn't care about this stuff will really care, you know? Or they'll just care about steps."* To expand on this idea, physicians were also asked whether they thought their colleagues would be interested in implementing WMS into their practice. Similar to John, Thomas emphasizes the influence of the type of practice that a physician has for their interest in WMS implementation:

> [When asked if he would implement WMS into his practice] "Probably not. And the reason for that would be because my ratio of like primary care to inpatient care is heavily on the inpatient care side... I think there's, I think there is a subset of, you know, family doctors who are keenly interested in prevention and lifestyle management. And I think certainly for those people, it would be, yeah."

Meanwhile, Emma perceived that lifestyle management was something frequently utilized by her colleagues and as a result believed that WMS would be a tool her colleagues would be interested

in*;"I can't speak for all, but I would say that… getting this type of data and information and really working on lifestyle is something that we all that we're always working on with our patients. So having new and better methods of monitoring, I think all my colleagues would be open to that."*

Therefore, to summarize, the physicians' differing perspectives on this concept suggests the influence a physician's approach to lifestyle management may have on the implementation of WMS into primary care. Hence, those believing in the importance and benefits of lifestyle management for health may be more receptive to adopting WMS in their practice.

Subtheme: Barriers - Education

Related to physicians' lifestyle management approach as a barrier to the implementation of WMS into primary care is their knowledge/education of the 24hrMG and the importance of achieving these guidelines for overall health. Some physicians are more knowledgeable regarding lifestyle management prescription and thus may be more inclined to implement WMS into their practice to improve the quality of their lifestyle management recommendations. This knowledge gap was presented by John as a potential barrier to the large-scale implementation of WMS.

> "I have a certain level of comfort for this kind of stuff. I enjoy like listening to these, to podcasts about fitness and longevity and exercise and optimizing exercise, but not every family Doc will, and I think there might be a really big knowledge gap, in the, the type of advice and counsel that people might need… I think that I think would probably be like for the for, for a global or a large-scale uptake. I think that's, in my opinion, the biggest barrier."

Conclusion

Overall, for interested physicians, WMS provide an opportunity to enhance patient care with the 24hr MG. Further, 'bought in' physicians believe that WMS implementation could have a positive impact on their use of pharmacare and for specific patient populations. These physicians believed that physical activity duration and intensity would be the most beneficial data parameters for use in primary care. Further, though some barriers to WMS implementation were identified, physicians did not perceive any technological barriers to WMS implementation due to the increased use of EMR and current familiarity among patients with using devices for health monitoring. Moreover, physicians without EMR believe that WMS implementation is feasible, and data could be tracked in paper charts, therefore highlighting the opportunity for wide-scale implementation. Lastly, a minimum of a weekly data summary was considered the most beneficial for physicians to track movement behaviour patterns. Many additional methods for data summary were discussed, indicating physicians preferred the opportunity to choose a method of data summary most suitable for their practice and patients. As such, this research could be used to develop an action plan for the pilot integration of WMS into primary care.

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Appendices

Appendix A: REB Approval Letter

Wednesday, April 9, 2025 at 9:40:45 AM Atlantic Daylight Time

Subject: Research Ethics Protocol #27497 "Clinicians' Perspective on the Implementation of Wearable Movement Sensors in Primary Care"
Date: Monday, January 6, 2025 at 10:14:43 AM Atlantic Standard Time
From: do-not-reply-stfx@researchservicesoffice.com
To: Claire Keyes (x2021byj)
CC: Angie Kolen, Ryan Reid, Jacqueline Beaton

ST. FRANCIS XAVIER UNIVERSITY

January 06, 2025

Claire Keyes (Principal Investigator)
Dr. Ryan Reid (Co-Investigator)
Dr. Angela Kolen (Co-Investigator)
Faculty of Science\Human Kinetics
St. Francis Xavier University

ROMEO File #: 27497
Project Title: Clinicians' Perspective on the Implementation of Wearable Movement Sensors in Primary Care

Dear Claire Keyes,

The Research Ethics Board (REB) has cleared the above cited proposed research project for ethics compliance with the Tri-Council Guidelines (TCPS) and St. Francis Xavier University's ethics policies. In accordance with the Tri-Council Guidelines, your project has been cleared for one year. At the end of each year, the REB will ask if your project has been completed and, if not, what changes have occurred or will occur in the next year. This will be required each year following approval until the project is reported to be completed, up to a maximum of five years.

Renewal Due-2026/01/06

You are reminded of your obligation to advise the REB of any adverse event(s) that occur during this one-year period. An adverse event includes, but is not limited to, a complaint, a change or unexpected event that alters the level of risk for the researcher or participants or situation that

1 of 2

requires a substantial change in approach to a participant(s).

You are also reminded that all changes that might affect human participants must be cleared by the REB. For example, you must report changes in study procedures or implementations of new aspects in the study procedures. These changes must be sent to the undersigned prior to implementation.

Level of Risk: Low

Level of review: • Expedited review- honours thesis

On behalf of the Research Ethics Board, I wish you continued success in your research.

Sincerely

Dr. Christine Lomore
Professor and Chair
STFX Research Ethics Board

Appendix B: Invitation to Participate

Invitation to Participate

Title of Research: Clinicians' Perspectives on Procedures for Implementing Wearable Movement Sensors into Primary Care

Name of Researcher(s):
Principal Investigator: Claire Keyes, BSc. Student, St. Francis Xavier University
Research Supervisors: Dr. Ryan Reid, Associate Professor, St. Francis Xavier University
Dr. Angie Kolen, Professor, St. Francis Xavier University

Invitation to Participate: You are invited to take part in this research study entitled: **Clinicians' Perspectives on Procedures for Implementing Wearable Movement Sensors into Primary Care**. You are being invited to participate in this study because of your experience in primary health care as a Primary Health Care Clinician (Physician or Nurse Practitioner) working in a Canadian healthcare institution.

Purpose and Description of the Research: The goal of this project is to understand the best practices for implementing wearable movement sensors (e.g., Fitbit, Apple Watch) into primary care as a method for clinicians to objectively monitor the lifestyle habits (i.e., physical activity, sleep time, and sedentary behaviour) of their patients.

What will be Required of Participants, including the Time Commitment: Your total time commitment to this research project will be approximately 90 minutes, through participation in a one-on-one interview with the principal investigator that will take place online using Microsoft Teams. Each interview will begin with a 5-10 minute preamble about wearable movement sensors, the information they offer and the two current models of remote monitoring health devices to ensure familiarity with the current framework of models that wearable movement sensors usage in primary care could be adapted from. This preamble will be followed by a semi-structured one-on-one interview discussing topics including feasibility, accessibility (to device and data), storage of patient data, type of data parameters, confidentiality and target population. Following the interview, the data will be transcribed verbatim and sent to you for verification and clarification.

Participation is Voluntary: Right to Withdraw Without Negative Consequences: Taking part in this study is entirely up to you, and you have the freedom to withdraw from the study at any point, without any negative consequences. During the interview, you have the right to refuse to answer questions without having to terminate your involvement. If you no longer wish to participate in the study, you can do so by contacting Dr. Ryan Reid (Research Supervisor; Telephone: (902) 867-5937; Email: rreid@stfx.ca). Any data collected from your participation will be immediately deleted following your withdraw.

Potential Benefits: You will have the opportunity to provide direct feedback on how implementing wearable movement sensors could be successfully accomplished into Canadian healthcare institutions. This may provide the opportunity for specific troubleshooting

conversations to take place. Moreover, by participating in this study, it may broaden your knowledge regarding the use of wearable movement sensors, perhaps advancing the implementation process in your own practice.

Foreseeable Risks/Harms and Costs: Besides effort and time, there are no known or expected harms associated with your participation in this research study.

Confidentiality: Pseudonyms will be created for each participant prior to the onset of each interview. Your responses during the interview will be kept de-identified and confidential. Only the primary investigator, and their research supervisors will have access to the data. No identifying information will be included in any document resulting or produced from this study.

Data Security: The virtual interview will include a waiting room and require a passcode for entry to increase confidentiality and security. Following the transcription and verification of the interview, the **audio recording** will be deleted. Any electronic versions of data resulting from this study will be stored on an encrypted hard drive, which will be kept under a double lock (in a locked file cabinet in the locked office of Dr. Ryan Reid at St. Francis Xavier University). If any records are printed, hard copy files will also be kept under double lock. This data will be stored for up to five years following the completion of the project. After this period, all data will be destroyed.

Contact Information: If you have questions now or later, you may contact the Principal Investigator or Research Supervisor:

Claire Keyes (Principal Investigator)
Department of Human Kinetics, St. Francis Xavier University
Email: x2021byj@stfx.ca

Dr. Ryan Reid (Research Supervisor)
Department of Human Kinetics, St. Francis Xavier University
Office 214, 42 West St., Antigonish, NS, CA, B2G 1R8
Telephone: (902) 867-5937
Email: rreid@stfx.ca

Dr. Angie Kolen (Research Supervisor)
Department of Human Kinetics, St. Francis Xavier University
Office 220, 42 West St., Antigonish, NS, CA, B2G 1R8
Telephone: (902) 867-3540
Email: akolen@stfx.ca

Should you have any ethical concerns with the study, please contact the REB Chair, Dr. Christine Lomore, St. Francis Xavier University Research Ethics Board by phone: (902) 867-5387 or by email: clomore@stfx.ca. The reference number for the study is ROMEO # 27497.

Appendix C: Consent Form

Consent Form

I have received a copy of the Invitation to Participate for the research project entitled **Clinicians' Perspectives on Procedures for Implementing Wearable Movement Sensors into Primary Care** via email.

I have had an opportunity to read the information provided or it has been explained to me, and I have had all questions that I may have had answered.

I agree to participate in this research project, understanding that I am doing so voluntarily, that confidentiality will be maintained and that I have the right to withdraw from the study at any point using the means outlined in the Invitation to Participate.

In clicking "Yes" below, I signify that I have read and understand the relevant information concerning this research study, I understand that I may ask questions concerning any aspect of the research in the future and that I indicate free consent to research participation by clicking "Yes" on this research consent form. I understand that by providing consent to participate in this study that I am not waiving my right to legal recourse.

Please enter your full name and email address below prior to clicking "Yes" so that the research can contact you to schedule your interview:

Full Name: _____
Email Address: _____

If you have questions now or later, you may contact the Principal Investigator or Research Supervisors:

Claire Keyes (Principal Investigator)
Department of Human Kinetics, St. Francis Xavier University
Email: x2021byj@stfx.ca

Dr. Ryan Reid (Research Supervisor)
Department of Human Kinetics, St. Francis Xavier University
Office 214, 42 West St., Antigonish, NS, CA, B2G 1R8
Telephone: (902) 867-5937
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Dr. Angie Kolen (Research Supervisor)
Department of Human Kinetics, St. Francis Xavier University
Office 220, 42 West St., Antigonish, NS, CA, B2G 1R8
Telephone: (902) 867-3540
Email: akolen@stfx.ca

Appendix D: Qualtrics Survey

All participants were asked to complete a Qualtrics Survey including the questions below. Options for the questions' answers will be yes/no, a drop-down menu, a fill in the blank, and/or 7-point Likert scale option.

1. What is your age?
2. What is your gender identity?
3. What is your professional title? (MD or NP)
4. How many years have you been practicing as a Primary Health Care Clinician?
5. As a physician, are you affiliated with a university?
6. Which province or territory is your primary health care practice located?
7. Is your primary health care practice classified as a rural or urban practice?
8. What is your primary practice's organization setting? (hospital or clinic)
9. On average, how many patients do you see per day?
10. Are you aware of Canada's 24-hour movement guidelines that include physical activity, sedentary time and sleep)?
11. Do you currently use this type of information in your practice when caring for patients?
12. Are you familiar with wearable movement sensors?
13. Do you own a wearable movement sensor?
14. Do you have any experience with the use of wearable movement sensors in the healthcare setting?

Appendix E: Pre-Interview Information for Participants

Our virtual interview will discuss topics pertaining to wearable movement sensors and their implementation in primary health care. The following includes some background information on other remote patient monitoring models.

Currently, there are other realms of healthcare utilizing remote monitoring devices to monitor other health parameters such as Cardiology and Endocrinology. Remote patient monitoring has been implemented in the speciality of Cardiology through ambulatory blood pressure monitoring systems and portable electrocardiograms, such as ECG patches and ECG Holter monitors. Meanwhile, Endocrinology has implemented remote patient monitoring through continuous glucose monitors (CGM) to assist individuals diagnosed with both type 1 and type 2 diabetes in their daily management and treatment.

Following the exploration of these health monitoring devices, there appears to be two categories/models of health monitoring devices. The first model includes Holter monitors and self- applied patches for ECG monitoring and ambulatory blood pressure devices for blood pressure monitoring. These devices are provided to the patient by their health professional for short-term use, with the purpose of diagnosing an at-risk patient's condition or confirming a diagnosis. Meanwhile, the second model includes CGM devices that are the property of the patient and worn for long-term monitoring to assist in management of a pre-existing health condition. In this model, the patient supplies the data from their device to their health professional, to receive guidance and recommendations regarding the management of their pre-existing health condition.

The success of these devices, and remote patient monitoring presents the hypothesis that wearable movement sensors could be used in a similar manner to monitor patients' adherence to the Canadian 24hrMG to provide similar health benefits. Through access to data from patients' activity monitors, health professionals may be better equipped to make more informed recommendations.

The Interview Questions include:

1. Do you currently use physical activity, sedentary time, or sleep in your patient care?
2. Do you think having access to the information from wearable movement sensors (WMSs) would be useful?

a. For your patients, your patient care etc.?

3. Would you consider implementing WMSs into your practice?
4. What do you think would be the most beneficial information to have from WMSs?
5. Of the models used for existing monitoring technology, which one do you think WMSs would follow/ be most effective to follow?
6. How would you want to receive/ store the data, so it is easily accessible while maintaining confidentiality?

7. Would you want the data to be summarized before receiving it? What level of summary would be beneficial?
8. Are there any other concerns/ questions/ comments you have that we have not yet covered?

Appendix F: Interview Guide

Interview Guide: Jan 30th

Preamble:

Hi, how are you? Thank you so much for taking the time to do this interview today, I know you are very busy and I really appreciate you making time for this. Before we begin I just want to double check your consent to participate in this study…

I also just want to check that you are aware that this interview is being recorded and transcribed…

And after the interview within 1-2days you will receive a copy of the transcript to review and just confirm it….Also throughout the interview I will be taking some notes, so if I look down at my desk that is why. Lastly, do you have any questions before we begin?

Okay great, Today I would like to talk about wearable movement sensors, like Fitbits and Apple Watches, devices that can track how much activity someone does in their daily life. Some of the common parameters that can be tracked by these wearable movement sensors include heart rate, step count, duration of exercise /movement activity, sleep duration and sleep patterns, standing time.

What I hope to learn from this study is what type of information, subjective vs. objective would be best utilized by Primary Health Care Clinicians, and what variables related to the 24-hour movement guidelines would be best suited for integration into primary care. The secondary purpose of this study is to explore what aspects of the existing remote patient monitoring models are most applicable to wearable movement sensors.

Interview Questions:

1. Do you use physical activity, sedentary time, or sleep duration in your patient care?
    a. In what way?
    b. Do you advocate the importance of these habits to your patients? - ie 24 hr movement guidelines of 150 minutes of MVPA per week, several hours of light PA (standing per day), 7-9 hours of good quality sleep per night, limiting sedentary time to less than 8hours for adults aged 18-64.

2. Do you think the information from wearable movement sensors would be useful?
    a. For patients in self-monitoring their health?
    b. For yourself in developing care plans for your patients?
    c. Pharmacare- improve accuracy of Rxs being prescribed
    d. If an objective tool such as a wearable movement sensor was provided to you, would you consider implementing/using them/the information in your practice?
        i. Is this something that you think could be covered through insurance? So it wouldn't pose an additional cost to yourself/patient
    e. What if you did not have to purchase the monitors but have access to the information provided by patients' own monitors? Would that make the use of these monitors more appealing/accessible?

f. Going along with this idea of implementing technology has your practice become more technologically advanced throughout your career?
    i. in what ways?
    ii. Do you think the introduction of WMSs aligns with the technological advancements? Or could help to progress/introduce technological advancements?
g. What information do you think would be the most beneficial to have access to?
    i. Steps, active minutes, hours of standing, sleep time, heart rate
h. Would some patients benefit from WMS more than others?
    i. Who? In what way? Why this specific population?
    ii. With the covid 19 pandemic we have seen an uptake in virtual care in Primary health care, and this has continued to be used for some patients following the pandemic
    iii. Ie when considering patients living in a rural location, it may be more difficult for them to come for in person appointments, do you think that WMSs could be beneficial for this patient population? (reduce burden of travelling and time), maybe provide a new way of remote patient monitoring?

3. Of the models used for existing monitoring technology, which might be best for WMSs?
    a. Why?
    b. If you could make the model better, what would you change for WMSs?

4. How would you receive/ store the data? What would be best for your practice?
    a. Potential options:
        i. Talking with patient regarding wearable movement sensor data
        ii. Patient screenshots data and shows to physician to make note of in file
        iii. Data is emailed to physician/administrative assistant to print/scan/upload to patient's file
        iv. Data is uploaded immediately to EMR...Do you have EMR?
        v. Would this add to your workload?

5. Are you worried about confidentiality?
    a. How would you maintain/ go about this?

6. Would you want the data to be summarized before receiving it? Are single numbers enough or would you prefer a more comprehensive summary (the whole picture)

For example: daily summary of patient's activity (i.e. 20 mins/ day), or weekly summary (i.e. 100 minutes/ week), or your patient did/ did not achieve the PA guideline

    a. How would you want the data to be summarized?
    b. What level of summarization?
        i. Most devices come with a summary of various data parameters (weekly or daily summary)
        ii. Would a summary of whether the patient was just meeting guidelines or not be sufficient? Would this be helpful or unnecessary?

iii. Would further summarization/or analyzation be required?

c. How often do you think you would want to follow up with your patients?
    i. How long is a regular follow-up period for you? - would you see these patients more or less than average?
    ii. Does this put their health more into their own hands? More control/ autonomy over their own health- less hands- on approach/work required by you?

Other Questions:

7. Are you aware of any other similar research projects?

8. Is this a topic you would be interested in attending a conference on? Learning curriculums?

9. Are wearable movement sensors something that you think your colleagues would be interested in implementing into their practice as well?
    a. Is this a topic you would advocate to your colleagues?
    b. What timeline do you see WMSs having the potential to be introduced into primary care?

10. Pharmacare- do you think the use of WMSs could reduce the need for pharmacare?
    a. Similar time requirements- writing an Rx for a patient, reviewing their activity data?
    b. Would this data allow you to make better adjustments/Rxs for patients?

11. Are there any other concerns/questions/ comments you have that we have not yet covered?

Appendix G: Updated Interview Guide

Updated Interview Guide: Jan 31st

Preamble:

Hi how are you? Thank you so much for taking the time to do this interview today, I know you are very busy and I really appreciate you making time for this. Before we begin I just want to double check your consent to participate in this study…

I also just want to check that you are aware that this interview is being recorded and transcribed…

And after the interview within 1-2days you will receive a copy of the transcript to review and just confirm it….

Also throughout the interview I will be taking some notes, so if I look down at my desk that is why. Lastly, do you have any questions before we begin?

Okay great, Today I would like to talk about wearable movement sensors, like Fitbits and Apple Watches, devices that can track how much activity someone does in their daily life. Some of the common parameters that can be tracked by these wearable movement sensors include heart rate, step count, duration of exercise /movement activity, sleep duration and sleep patterns, standing time.

What I hope to learn from this study is what type of information, subjective vs. objective would be best utilized by Primary Health Care Clinicians, and what variables related to the 24-hour movement guidelines would be best suited for integration into primary care. The secondary purpose of this study is to explore what aspects of the existing remote patient monitoring models are most applicable to wearable movement sensors.

Interview Questions:

1. Do you use physical activity, sedentary time, or sleep duration in your patient care?
    a. In what way?
    b. Do you advocate the importance of these habits to your patients? - ie 24 hr movement guidelines of 150 minutes of MVPA per week, several hours of light PA (standing per day), 7-9 hours of good quality sleep per night, limiting sedentary time to less than 8hours for adults aged 18-64.
    c. Is there one of these that you tend to focus on more than others? One that you focus on less than others? Why?
    d. Why are these important to you in your patient care?

2. Do you think the information from wearable movement sensors would be useful?
    a. For patients in self-monitoring their health?
        i. Why?
    b. For yourself in developing care plans for your patients?
        i. Why?
    c. Do you think that by having information from WMSs and therefore a better understanding of your patients' lifestyle behaviours that would impact your use of pharmacare?
        i. Maybe improve accuracy/need for prescriptions?
    d. If an objective tool such as a wearable movement sensor was provided to you, would you consider implementing/using them/the information in your practice?

i. Is this something that you think could be covered through insurance? So it wouldn't pose an additional cost to yourself/patient
ii. If you had to purchase the devices yourself… would you still be as interested in implementing them?

e. What if you did not have to purchase the monitors but have access to the information provided by patients' own monitors? Would that make the use of these monitors more appealing/accessible?
i. Have you noticed an uptake in the use of WMSs by your patients?

f. Going along with this idea of implementing technology has your practice become more technologically advanced throughout your career?
i. In what ways? Positive and negative?
ii. Do you think the introduction of WMSs aligns with the technological advancements? Or could help to progress/introduce technological advancements?

g. What information do you think would be the most beneficial to have access to?
i. Steps, active minutes, hours of standing, sleep time, heart rate
ii. Why would you choose this information?/ Why do you think this information would be the most beneficial?
iii. Is there any information that you don't trust/ would be less likely to use?

h. Would some patients benefit from WMS more than others?
i. Who? In what way? Why this specific population?
ii. Would you have a specific goal for this population?—motivation?
iii. With the covid-19 pandemic we have seen an uptake in virtual care in Primary health care, and this has continued to be used for some patients following the pandemic do you think WMSs could be used through virtual care?
iv. More or just as pertinent than in-person care… ie call and renew prescriptions, look at data being received… without in-person visit?
v. Do you think these could be used for individuals living in a rural location? Why?
vi. There has also been an increase in individuals working remotely, do you think this population could benefit from WMSs in primary care?
vii. I.e. when considering patients living in a rural location, it may be more difficult for them to come for in person appointments, do you think that WMSs could be beneficial for this patient population? (reduce burden of travelling and time), maybe provide a new way of remote patient monitoring?

3. Of the models used for existing monitoring technology, which might be best for WMSs?
a. Why?
b. If you could make the model better, what would you change/modify to better suit WMSs?

4. How would you receive/ store the data? What would be best for your practice?
a. Potential options:
i. Talking with patient regarding wearable movement sensor data

ii. Patient screenshots data and shows to physician to make note of in file
iii. Data is emailed to physician/administrative assistant to print/scan/upload to patient's file
iv. Data is uploaded immediately to EMR...Do you have EMR?
v. Would this add to your workload? Positive and negative impacts?

5. Are you worried about confidentiality?
    a. How would you maintain/ go about this?
    b. Are there any other concerns you would have with implementing WMSs?

6. Would you want the data to be summarized before receiving it? Are single numbers enough or would you prefer a more comprehensive summary (the whole picture)

For example: daily summary of patient's activity (i.e. 20 mins/ day), or weekly summary (i.e. 100 minutes/ week), or your patient did/ did not achieve the PA guideline

    a. How would you want the data to be summarized?
    b. What level of summarization?
        i. Most devices come with a summary of various data parameters (weekly or daily summary)
        ii. Would a summary of whether the patient was just meeting guidelines or not be sufficient? Would this be helpful or unnecessary?
        iii. Would further summarization/or analyzation be required?
    c. How often do you think you would want to follow up with your patients?
        i. How long is a regular follow-up period for you? - would you see these patients more or less than average?
        ii. How would appointment frequency change with time? Would it?
        iii. Does this the health of your patients more into their own hands? More control/ autonomy over their own health, transfer from accountability/responsibility? less hands- on approach/work required by you?

Other Questions:

7. Are you aware of any other similar research projects?

8. Is this a topic you would be interested in attending a conference on? Learning curriculums?

9. Are wearable movement sensors something that you think your colleagues would be interested in implementing into their practice as well?
    a. Is this a topic you would advocate to your colleagues?
    b. What timeline do you see WMSs having the potential to be introduced into primary care?

10. Pharmacare- do you think the use of WMSs could reduce the need for pharmacare?
    a. Similar time requirements- writing an Rx for a patient, reviewing their activity data?
    b. Would this data allow you to make better adjustments/Rxs for patients?

11. Are there any other concerns/questions/ comments you have that we have not yet covered?