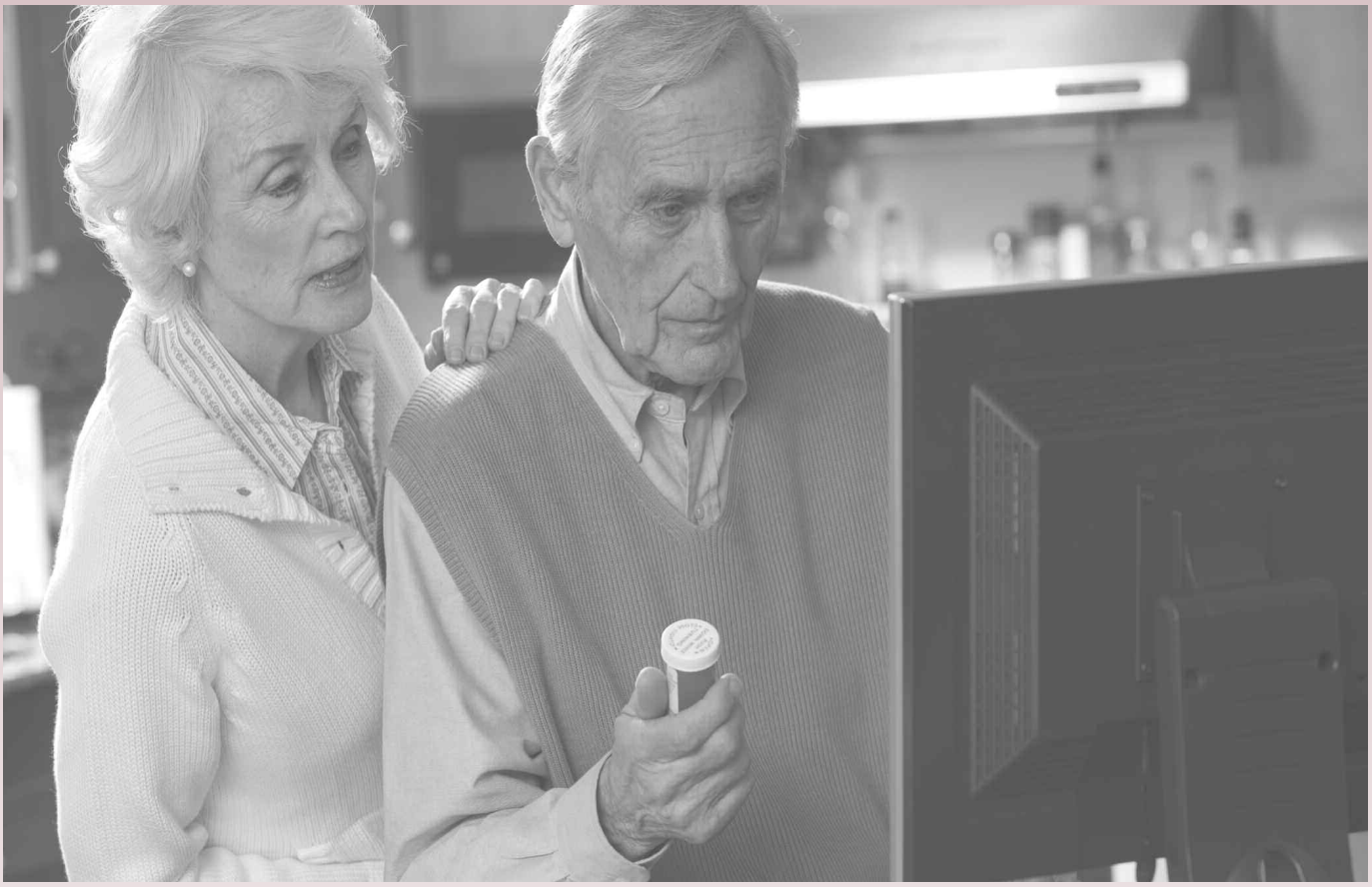
Final ACTION Contract Report

Communication-Focused Technologies:

Technologies for Enhancing Access to Health Management



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Final Report

Communication-Focused Technologies: Technologies for Enhancing Access to Health Management

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Preface

This project was funded as an Accelerating Change and Transformation in Organizations and Networks (ACTION) task order contract. ACTION is a 5-year implementation model of field-based research that fosters public–private collaboration in rapid-cycle, applied studies. ACTION promotes innovation in health care delivery by accelerating the development, implementation, diffusion, and uptake of demand-driven and evidence-based products, tools, strategies, and findings. ACTION also develops and diffuses scientific evidence about what does and does not work to improve health care delivery systems. It provides an impressive cadre of delivery-affiliated researchers and sites with a means of testing the application and uptake of research knowledge. With a goal of turning research into practice, ACTION links many of the Nation's largest health care systems with its top health services researchers. For more information about this initiative, go to http://www.ahrq.gov/research/action.htm.

This project was one of three task order contracts awarded under the *Communication-Focused Technologies* request for task order (RFTO). The goal of this RFTO was to develop and test proof-of-concept projects that leverage innovative communication-focused technologies to improve access to care, service quality, or patient safety in ambulatory settings. Of particular interest were projects that made innovative use of communication-based technologies, were person-centered, focused on hard-to-reach populations, and addressed ambulatory care issues.

Acknowledgments

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List of Abbreviations

ACTION – Accelerating Change and Transformation in Organizations and Networks
AHRQ – Agency for Healthcare Research and Quality
BP – Blood Pressure
HCBS – Home and Community-Based Services
HCP – Health Care Portal
ID – Identification
ISP – Internet Service Provider
MOP – Manual of Procedures
PCP – Primary Care Physician
RFTO – Request For Task Order
SD – Standard Deviation
TEAhM – Technologies for Enhanced Acceleration to health Management
VNC – Virtual Network Computing
WSU – Wright State University

Executive Summary

Rationale for the Project

Despite extensive public and professional education and the availability of efficacious treatments, hypertension remains the most common and strongest risk factor for cardiovascular disease in North America. Hypertension is a critical target for intervention among affected persons due to the costs associated with this condition and its sequelae, most notably stroke and myocardial infarction. Hypertension is present in more than 70 percent of Americans aged 80 and older, and it is the single most important risk factor for stroke. Improved approaches to patient self-management are increasingly viewed as an integral part of the healthcare process, and can offer particular promise for conditions like hypertension. Telehealth may provide a novel approach to enhancing the ability of older adults to manage hypertension and other chronic conditions, especially if this technology is delivered in community-based settings that are easily accessed by seniors.

Intervention Design

The Technologies for Enhancing Access to health Management (TEAhM) project was a pilot study designed to explore the feasibility of installing telehealth kiosks in community-based senior centers. TEAhM had two primary goals: (1) collect preliminary data on the logistics and operational considerations associated with implementing nurse-monitored telehealth kiosks in community-based senior centers and (2) conduct a preliminary comparison of blood pressures among hypertensive seniors who used the kiosk for 10 months and those who did not. A total of 113 hypertensive seniors were enrolled in TEAhM, of whom 41 were in the telehealth intervention group. The project was conducted by a partnership consisting of researchers from LeadingAge and Wright State University (WSU), Healthanywhere, a telehealth technology company, and four senior centers in Ohio.

Preparatory Activities

Our team identified four senior centers in rural Ohio to serve as field centers for this project. Criteria for selection of these centers included provision of onsite meals at least once per week, willingness to permit onsite installation of telehealth equipment, willingness to have a staff member trained in turning the equipment on/off and rebooting the computer and assist seniors in using the kiosks if necessary, willingness to permit study staff to visit on a regular basis to engage in study activities, adequate space to accommodate the kiosk, high speed Internet access, location in rural, underserved areas, and estimated service provision to a sufficient number of seniors to meet recruitment targets. Training of study nurses, senior center staff and participants was conducted as part of the protocol.

Implementation

The project involved recruitment of four senior centers, two of which provided participants for the intervention (telelhealth) group with the other two centers providing participants for the control group. Blood pressure data from telehealth stations at the intervention centers were streamed to a secure central server managed by a telehealth vendor and monitored by study nurses. Recruitment of participants occurred by direct interaction between study staff, senior center staff and potential study participants. Participating centers advertised the project via flyers and by word of mouth for several weeks preceding posted recruitment days. On screening/enrolment days, study nurses were onsite at the centers to screen and enroll participants. Study nurses contacted participants' primary care physicians to obtain blood pressure referral criteria. These criteria were entered into an electronic record such that study nurses were alerted by email immediately if the participant's blood pressure exceeded the threshold defined by the primary care physician.

Physician Engagement

Connecting with participants' primary care physicians to obtain blood pressure referral protocols was a challenging aspect of this project. It was often the case that staff could not directly interact with participants' physicians. Indeed, the physician survey that was administered at the end of the project suggested that many physicians were not aware that one of their patients was enrolled in the study. Engaging physicians in future studies of this kind is likely to be challenging, a reality that requires careful thought to identify strategies to successfully navigate the physician office aspect of future work.

Senior Center Staff Feedback

Senior center directors at the intervention sites were interviewed at the end of the project. Center directors felt that their clients understood and valued the telehealth intervention. They also indicated that the technology was easier for them and their clients to use than they expected. Both directors felt that seniors were becoming more technologically sophisticated over time, and that the role of the senior center as a community resource would need to evolve in order to meet seniors' changing needs and expectations. Directors indicated that because health screenings and health-related programming were already integral parts of their services, provision of telehealth services in the senior center venue was simply an extension of existing programming in the community.

Summary of Lessons Learned

Participants

- Most participants had used an automatic blood pressure device of some kind prior to the study.
- Participants were highly compliant with use of the technology, but this use dropped off somewhat over the 10 months of followup.
- A number of very high blood pressure readings were noted during the study period, permitting immediate action to be taken.
- Some participants reported frustration with repeated followup phone calls that occurred as a result of the nurses' being alerted of elevated pressures.
- Ninety-five percent of participants reported being "very comfortable" with use of the telehealth kiosk at the end of the study.

Senior Center Staff

- Staff saw clear value in telehealth, and felt senior centers were an appropriate venue in which this service could be provided.
- Staff felt that their clients were able to see the value added in this service and that they embraced the use of this technology after appropriate training was provided.
- Staff said that they would be willing to permanently house telehealth stations, but that the cost of the equipment and its ongoing maintenance would have to come from outside sources.

Primary Care Physicians

- Securing a direct line of communication with physicians was challenging.
- A future, office-based telehealth intervention would benefit from closer contact with seniors' primary care providers.
- Physicians' perceptions of the value of telehealth in chronic disease management were generally positive, with most physicians agreeing that telehealth-generated blood pressure reports would help them better manage their patients.

Nurse Monitoring

- Study nurses reported a high degree of satisfaction with the technology, but indicated that having access to the health care portal on a mobile device would have been a good addition to the technology platform.
- Nurses were able to provide quick and effective nursing interventions in response to elevated blood pressure readings.
- Greater access to participants' physicians would have helped study nurses utilize the technology more effectively.

Recommendations

This project strongly suggests that telehealth technology will be embraced by both seniors and senior center staff. Based on these findings, the next logical step is to explore how to coordinate the nurse monitoring aspect of the project with primary care. A future study could involve identifying primary care practices that would be willing to collaborate with senior centers on a 'second generation' telehealth study that builds on TEAhM. Such a study could focus on operational and logistical issues associated with building the bridges between physicians who care for seniors and the community-based senior centers that are routinely utilized by these individuals. This line of investigation would make a significant contribution toward advancing community-based, communication-focused technologies for this vulnerable population.

Rationale for the Project

Most older adults prefer to age in place and spend the end of their lives in their own homes and communities.[1,2] Home and community-based services (HCBS) are essential to enable seniors to age in place in diverse residential settings before and after acute health events. HCBS encompass a variety of supportive services delivered in community settings or in a person's home.[3,4] These services are designed to help older persons and adults with disabilities remain living at home. Although availability of adequate HCBS is an effective means to keep seniors independent in the community, HCBS are often sparse in rural areas,[5] placing rural elders at enhanced risk of loss of independence and poor disease management relative to their urban counterparts.[6] Beyond issues associated with limited availability of HCBS in rural areas, rural seniors often have a confluence of circumstances that present unique challenges to maintenance of health and quality of life in old age. Rural elderly often—

- Have multiple chronic conditions.[7]
- Live long distances from acute care facilities, primary health care providers, pharmacies and other health care resources.[8]
- Have few transportation options and limited, if any, mass transportation.[9]
- Have high poverty rates.[10]
- Embrace community norms that place value on "staying local."[11]
- Have high turnover of health care providers due to significant recruitment issues in rural America.[12]

Chronic illnesses affect over 100 million individuals in the United States and patients with poorly managed chronic conditions are among the costliest to the healthcare system.[13] Although it is common for older adults to experience multiple comorbidities, additional burdens associated with living in rural areas such as poverty, limited transportation and the paucity of health care professionals and health care infrastructure result in less favorable health profiles in this older population.[14,15] These differences are due in part to the lack of opportunities to, and the practical limitations involved in, engaging rural elders actively in the management of their chronic medical conditions. These challenges create marked health disparities for the rural elderly that are unrelated to their desire and motivation to actively engage in self-management.[16,17] However, these disparities also create opportunities to explore novel approaches to chronic disease management in this population and to develop innovative strategies to target provision of HCBS to those most in need.

Despite extensive public and professional education and the availability of efficacious treatments, hypertension remains the most common and strongest risk factor for cardiovascular disease in North America.[18] Hypertension is a critical target for intervention among affected persons due to the costs associated with this condition and its sequelae, most notably stroke and myocardial infarction. Hypertension is present in more than 70 percent of Americans aged 80 and older, and it is the single most important risk factor for stroke.[19-21] Improved approaches to patient self-management are increasingly viewed as an integral part of the healthcare process, and can offer particular promise for conditions like hypertension.[22]

There is growing evidence that some chronic conditions can be managed effectively, and less expensively, with telehealth technologies.[23] Telehealth can be defined as the delivery of health-related services and information via telecommunications technologies. Telehealth addresses health promotion, disease prevention, timely management as well as efforts to cure or change the trajectory of disease. A key feature of telehealth technologies is that they offer the opportunity to "extend" physician and nursing care beyond the walls of traditional office settings at relatively low cost. Further, new technologies, when appropriately incorporated into successful HCBS infrastructures, may offer the opportunity to manage chronic disease more aggressively, with fewer risks and at lower cost than traditional office-based care. These practical considerations may be especially valuable for exploring novel approaches to hypertension management among rural seniors.

The idea that telehealth technologies can support hypertension management lies in research showing that home-based telemonitoring can improve quality of life and functional status in patients with chronic illness.[24] A recent trial[25] showed promising results for older adults in a study of a home-based automated blood pressure cuff and telephony system backed by nurses. In that study 54 percent of older patients received a change to or an additional prescription for blood pressure medication by nurses longitudinally tracking blood pressure readings; 87.5 percent of those in the program had systolic blood pressure readings within target ranges and 96.8 percent were in compliance with diastolic blood pressure target ranges. Based on these studies, we conducted a systematic review of the literature on the impact of blood pressure (BP) telemonitoring on BP control and other outcomes in telemonitoring studies targeting patients with hypertension as a primary diagnosis. We found that BP telemonitoring resulted in reduction of BP in 13 of 15 studies meeting review criteria. Systolic BP declined by 3.9 to 13.0mm Hg and diastolic BP declined by 2.0 to 8.0mm Hg across the studies. These magnitudes of effect were comparable to those observed in efficacy trials of some antihypertensive drugs. Compliance with BP telemonitoring among patients was favorable, but compliance among participating healthcare providers was not well-documented.[26] The TEAhM pilot study extends previous work on community-based telemonitoring of hypertension and specifically addresses implementation of this technology in senior centers.[27]

Target Organizational Setting

The Administration on Aging's (AoA) Elderly Nutrition Program provides grants to support nutrition services to older people throughout the country. The Elderly Nutrition Program, authorized under Title III, Grants for State and Community Programs on Aging, is intended to improve the dietary intakes of participants and to offer participants opportunities to form new friendships and to create informal support networks. The legislative intent of these centers is to make community-based services available to older adults who may be at risk of losing their independence. Community-based technologies that assist in enhancing chronic care management share the same goal. Thus, the potential for synergy between these systems and approaches to community-based, person-focused wellness is obvious.

The Elderly Nutrition Program provides for congregate and home-delivered meals. These meals and other nutrition services are provided in a variety of group settings, such as senior centers, faith-based settings and schools. These meals are also delivered to older adults who are

homebound. The Elderly Nutrition Program's 3 million participants are receiving an estimated 40 to 50 percent of required nutrients from meals provided by the program.

The potential for scaling-up of a successful telehealth program in the senior center setting is substantial: There is a network of approximately 4,000 Title III nutrition centers across the nation. Supplementing this vast, Federally-supported network is an even larger network of privately-funded centers providing similar community-based nutrition and support services. In collaboration with local primary care physicians, these centers have the potential to form the backbone of a novel telehealth network promoting community-based chronic care management that could be regional or national in scope. The costs and other considerations associated with this "scale up" are also addressed in this project and are discussed later in the report.

Use of Existing Senior Center Infrastructure

Because the goal of TEAhM was to translate research findings on the benefits of telehealth into practice, success of this project was, by definition, predicated on successful utilization of existing staff and resources at participating senior centers. It was therefore necessary to think carefully about how hypertension screening and intervention programs could be incorporated into routine activities in this setting, which types of staff would be engaged in specific study activities and how the overall program could be structured in order to maximize the possibility of rolling out a larger demonstration project in the future should the preliminary data prove promising. To this end, we identified several key staff in the senior centers who would be critical not only for the success of the proposed project, but also for the success of future efforts based on the model tested in the current project. Accordingly, we worked in collaboration with the leadership at each center to secure access to, and participation of, key staff at each site.

A strength of TEAhM was that study activities did not represent a major departure from routine job-related activities for key staff. Indeed, many senior centers provide health education and supplementary programs related to common chronic conditions including hypertension, a fact that made the telehealth intervention consistent with the broader mission of these organizations. Senior center staff at all four sites identified space for recruitment activities. Staff at the two intervention centers identified space for installation of the telehealth kiosks, promoted the study, encouraged potential participants to be screened for enrollment, and acted as meaningful points of contact to study nurses throughout the project period. Although research activities such as assisting with recruitment of seniors did represent additional tasks for center staff, this time was minimal and represented only a slight departure from their current scope of work. Nevertheless, WSU nurse-researchers worked with senior center staff throughout the project period to ensure that project objectives were met, problems addressed quickly and that the burden of study-related activities were minimized to the greatest degree possible.

Intervention Design

Equipment Installation and Testing

Technology Requirements

The telehealth intervention used in this project had specific requirements. Most of the technology (listed below) was provided by the vendor. The only technical requirement on the part of the senior centers was reliable Internet service. The issue of reliable internet service is discussed at length later in this report.

Health Station Components for Each Senior Center included the following:

- 1 Wireless peripheral blood pressure device set
- 1 Card Reader
- 1 Touch Screen Monitor
- 1 Personal Computer
- 1 Printer
- 2 Speakers
- Audio Video Cabling
- Bluetooth Adapter

Adaptation of Telehealth Tools

BP monitoring stations were installed in two senior centers (Urbana and Logan) in West Central Ohio. Data from these stations were streamed to a secure central server managed by the telehealth vendor. This information was monitored by WSU nurse-researchers. The telehealth vendor worked with the study team to adapt the technology in a number of key ways to suit the specific needs of this project. For instance, the vendor worked with the team to modify screens and prompts to allow a focus on hypertension measurements; certain questionnaires that are relevant only to the intervention group were “built into” the system and exporting of blood pressure and questionnaire data from the vendor’s server to LeadingAge was conducted on a monthly basis. The specifics of these modifications are discussed further below. The vendor participated actively in bi-weekly phone calls with the study investigators and field staff.

Preparatory Activities

Recruitment of Senior Centers

Our team identified four senior centers in rural Ohio to serve as field centers for this project. Criteria for selection of these centers included provision of onsite meals at least once per week, willingness to permit onsite installation of telehealth equipment, willingness to have a staff member trained in turning the equipment on/off and rebooting the computer and assist seniors in using the kiosks if necessary, willingness to permit study staff to visit on a regular basis to engage in study activities, adequate space to accommodate the kiosk, high speed Internet access, location in rural, underserved areas, and estimated service provision to a sufficient number of seniors to meet recruitment targets. In addition, we looked for demonstration of strong, stable leadership, commitment to this research program, and the availability of key staff whose current roles permit involvement in the project. The rationale for these considerations was straightforward: Finite resources required our team to identify centers with relatively large client bases in order to achieve the desired recruitment goals within budget. Strong leadership at participating centers was critical to ensure that all staff and clients were fully aware of, and invested in the project prior to recruitment.

A project of this kind can fall short of its goals if local leadership at participating senior centers is lacking. Thus, we spent a great deal of time discussing the project with center directors and assessing the readiness of the center leadership to embrace the project. It was important to assess the extent to which these facilities were committed to engaging in the research enterprise and to be mindful of the that doing research in a “real world” setting requires consideration of factors such as staff time, scarce resources, the need to place service provision first above all research activities, availability of reliable Internet connectivity, etc. We identified only those facilities that understood the value of research in the context of continued service provision and selected from among this group. Indeed, the cooperation of center leadership proved indispensible as we were recruiting participants and troubleshooting the technology.

Training

Training activities were organized into four steps:

1. Installation of telehealth equipment and training of WSU, LeadingAge, and senior center staff on equipment.
2. Training of WSU staff on study protocol, data collection forms, use of the study database and delivery of data to LeadingAge.
3. Training by WSU staff of nurse-researchers on the study protocol and data collection.
4. Training of intervention participants on use of the telehealth equipment.

A training checklist was developed to track the training that study staff completed. This checklist, along with a minimum amount of training had to be completed prior to the receipt of a staff identification (ID) number. This ID number was required before a staff person conducted any data collection.

The telehealth vendor provided a Telecare Coordination Specialist who conducted onsite installation and training for study staff at each senior center. During this training visit, LeadingAge and WSU staff were trained on use of the equipment, accessing the website and on security measures to protect participant data. Prior to the in-person training, a Webinar was conducted for LeadingAge and WSU staff to provide a working knowledge of the technology in a manner that prepared staff for the in-person training. User and training manuals were provided by the vendor. Additional materials included PowerPoint presentations and how-to reference guides. The vendor provided User Manuals and Quick Reference Guides in printed form, via email, as well as in CD format. The training manuals consisted of modules or chapters that could be inserted or omitted as required based on the specifications of the project.

Prior to the first step of training (training on the telehealth equipment), it was necessary to have detailed discussions with the vendor regarding customization of the telehealth software. These discussions took place during bi-weekly conference calls that were attended by all study staff. The majority of these discussions involved how the screens would appear to the participant, how the system would detect “missing visits” and how out of range blood pressure data would be delivered to WSU staff. Thus, there was a mix of operational, scientific and clinical discussions that have been implemented into a customized set of screens for this project. Regular, collaborative discussions among researchers, clinical personnel, senior center staff and the telehealth vendor proved to be a critically important feature of the overall success of this project.

Prior to the second step of training (training on study protocol), another set of detailed discussions between LeadingAge, WSU, and the vendor occurred to finalize the protocol, study forms, and data collection processes. The training itself was conducted by LeadingAge for WSU researchers. Because of the extensive level of preparation and communications leading to this point, the only aspect of the training that was new to the WSU team was the study data entry tool. This tool was developed at LeadingAge for use at WSU. The remaining part of the study protocol and data collection training was a review because the WSU team helped to develop both the protocol and the data collection forms. A Manual of Procedures (MOP) was written and the details of the protocol were reviewed as part of this training. Training binders were produced that included the MOP, data collection forms, informed consent forms, study tools (such as recruitment material and training checklists), data entry manual, and the vendor’s equipment manuals. Extra training binders were made to assist with the third step in training.

The third step of training (training of nurse researchers on study protocol, data collection, and telehealth equipment) was conducted by the WSU team for each of the nurses that were hired to recruit and enroll participants and collect data. Training sessions concerning human subject protection and orientation about the study and the MOP were conducted at Wright State University. Following this session, the nurses completed the NIH Human Subjects Protection Training. The nurse researchers were then ready to complete the onsite trainings for the field work. Training for the control site nurses began when the nurses were introduced to the protocol and procedures during a two-hour training. At the control sites, nurses were introduced to the center staff, instructed on the set up of the screening and consenting area, provided with the needed supplies, and reviewed the steps and the forms to be used for data collection. The control site staff was then ready to consent and recruit participants.

Use of the automatic blood pressure device for baseline blood pressure readings was demonstrated and control site nurses practiced and demonstrated their skills for staff. Training for intervention site nurses was similar, except that in addition to the activities described above, intervention site nurses received instruction on the two-step process involved in consenting and enrolling participants and in use of the telehealth blood pressure device. It later became evident that some aspects of intervention site training were inadequate because certain elements of the protocol were either missed or misunderstood by some staff. For example, staff conducting baseline data collection at the two intervention sites did not understand that blood pressures taken for the Baseline Health Form were to be collected manually instead of by using the BP monitoring station. Fortunately, issues with training of the research nurses were discovered early which permitted retraining of all research nurses before further recruitment took place.

The fourth step of training (training of participants on use of the telehealth equipment) was conducted by the nurse researchers. This was the most critical step of the training because it established participants' understanding of how to use the technology. Participant training was conducted by nurse researchers on an individual basis, with sessions generally lasting between 30 and 60 minutes. These telehealth training sessions consisted of the nurse researchers demonstrating use of the telehealth device and then letting the participants perform the procedures themselves. Evaluation of the effectiveness of the intervention is partly an evaluation of the effectiveness of this training, and of self-reported data on participants' level of comfort with the technology. These and other data are summarized at the end of this report.

Implementation

Study Design

TEAhM is a pilot study whose goals were to (1) collect preliminary data on the logistics and operational considerations associated with implementing nurse-monitored telehealth kiosks in community-based senior centers and (2) conduct a preliminary comparison of blood pressures among hypertensive seniors who used the kiosk for 10 months and those who did not. The fundamental design features of this project involved recruitment of four senior centers, two of which provided participants for the intervention (telelhealth) group with the other two centers providing participants for the control group.

Participant Screening, Enrollment and Retention

TEAhM's goal was to enroll 144 (72 in each group) older adults with hypertension. Individuals were recruited from the client base of four senior centers. This sample size was selected to provide robust estimates of the parameters of interest and also to provide information on key operational aspects of the project that relate to feasibility and future potential for a larger roll-out of the intervention.

Recruitment of participants occurred primarily by direct interaction between WSU staff, senior center staff and potential study participants. Posters and fliers were placed in the centers with permission of center leadership, and specific enrolment days were defined during which WSU staff will conduct consenting and enrollment activities. Participating centers advertised the project via flyers and by word of mouth for several weeks preceding posted recruitment days. On screening/enrolment days, WSU nurse researchers were onsite at the centers to screen and enroll participants.

Participant inclusion criteria—

1. Adults ≥55 years
2. Self-reported, physician-diagnosed hypertension
3. Current use of nutrition center resources ≥1 time/week
4. Clinically stable with oral therapy
5. Have identified primary care physician
6. Willingness to give permission for nurses and primary care physicians to interact (intervention group only)

Participant Exclusion criteria—

1. Age < 55 years
2. Self-reported dialysis or renal failure
3. Cognitive impairment as evaluated by study staff
4. Failure to provide consent
5. Failure to meet all inclusion criteria

As noted above, enrolment of participants into the telemonitoring group was lower than expected. This led to additional recruitment efforts in the two telemonitoring centers. These activities involved additional on-site trips by the WSU nurse researchers to meet with any available senior center clients. A great deal of coordination between center staff and nurse researchers allowed these visits to coincided with ongoing center activities. To boost the enrolment, we changed the key days WSU nurse researchers were present to capture new groups, asked that announcements be made at lunch, tried to be present for large special events, and worked with site directors to make clients aware of the study. These efforts helped in recruiting more participants to reach our final number, which still fell short of the desired target.

It was important to retain study participants once they were enrolled. Our team employed a number of strategies to minimize attrition. First, staff generated a friendly, productive rapport with participants. Relationships between WSU nursing staff and participants build on existing relationships between participants and senior center staff. The WSU researchers' visits to the centers and the phone calls to participants to carry out physicians' protocols when necessary help to strengthen this relationship. Second, the serial measures that were taken as part of the protocol require the participants to attend visit the center on a regular basis. These regular contacts were already in place for many study participants, a factor that served to introduce little additional burden on them, and to enhance the experience of center visits. The frequent contact with study staff as well as ongoing use of study equipment served to keep participants actively engaged in the research project, thereby minimizing attrition and loss to followup.

Our group recognized that some participants were of low socioeconomic status, a consideration that raised the possibility that financial incentives could be coercive. In thinking about this issue, our group decided to utilize grocery cards as a non-cash, nutrition-related incentive for all participants. Accordingly, at the time of screening ($10 for all screened participants) and every three months thereafter ($20 for all enrolled participants who met minimum adherence criteria after baseline) study staff distributed grocery cards as an expression of gratitude for participation in the study and as an incentive for continued participation. At the start of the study, these cards were distributed by senior center staff, but the process for distributing the cards changed for a number of reasons: (1) Site directors expressed uneasiness at monitoring disbursement of the cards; (2) site directors described uneasiness regarding security and storage of the cards; and (3) closer monitoring of the dates that participants received their cards was needed, something that required the time of a paid study staff person. For these reasons, the cards were distributed by one of the research nurses via USPS Certified Mail. There were several misunderstandings regarding the minimum adherence criteria that resulted in most the $20 gift cards being distributed regardless of the participants' adherence level.

Physician Engagement

The project protocol required staff to obtain a BP referral protocol from the primary care physician (PCP) of each participant who enrolled in the intervention group. This protocol was used in conjunction with BP data collected from the kiosk to determine if the study nurses needed to contact participants for further action as a result of readings that were outside prescribed ranges. Securing access to participants' PCPs to obtain these protocols proved to be very difficult. After receiving permission from eligible participants, project staff made repeated calls to physicians'

offices to discuss the project and to ask for referral protocols. It was common for office managers or nurses to take messages from project staff, and to act as the main point of contact for the physicians. However, PCPs (or someone in their office) provided a BP referral protocol for all enrolled participants. The issue of physician engagement and communication with physicians resurfaced at the end of the project when we conducted the postproject physician survey, which is discussed below.

Data Collection and Transfer

Several distinct types of data were collected in this project:

- Participant interviews conducted by study staff and collected on paper forms.
- Blood pressure and related data collected via the kiosk and stored on a central server administered by the telehealth vendor.
- Postproject surveys that were mailed to primary care physicians.
- Postproject structured interviews conducted with intervention site directors.

Each of these types of data is described below, and a data collection timeline that summarizes when the information was collected is summarized in Table 1. For example, the Background Health form was administered in person at the baseline exam, the Followup form was administered by telephone in months 2, 4, 6, and 8 and blood pressure measurements were collected via the kiosk throughout the study among intervention participants.

Table 1. TEAhM data collection format and schedule in months

Questionnaire	In-person	Telephone	Kiosk	Screen	Baseline	1	2	3	4	5	6	7	8	9	10
Consent	x			x											
Inclusion/exclusion	x			x											
Demographic/Technology	x				x										
Background Health	x				x										
Kiosk Baseline*	x				x										
Kiosk End*	x														x
Follow up		x					x		x		x		x		
Final Follow up	x														x
Blood pressures*			x			x	x	x	x	x	x	x	x	x	x
Missed Contact†		x													
Withdrawal†															
Non-compliance*†		x													
Referral*†		x													

*Indicates form is done only in intervention group

†Indicates "as needed"

Table 1 caption: The purpose of Table 1 is to show format (in-person, telephone, or kiosk-based) and schedule (screening, baseline, and/or month of followup) of the various data collection pieces.

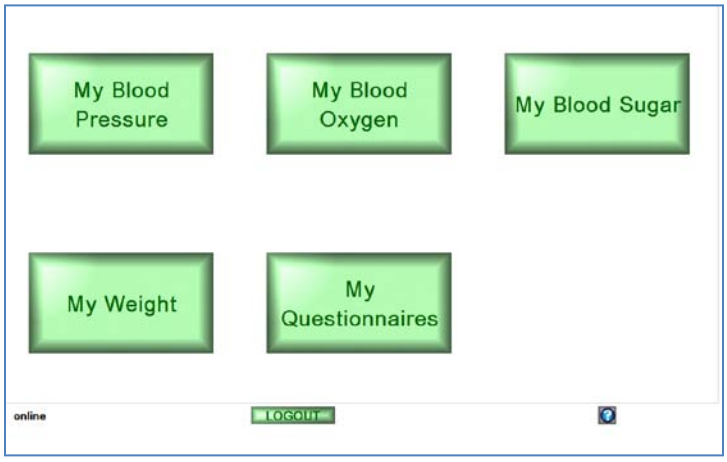
Participant Interviews and Interim Contacts

In-person interviews were conducted for all participants at baseline and at the end of the study. In-person blood pressures for both groups were also collected at this time. The initial in-person interview consisted of the screening and enrollment process, and for eligible participants, additional data collection forms detailing health histories and experience with technology. Interim contacts were made every two months during which endpoints of interest were ascertained. The close-out interviews and blood pressure measurements were conducted in a similar manner. Interview data were collected on paper forms and later entered into the study database. This database was maintained at WSU, and delivered on a monthly basis to LeadingAge where these data were merged with blood pressure data from the telehealth vendor into a single study database.

Kiosk-Based Data

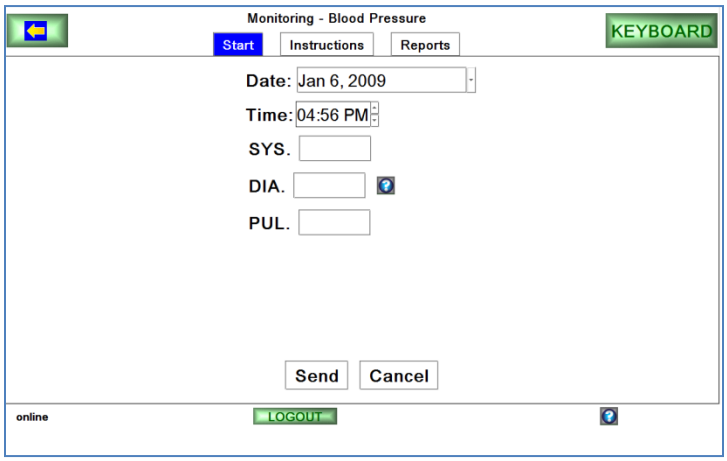
Once enrolled in the study, participants signed in with senior center staff to initiate a record and obtain their personal telehealth card. The participant could go at any time to the kiosk and insert their card into the card reader. The main screen appeared with the client's name. This screen showed the "Vital Sign" buttons as set up in the Healthcare Professional Web-Portal (shown below). From this screen, the participant selected the blood pressure option by touching the screen.

Figure 1. Kiosk main menu



This allowed the participant to enter the Monitoring Screen for the vital sign selected, e.g., "Blood Pressure" (shown below).

Figure 2. Blood pressure monitoring screen



While in the Vital Sign Monitoring Screen, the participant took his/her blood pressure measurement using a Bluetooth wireless peripheral blood pressure monitor. The reading appeared on the monitoring screen and was sent in real-time to the Healthcare Professional Web-Portal and was immediately stored in the participant's personal Health Data Record. The "Send" button was used to manually send readings to the web-portal. If a high reading was noted, the participant selected the "Questionnaire" button to fill out self-reported interim data instruments that were customized by the telehealth vendor for this project. Kiosk-based data were delivered monthly from the telehealth vendor to LeadingAge for merging in the main project data base.

Primary Care Physician Survey

At the conclusion of data collection, a mailed survey was sent to the 30 primary care physicians who provided BP referral protocols for the participants in the intervention arm of the study. These mailed surveys were preceded by a letter explaining the purpose of the survey and a timeline for mailing of the survey. A protocol was followed in which survey responses were tracked, and repeat mailings and telephone followups were made to non-responding physicians. Physicians were provided with stamped envelopes that they could use to return the anonymous surveys to LeadingAge. After completion of the PCP protocol, 11 of the 30 physicians had returned the survey. The survey data were entered into a spreadsheet and are summarized in the *Outcomes* section of this report. A copy of the survey instrument can be found in Appendix A.

Senior Center Director Survey

At the conclusion of data collection, the senior centers that participated in the kiosk intervention were asked to engage in a close-out interview in which various issues related to acceptability of the intervention, barriers and facilitators of the intervention and other issues were discussed, and for which feedback was sought. This qualitative information was synthesized and is presented below. A copy of this structured interview can be found in Appendix B.

Data System Development and Use

LeadingAge designed, tested and deployed the data system used in TEAhM. The system provided the ability for research staff to input data directly from paper forms and to harmonize those data with information that was exported from the telehealth vendor's central server. The data system allowed users to make changes that were tracked in the system and queried as necessary. The application supported data collection from the time of participant screening through the final followup visit. The system permitted addition of records, a method to enroll participants, edit forms, delete forms, view an inventory of forms, and view a visit schedule for all participants. LeadingAge developed a training module and a data system user's manual to accompany the study data system to ensure flexibility in staffing of this aspect of the study.

Study Documentation

LeadingAge developed and maintained two primary pieces of research documentation for the project, a Manual of Procedures (MOP) and a data system user's guide.

Manual of Procedures (MOP)

The MOP describes the study protocol in enough detail that other scientists would be able to replicate the study. The MOP describes how each procedure or measurement was conducted and details additional information such as scripts. Another important aspect of the MOP is a description of how protocol deviations are handled. This portion of the MOP provides approaches for avoiding errors, a method for documenting errors, informing study personnel, and methods to account for the errors in interpreting results.

Data System User's Manual

The data system User's Manual was written as a training tool and reference guide for data entry personnel and other personnel who are authorized to use the data system. This manual describes how to access the data system, add and edit data, and how quality control checks in the data system function.

LeadingAge was responsible for maintaining study documentation and archiving old versions as newer versions evolve during the life of the study. A comprehensive version 1.0 of the MOP was in place before any participants were enrolled and any data were collected. Study documents were considered dynamic throughout the life of the study. Master copies of these documents were kept at LeadingAge and for version control purposes, any edits to these documents were conducted through LeadingAge. The version of each document was labeled with each new release. LeadingAge maintained a study file to store hard copies of this documentation. Additionally, all study memos were cc'd to the study file to ensure that all study documentation was preserved.

Nurse-Monitoring

Participants were asked to provide information that allowed study nurses to apply physicians' recommended referral protocols and contact their primary care physician as part of the study. As part of this process, BP data from intervention sites was streamed to the telehealth vendor's central server where they were accessed by study nurses and LeadingAge staff. These data were monitored daily during the study period and physician recommended interventions as well as referrals were made for a primary care visit based on predetermined intervention protocols and referral criteria provided by participants' primary care physicians at the beginning of the study. BP was monitored in the intervention arm of the study according to the following general approach:

- Monitored blood pressure among participants with previous diagnosis of hypertension defined as systolic blood pressure >140 and diastolic blood pressure >90.
- Obtained current treatment upon enrollment into the study and updated regularly by asking participants of any changes that have been made.
- Intervention protocols and referral criteria/alerts entered into individual participant health record.
- Any blood pressure reading that exceeded the physician's referral threshold generated a flag that alerted the nurse responsible for monitoring data.
- Once notified of the high BP reading, the nurse evaluated the reading within the context of the patient's protocol and recent blood pressure trends.
- Nurse researchers then provided nursing interventions as needed, per criteria defined for individual participants by their primary care physicians. The participant's treatment protocol could involve any of the following: contacting the participant's physician; adjusting medication dosages; dietary changes; changes in activity level; scheduling an appointment with the participant's physician, or referral to an emergency treatment center.
- Co-morbidities in each participant's case were handled per participant's physician protocol.

Project Outcomes

Senior Center Engagement

All four senior centers involved in this project were eager participants. The most relevant information regarding the potential for larger roll-out of this approach to community-based telehealth lies with the intervention centers. The two center directors were both eager to have their centers involved in this project—these impressions came both from WSU staff who engaged with the centers at the beginning of the project and from LeadingAge staff that conducted the close-out interviews at the end of the project. Center directors reported taking the project opportunity to their boards of directors to solicit support, and both also felt that the goals of this project were highly consistent with their centers' missions. Neither center had been part of a research study in the past. Nevertheless, one of the directors clearly articulated the potential she felt for telehealth to "…help seniors take control of their health and stay independent longer in the community." The center directors felt that the telehealth project fit nicely into a mix of ongoing activities, and that it offered a valuable service to their clients.

Table 2. Enrollment by senior center

Facility Name	Participants	Study Arm
Miamisburg Senior Adult Center	42	Control
Urbana-Champaign County Senior Center	16	Intervention
Spring Valley Senior Center	30	Control
Logan County Friendly Senior Center	25	Intervention

Table 2 caption: The purpose of table 2 is to list the senior centers, their roll in the study, and the number of participants enrolled.

Center directors promoted the project in their newsletters, with their Area Agency on Aging, and one of the directors arranged for an article to be written about the project in the local newspaper. These efforts were directed at keeping the community informed of the center's activities and communicating value to local seniors. Center directors reported that they felt that the training provided by the project was adequate for the purposes of the project, and that project staff were available when issues or questions came up. Further, both center directors reported that the device was easy to use, and one reported that it was much easier to use than she anticipated. One of the center directors was emphatic about her belief that these technologies were "the way of the future" and that senior centers needed to be prepared for the changing demands of their clients as seniors who are currently "aging-in" become more tech-savvy. In this regard, the director highlighted the changing needs and expectations of the coming wave of baby boomers that will constitute senior centers' client bases in the future.

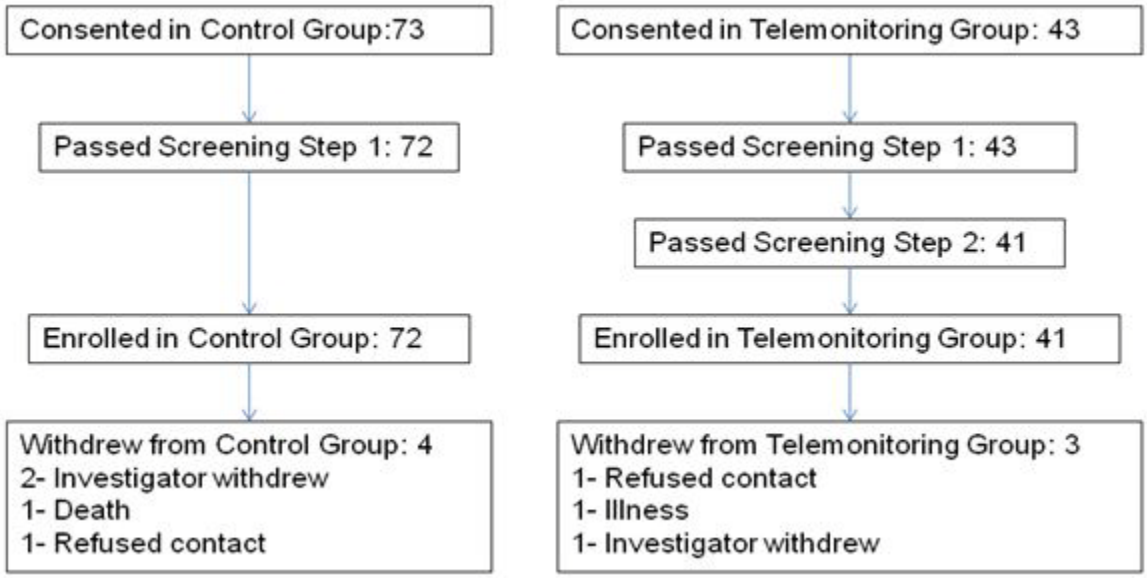
Both center directors were impressed by the ability of the project to be on "auto pilot" most of the time and they were gratified to be able to provide a health-related service with direct relevance to their clients without the need to have clinical personnel onsite. Both center directors felt that their clients were highly invested in the project, and it was also the case at both centers that center staff people were also eligible for the study and enrolled themselves as active participants. The added legitimacy that staff provided as active participants underscored the value of the project to other participants.

Participant Enrollment

As noted above, TEAhM's goal was to enroll 144 (72 in each group) older adults with existing hypertension from four senior centers. Participant enrollment by senior center and study arm is shown in Table 2. We had more difficulty recruiting participants than anticipated, particularly at the intervention centers. The first challenge was that there were fewer people with hypertension at the intervention centers than we anticipated—thus, the difficulty in enrollment was related more to the low prevalence of hypertension at these centers than to unwillingness on the part of hypertensive individuals to participate in the study. Indeed, enrollment was very high among screened persons overall. A second challenge was that there were fewer unique individuals using the senior centers than anticipated. While each of the centers had an active schedule with strong participation in many of their events, it was often the case that the same people attended multiple events, a pattern that yielded fewer unique individuals with hypertension. The study team spent extra time scheduling research staff time at various events at the centers only to find that the people attending these events were the same people who attended previous recruitment events.

We reached our goal of 72 participants in the control group. The Spring Valley control group center yielded fewer participants than we planned, but we were able to make up for that in the Miamisburg control group center. We were only able to recruit 41 of our target 72 participants from the intervention group centers. While the reduced sample size in the intervention group was a disappointment, we did not design the study to conduct hypothesis testing. Thus, the smaller sample size did not prevent us from achieving our primary study aims. The figure below details the flow of participants through the study, from the point of screening for eligibility to study end.

Figure 3. Participant flow chart



Participant Data Summary

We have baseline data on 112 of our 113 participants. Tables 3-5 show baseline characteristics by study intervention group. The most surprising finding from baseline was that almost 85 percent of participants reported previous use of an automatic BP machine and 43 percent of those reported using one at least 100 times. The control group was slightly older and has higher blood pressures, but lower BMI than the intervention group. These difference need to be considered when looking at any clinical outcomes between groups. It should be noted that the approach for taking blood pressure measurements was different between the two groups at baseline. In the control group, nurses used the automatic cuff alone to take the measurements while in the telemonitoring group, nurses used the same automatic cuff hooked up to the telehealth station.

Table 3. Demographic characteristics of older hypertensive adults enrolled in the TEAhM study

Characteristic	All	Telemonitoring	Control
N	112	40	72
Mean age (years; (SD))	74.1 (8.3)	71.2 (7.8)	75.8 (8.3)
Gender (% male)	25.9	27.5	25.0
Race/ethnicity (%)[a]: White	98.2	97.5	98.6
Marital Status (%): Married	49.1	45.0	51.4
Marital Status (%): Widowed	37.5	35.0	38.9
Marital Status (%): Divorced	9.8	15.0	6.9
Marital Status (%): Never Married	3.6	5.0	2.8
Education (%): < High School	8.9	7.5	9.7
Education (%): High School Graduate	39.3	37.5	40.3
Education (%): Some College	29.5	30.0	29.2
Education (%): College Graduate	22.3	25.0	20.8
% of people who live alone	42.0	47.5	38.9
Currently Employed (% yes)	13.4	22.5	8.3
Mean Hours Worked per Week (SD)[b]	24.7 (17.2)	31.1 (18.1)	15.0 (10.8)
Annual Income: <10K	5.7	2.7	7.5
Annual Income: $10,000-$20,000	22.1	27.0	19.4
Annual Income: $20,001-$30,000	26.9	21.6	29.9
Annual Income: $30,001-$40,000	19.2	29.7	13.4
Annual Income: $40,001-$50,000	16.4	8.1	20.9
Annual Income: >$50,000	9.6	10.8	9.0

[a] Participant could identify more than one race/ethnicity group.
[b] Asked only of participants who reported being currently employed for wages.
Table 3 caption: The purpose of table 3 is to show some of the demographic characteristics of participants overall and for each of the two groups separately.

Table 4. Baseline health characteristics of older hypertensive adults enrolled in the TEAhM study

Characteristic	All	Tele monitoring	Control
N	112	40	72
Self-Rated Health (%): Excellent	6.3	7.5	5.6
Self-Rated Health (%): Very Good	31.3	17.5	38.9
Self-Rated Health (%): Good	50.0	57.5	45.8
Self-Rated Health (%): Fair	11.6	17.5	8.3
Self-Rated Health (%): Poor	0.9	0.0	1.4

Characteristic	All	Tele monitoring	Control
Self-Reported Chronic Conditions (%): CHD	20.5	22.5	19.4
Self-Reported Chronic Conditions (%): MI	14.4	20.0	11.3
Self-Reported Chronic Conditions (%): Stroke	12.5	15.0	11.1
Self-Reported Chronic Conditions (%): Lung Disease	15.3	20.0	12.7
Self-Reported Chronic Conditions (%): Arthritis	77.7	75.0	79.2
Self-Reported Chronic Conditions (%): Diabetes (including borderline)	25.2	25.0	25.4
Covered by Health Insurance (% yes)	100	100	100
What kind of Insurance (%)[a]: Private	46.4	55.0	41.7
What kind of Insurance (%)[a]: Medicare	83.9	85.0	83.3
What kind of Insurance (%)[a]: Medicaid	4.5	5.0	4.2
What kind of Insurance (%)[a]: Military	3.6	5.0	2.8
What kind of Insurance (%)[a]: Other	38.4	47.5	33.3
Does Health Plan Cover Prescriptions (% yes) [a]	96.4	92.5	98.6
In Past 12 Months, Any Time No Insurance? (% yes) [a]	1.8	2.5	1.4
Usual Place for Health Care? (% yes)	99.1	100	98.6
What Kind of Place for Health Care? (%)[b]: Clinic	2.7	2.5	2.8
What Kind of Place for Health Care? (%)[b]: Doctor's office or HMO	97.3	97.5	97.2
Mean Number Doctor Visits in Last 12 Mos (SD)	5.5 (5.4)	5.6 (4.7)	5.5 (5.8)
How Long Since Last Seen Doctor (%) <=6 mos	94.6	92.5	95.8
How Long Since Last Seen Doctor (%) 6 mos to <1 year	3.6	5.0	2.8
How Long Since Last Seen Doctor (%) 1 year to <3 years	1.8	2.5	1.4
Hospitalizations in Past Year (%) 0	83.9	90.0	80.6
Hospitalizations in Past Year (%) 1	12.5	7.5	15.3
Hospitalizations in Past Year (%) >=2	3.6	2.5	4.2
Mean Hospitalizations due to Blood Pressure (SD)[c]	0	0	0
ER Visits in Past Year (%): 0	81.3	82.5	80.6
ER Visits in Past Year (%): 1	17.0	17.5	16.7
ER Visits in Past Year (%): >=2	1.8	0	2.8
Mean Age at Hypertension Diagnosis (years; (SD))	58.0 (13.8)	53.8 (14.0)	60.3 (13.3)
Smoked >100 Cigarettes in Lifetime? (% yes)	40.5	47.5	36.6
Current Smoker? (% yes)[d]	5.9	6.9	5.1
Currently Drink Alcohol? (% yes)	29.5	37.5	25.0
Mean Drinks in Typical Week? (SD)[e]	1.6 (1.2)	1.4 (0.5)	1.7 (1.5)
Ever Been Told to Reduce Fat Intake? (% yes)	72.3	65.0	76.4
Currently Following this Advice? (yes)[f]	81.5	73.1	85.5
Ever Been Told to Lose Weight? (% yes)	46.9	61.5	38.9
Currently Following this Advice? (%yes)[g]	71.2	58.3	82.1
Ever Been Told to Increase Exercise? (% yes)	64.3	65.0	63.9
Currently Following this Advice? (% yes)[h]	70.8	73.1	69.6
Blood Pressure Ever Measured at This Center? (% yes)	58.9	60.0	58.3
Prescribed Blood Pressure Medication (% yes)	98.8	97.6	98.6
Satisfaction with Current Health Care Team (%): Very Satisfied	52.7	30.0	65.3
Satisfaction with Current Health Care Team (%): Satisfied	41.1	55.0	33.3
Satisfaction with Current Health Care Team (%): Neither	5.4	12.5	1.4
Satisfaction with Current Health Care Team (%): Dissatisfied	0.9	2.5	0
Satisfaction with Current Health Care Team (%): Very Dissatisfied	0	0	0

Characteristic	All	Tele monitoring	Control
Level of Understanding of BP Control (%): Excellent	46.0	30.8	54.2
Level of Understanding of BP Control (%): Very Good	36.0	35.9	36.1
Level of Understanding of BP Control (%): Good	16.2	28.2	9.7
Level of Understanding of BP Control (%): Fair	0.9	2.6	0
Level of Understanding of BP Control (%): Poor	0.9	2.6	0
Mean First BP Measurement (mmHg; (SD)) [i]: Systolic	137 (21.7)	132.4 (22.4)	140.4 (20.9)
Mean First BP Measurement (mmHg; (SD)) [i]: Diastolic	78.8 (11.8)	75.8 (11.7)	80.5 (11.6)
Mean Second BP Measurement (mHg; (SD)) [i]: Systolic	135.3 (21.2)	131.0 (21.0)	137.7 (21.1)
Mean Second BP Measurement (mHg; (SD)) [i]: Diastolic	77.7 (11.1)	76.3 (12.0)	78.5 (10.5)
First BP < 140/90 (%)[i]	58.9	75.0	50.0
Second BP < 140/90 (%)[i]	58.0	70.0	51.4
Mean BMI (kg/m^2; (SD))[j]	30.5 (5.6)	32.8 (6.3)	29.2 (4.7)

[a] Asked only of participants who reported being covered by health insurance. Participants could specify up to 3 types of insurance.
[b] Asked only of participants who reported a usual place for health care.
[c] Asked only of participants who reported being hospitalized in the last year.
[d] Asked only of participants who reported smoking >100 cigarettes in their lifetime.
[e] Asked only of participants who reported being current drinkers.
[f] Asked only of participants who reported having been told to reduce fat/cholesterol.
[g] Asked only of participants who reported having been told to lose weight.
[h] Asked only of participants who reported having been told to increase exercise.
[i] Intervention group's baseline blood pressures taken by automated device; control group taken by traditional method.
[j] Calculated from self-reported height and weight.
Table 4 caption: The purpose of Table 4 is to show some of the baseline health characteristics for study participants overall and for each of the two groups separately.

Table 5. Baseline experience and comfort with technology among older hypertensive adults enrolled in the TEAhM study

Characteristic	All	Tele monitoring	Control
N	112	40	72
Ever Owned Home Computer (% yes)	64.3	75.0	58.3
Currently Own Home Computer (% yes)[a]	94.4	93.3	95.2
Comfort Level with Home Computer (%)[b]: Very comfortable	38.8	29.6	45.0
Comfort Level with Home Computer (%)[b]: Somewhat Comfortable	41.8	59.6	30.0
Comfort Level with Home Computer (%)[b]: Somewhat Uncomfortable	3.0	0.0	5.0
Comfort Level with Home Computer (%)[b]: Very Uncomfortable	16.4	11.1	20.0
Ever Owned Cellular Phone (% yes)	84.7	90.0	81.7
Currently Own Cellular Phone (% yes)[c]	89.4	88.9	89.7
Comfort Level with Cellular Phone (%)[d]: Very comfortable	63.1	50.0	71.2
Comfort Level with Cellular Phone (%)[d]: Somewhat Comfortable	26.2	34.4	21.2
Comfort Level with Cellular Phone (%)[d]: Somewhat Uncomfortable	8.3	9.4	7.7
Comfort Level with Cellular Phone (%)[d]: Very Uncomfortable	2.4	6.3	0.0
Ever used BP device? (%yes)	83.9	85.0	83.3
Used BP device at least 100 times (% yes)[e]	42.5	33.3	47.4
Comfort Level Using BP Device [e]: Very comfortable	79.8	73.5	83.3
Comfort Level Using BP Device [e]:Somewhat Comfortable	18.1	23.5	15.0
Comfort Level Using BP Device [e]: Somewhat Uncomfortable	1.1	0.0	1.7
Comfort Level Using BP Device [e]: Very Uncomfortable	1.1	2.9	0.0

[a] Asked only of participants who reported having ever owned a home computer
[b] Asked only of participants who reported currently owning a home computer
[c] Asked only of participants who reported having ever owned a cellular phone
[d] Asked only of participants who reported currently owning a cellular phone
[e] Asked only of participants who reported having used an automatic blood pressure cuff outside of a doctor's office visit.
Table 5 caption: The purpose of Table 5 is to show some baseline experience and comfort with technology levels for study participants overall and for each of the two groups separately.

Forty-one telemonitoring participants and 71 control participants had at least one followup contact completed during the 10 months of followup. Table 10 shows incidence rates and average number of events for various outcomes by group. Incidence rates are cumulative over the entire study period. Blood pressures at 10 months are also shown. Mean blood pressure scores were lower and percent with controlled blood pressure were higher among participants in the telemonitoring group relative to the control group.

Table 6. Health services utilization among older hypertensive adults enrolled in the TEAhM study, among those with ≥1 followup contact

Characteristic	All	Tele monitoring	Control
N	112	41	71
Average Number of PCP Visits (SD)	3.4 (2.8)	3.8 (3.3)	3.2 (2.5)
Average Number of PCP Visits for BP (SD)	0.3 (0.9)	0.3 (0.6)	0.4 (1.1)
Average Number of ER Visits (SD)	0.4 (0.8)	0.4 (1.0)	0.4 (0.6)
Average Number of ER Visits for BP (SD)	0.0 (0.2)	0.0 (0.0)	0.1 (0.3)
Average Number of Hospital Visits (SD)	0.4 (0.8)	0.4 (0.9)	0.3 (0.7)
Average Number of Hospital Visits for BP (SD)	0.0 (0.2)	0.0 (0.0)	0.0 (0.3)
Stay in Hospital for BP >1 day? (% yes)	0.9	0.0	1.4
Experienced Challenges Due to BP (% of participants)	10.7	12.2	9.9
Experienced Challenges Due to BP (% of visits)	3.0	2.7	3.1
Reported Symptoms (% of participants): Headache	1.8	2.4	1.4
Reported Symptoms (% of participants): Dizziness	8.0	4.9	10.0
Reported Symptoms (% of participants): Flushed Face	0.0	0.0	0.0
Reported Symptoms (% of participants): Nausea	1.8	2.4	1.4
Reported Symptoms (% of participants): Vomiting	0.9	2.4	0.0
Reported Symptoms (% of participants): Blurred Vision	2.7	4.9	1.4
Reported Symptoms (% of participants): Ringing/Buzzing in Ears	0.0	0.0	0.0
Reported Symptoms (% of participants): Nosebleeds	0.0	0.0	0.0
Reported Symptoms (% of participants): Chest Pain	2.7	2.4	2.8
Reported Symptoms (% of participants): Other	8.9	9.8	8.5
Reported Symptoms (% of visits): Headache	0.4	0.6	0.3
Reported Symptoms (% of visits): Dizziness	2.0	1.1	2.5
Reported Symptoms (% of visits): Flushed Face	0.0	0.0	0.0
Reported Symptoms (% of visits): Nausea	0.4	0.6	0.3
Reported Symptoms (% of visits): Vomiting	0.2	0.6	0.0
Reported Symptoms (% of visits): Blurred Vision	0.6	1.1	0.3
Reported Symptoms (% of visits): Ringing/Buzzing in Ears	0.0	0.0	0.0
Reported Symptoms (% of visits): Nosebleeds	0.0	0.0	0.0
Reported Symptoms (% of visits): Chest Pain	0.6	0.6	0.6
Reported Symptoms (% of visits): Other	2.0	2.2	1.9
Reported BP Measure to PCP? (% of participants)[a]	50.0	56.1	46.5
Reported BP Measure to PCP? (% of visits)[a]	26.1	31.7	22.9
Self-Rated Health at 10 months: Excellent	7.6	7.9	7.5
Self-Rated Health at 10 months: Very Good	39.1	36.8	40.3
Self-Rated Health at 10 months: Good	43.8	47.4	41.8
Self-Rated Health at 10 months: Fair	8.6	5.3	10.5
Self-Rated Health at 10 months: Poor	1.0	2.6	0.0
Mean First BP Measurement (mmHg; (SD)): Systolic	132.4 (22.8)	127.8 (20.9)	135.0 (23.7)
Mean First BP Measurement (mmHg; (SD)): Diastolic	76.2 (10.9)	77.8 (10.0)	75.3 (11.4)
Mean Second BP Measurement (mHg; (SD)): Systolic	130.1 (20.8)	126.1 (19.8)	132.5 (21.1)
Mean Second BP Measurement (mHg; (SD)): Diastolic	74.3 (10.1)	76.6 (11.6)	73.0 (8.9)

Characteristic	All	Tele monitoring	Control
First BP < 140/90 (%)	63.5	73.7	57.6
Second BP < 140/90 (%)	67.7	68.4	67.2

[a] Intervention participants were asked about BP measurements "except for the blood pressure taken using the telehealth BP stations at the senior centers."

Table 6 caption: The purpose of Table 6 is to show health service utilization over the course of followup for study participants overall and for each of the two groups separately.

Table 7 shows comfort levels among persons in the telemonitoring group with two aspects of the intervention at the last time measured for each participant. For the most part, participants said that they were very comfortable with using the cuff and health station.

Table 7. Comfort with blood pressure monitoring intervention

Measure	Pct
N	40
Comfort Level Using BP Cuff at 8 months or most recent (%): Very comfortable	92.5
Comfort Level Using BP Cuff at 8 months or most recent (%): Somewhat Comfortable	5.0
Comfort Level Using BP Cuff at 8 months or most recent (%): Somewhat Uncomfortable	0.0
Comfort Level Using BP Cuff at 8 months or most recent (%): Very Uncomfortable	2.5
Comfort Level Using Health Station at 8 months or most recent (%): Very comfortable	95.0
Comfort Level Using Health Station at 8 months or most recent (%): Somewhat Comfortable	2.5
Comfort Level Using Health Station at 8 months or most recent (%): Somewhat Uncomfortable	2.5
Comfort Level Using Health Station at 8 months or most recent (%): Very Uncomfortable	0.0

Table 7 caption: The purpose of Table 7 is to show comfort levels with the use of the blood pressure kiosk at the end of the study among participants in the telemonitoring group.

Table 8 shows how telemonitoring participants rated their experience with the intervention components after the baseline training and again at the end of the study. For the most part, participants said that they were less anxious and using the equipment was easier at the end of the study than at baseline. However, a higher percentage of people said that using the BP cuff was "very easy" at baseline than at the end of the study.

Table 8. Baseline and end of study experience with blood pressure monitoring intervention

	Baseline (after training)	End of study
N	40	38
Anxiety Level While Using Cuff Training (%): Very Anxious	2.5	5.3
Anxiety Level While Using Cuff Training (%): Somewhat Anxious	17.5	10.5
Anxiety Level While Using Cuff Training (%): Not Anxious at All	80.0	84.2
Ease of Use of BP Cuff (%): Very Easy	85.0	71.1
Ease of Use of BP Cuff (%): Somewhat Easy	12.5	26.3
Ease of Use of BP Cuff (%): Somewhat Difficult	2.5	0.0
Ease of Use of BP Cuff (%): Very Difficult	0.0	2.6
Anxiety Level While Using Health Station Training (%): Very Anxious	10.0	0.0
Anxiety Level While Using Health Station Training (%): Somewhat Anxious	27.5	7.9
Anxiety Level While Using Health Station Training (%): Not Anxious at All	62.5	92.1

	Baseline (after training)	End of study
Ease of Use of Health Station (%): Very Easy	62.5	81.6
Ease of Use of Health Station (%): Somewhat Easy	30.0	15.8
Ease of Use of Health Station (%): Somewhat Difficult	5.0	2.6
Ease of Use of Health Station (%): Very Difficult	2.5	0.0
Recommend BP Telehealth to Friends? (% yes)	N/A	89.5

Table 8 caption: The purpose of Table 8 is to show how the telemeonitoring participants described their experience using the kiosk at baseline and at the end of the study.

Experience with Nurse Monitoring

In TEAhM, nurses provided blood pressure monitoring for participants through use of the telehealth stations installed in the two intervention centers. Through monitoring of the blood pressure readings, nurses were able to identify individuals whose blood pressure readings were beyond the blood pressure protocols that were obtained from their primary care physicians (PCP). Identification of these readings allowed timely delivery of appropriate followup. Nurse monitoring was available five days a week during the hours the senior centers were open for business. Monitoring was conducted by two study nurses from WSU.

Physician-defined BP protocols needed to be programmed into the Health Care Portal (HCP). Clearly defining these limits were crucial to monitoring because if a participant's blood pressure was outside of these PCP-directed parameters, an alarm would alert the study nurse to take further action. However, as noted above, obtaining the BP protocols proved to be very difficult. In addition to difficulties in contacting PCPs for these protocols, when the protocols were ultimately obtained, the team suspected that in many cases, protocols were simply "generic" guidelines rather than thresholds that were tailored for each participant. This resulted in some participants being contacted by a study nurse every time they took their readings because the BP thresholds provided by the PCPs were systematically lower than routine readings for these participants.

Nurses received an email each time a participant had a reading outside of PCP-directed limits. The nurses would then access the Health Care Portal (HCP) to retrieve participant information related to what intervention or followup the PCP prescribed for that patient. It was often the case that the nurses would have the HCP portal "live" on their computer and see in alarms in real time.

Nurses received an email alert indicating that an alarm was triggered and that provided the participant ID number for the person in question. No identifying information was in the email. One nurse arranged to receive these emails through an iPhone and the other nurse through a Blackberry. In both cases, the nurses were informed almost immediately after a blood pressure measurement that triggered an alarm was registered in the system. Upon receipt of an alert, nurses would log onto a computer and then into the HCP to access participant information needed to act on the alert. Although access to the HCP was not available via an iPhone application or Blackberry®, this would have been very convenient for the study nurses.

Participants had very high readings on several occasions. When these were noted, study nurses utilized their clinical experiences/knowledge in directing the participants to contact their PCPs immediately or to seek emergency care. This small number of very high readings would have been left undetected until the participants' next PCP visit were it not for their having been ascertained as part of this telehealth pilot. This finding underscores the ability of this technology to identify

extremely high risk patients and to provide an opportunity to act on findings at periods between routine PCP visits.

Participants provided a great deal of meaningful information during the followup calls. At least one participant informed the study nurse that her PCP did not want to be called by the participant unless her BP was over a certain threshold, with this threshold being higher than the referral protocol that had been given to the nurses. This feedback suggested that at least some of the protocols that were provided at the beginning of the study were not sufficiently tailored to participants' needs. Another participant told the study staff that her PCP had changed her medication because she was consistently having high blood pressure readings at the center. This feedback suggested that the information collected and acted upon as a result of this project resulted in a medication titration that would otherwise not have occurred were it not for the project.

One of the goals of this project was to explore the idea that senior-center based telemonitoring could be a vehicle to move chronic care management into the community. Our team found that there was great potential to move the point of care into the community using self-management technologies as a vehicle. Participants were able to have their blood pressure tracked by qualified clinical personnel in a comfortable, familiar environment, and to engage in these self-management activities as often as they liked at the center as opposed to having BPs collected only during doctor's visits. Serial tracking of BP permitted immediate identification of acute episodes of hypertension, meaningful changes in BP readings, and if necessary, referrals to the PCP or emergency department. These ongoing interventions may offer promise to prevent strokes, titrate medications as soon as a titration is indicated and to provide counseling about diet and exercise.

Overall, the investigative team felt that the best feature of the nurse monitoring was the ongoing availability of information for the provider and the fact that data were collected from a setting of choice for the senior. Monitoring features that may require addressing in the future include ensuring proper cuff placement, and use of the pop-up questionnaire. In some cases, participants had to wait in line to use the telehealth kiosk and some found this waiting time to be inconvenient. Moreover, there were cases in which participants who were first in line to take readings suggested to others in the line that the machine was not operating properly. This caused some participants not to use the device. The latter observations suggested to the investigators that added privacy in the senior center and perhaps a sign up list to use the device might be beneficial for participants who use the kiosk.

Participant Attrition

Six percent of enrolled participants (n=7) did not complete followup. Of these, one died, three were withdrawn by investigators, two refused contact and one withdrew due to illness. Overall, lost to followup was considered modest in this project.

Protocol Compliance

TEAhM had a number of different measures of compliance among persons in the intervention group, and these are summarized in Tables 9 and 10. These measures were important to understand because no technology will yield benefit to seniors if the technology is not used. Table 9 shows

adherence rates with the intervention. The percent of weeks with at least one BP reading was 69 percent and high readings that were followed by a second reading was 61 percent. For reasons that are unclear, the percent of high readings with a second reading was higher in Urbana than at Logan. Both sites had very low usage of the questionnaire. The protocol stated that nurses were to call participants the same day as a high reading; however, the referral was not considered completed until the nurse communicated directly with the participant. The referral was completed on the same day 63 percent of the time and within one day 71 percent of the time. It should be noted that some participants reported frustration with repeated followup phone calls that occurred as a result of the nurses' being alerted of elevated pressures on multiple occasions. In some cases, by the time nurses reached the participant by phone for followup, the participant had already contacted their PCP. In other cases, participants simply became weary of repeated followup calls. Future efforts should focus on approaches to tailoring followup in ways that are more flexible and consistent with seniors' preferences. Participants were not asked to take BP readings on multiple days during the same week, but did so 17 percent of the time.

Table 9. Adherence with blood pressure monitoring intervention

Measure	Overall	Logan	Urbana
Weeks with at least 1 BP reading (%)	69.1	69.4	68.6
High readings with a 2nd reading (%)	61.1	51.1	75.2
High readings with a questionnaire (%)	12.9	12.9	12.8
High readings with a nurse followup in the same day* (%)	62.5	73.4	50.0
High readings with a nurse followup within 1 day* (%)	70.5	77.3	62.5
Weeks with multiple BP readings (%)	17.0	15.9	19.0

*Must have had 2 high readings in the same day to be counted

Table 9 caption: The purpose of Table 9 is to show adherence levels with various aspects of the telemonitoring intervention throughout the study period.

Figure 4 shows the distribution of alerts that were generated among participants in the intervention group. There were 303 distinct alerts noted among 35 of the 41 intervention participants. This translates to approximately 7.4 alerts per intervention participant during followup. However, the figure shows that there was a great deal of variation in the frequency of alerts, with some participants having no alerts at all while others had many. It is perhaps not surprising that participants with alerts that occurred at high frequencies experienced frustration with repeated followup calls from study nurses, and underscores the need for future work to focus on tailoring followup to seniors' needs and/or enhancing input from PCPs into the followup protocol.

Figure 4. Frequency distribution of the number of blood pressure alerts per participant

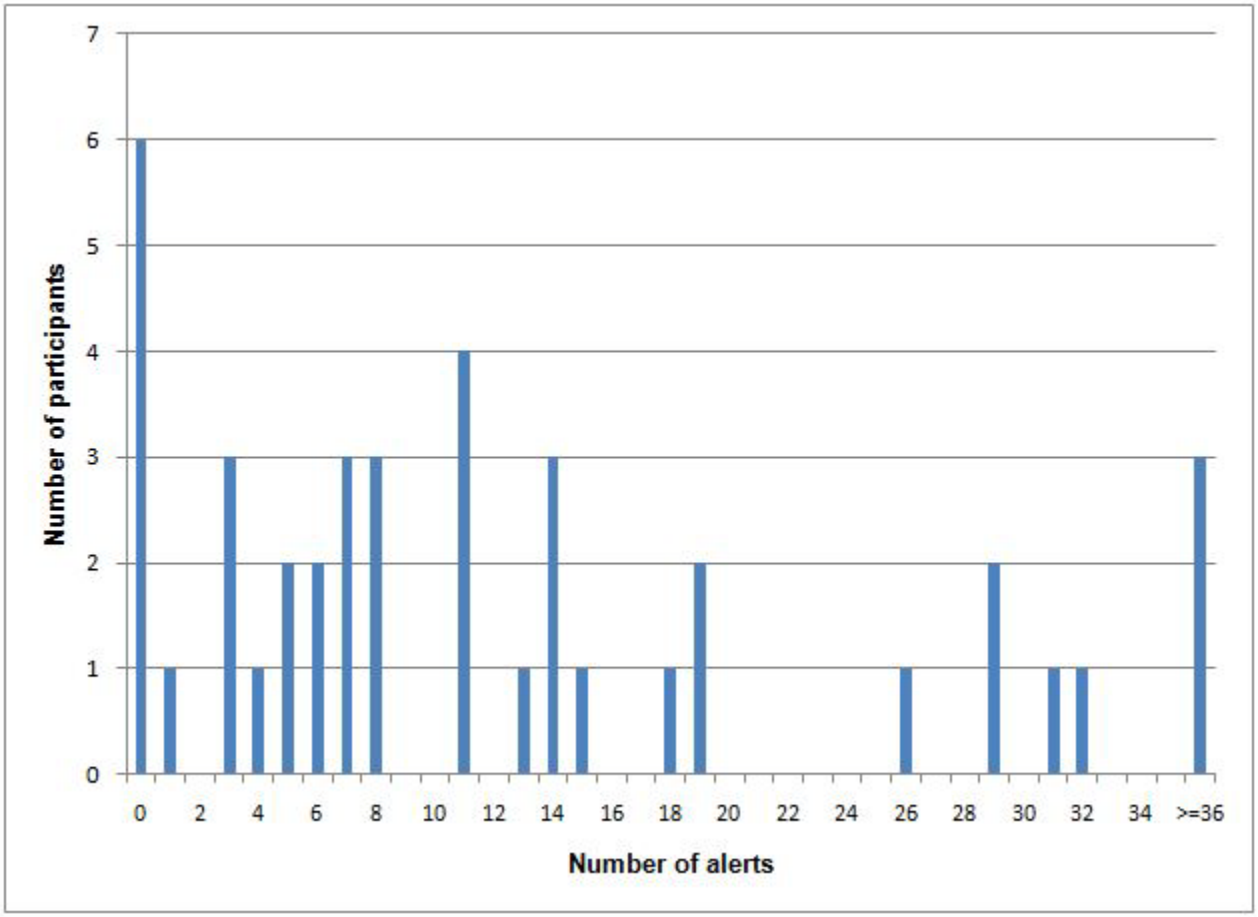


Table 10 shows adherence rates with the intervention over time. There was a noticeable increase in weeks with at least one BP reading over the first 5 months of the study, then an even more dramatic decrease between 5 months and 10 months. The somewhat extreme looking percentages of high readings with a second reading and high readings with a questionnaire in the last two months are probably more of a reflection of a small denominator (due to a lower percentage of weeks with a reading and lower number of high readings) than any pattern in adherence with these two elements of the protocol.

Table 10. Adherence with BP monitoring intervention by followup month

	1	2	3	4	5	6	7	8	9	10
Weeks with ≥1 BP reading (%)	68.5	70.5	76.9	71.8	80.1	71.8	66.9	68.3	58.5	47.3
High readings with a 2nd reading (%)	56.9	70.0	64.4	58.8	50.0	60.9	66.7	56.7	75.0	100.0
High readings with a questionnaire (%)	11.8	12.5	13.3	14.6	8.3	21.7	5.6	16.7	0.0	33.3

Table 10 caption: The purpose of Table 10 is to show adherence levels with the three primary goals of the telemonitoring intervention on a monthly basis throughout the study period.

Overall, analysis of compliance data suggested that efforts are needed to ensure continued use of this technology following the initial “honeymoon” period. Future work aimed at maximizing the impact of this technology should focus on identifying ways to encourage seniors not only to adopt the technology, but also to engage in consistent use over time.

Technical Considerations

At intervention sites, several distinct categories of technology-related issues emerged, all of which are relevant to a larger application of this approach to provision of kiosk-based telehealth-facilitated chronic disease management in the community, and particularly in rural areas. These issues included: internet connectivity, Internet Service Provider (ISP) support, hardware, software, and human factors-related issues. We consider each of these issues in terms of its influence on broader implementation of nurse-mediated telehealth in the setting of community-based senior centers or similar congregate settings, as opposed to home-based telehealth.

Internet Connectivity

Internet connectivity at the intervention sites was not optimal despite preimplementation screening of the centers for adequacy of service. One site in particular had trouble obtaining service and maintaining continuity from its local internet service provider (ISP). There was a period of approximately 10 days during which internet connectivity was unstable or unavailable. Difficulties at this center led not only to problems with the functioning of the telehealth kiosk, but they also created frustrations for both participants and senior center staff. Most notably, service interruptions resulted in the inability to transfer data from the kiosk to the vendor’s server. Although service interruptions were generally brief and no emergency situations arose during these times, nurses were nonetheless unable to monitor blood pressure “in real-time” during these episodes of interrupted service. In this sense, internet service interruptions not only undermined compliance efforts among participants, but they also influenced the ability of nurses to respond to health data in real-time.

ISP Support

Technical support from the local internet service provider was at best inconsistent, and at worst, unavailable. The ISP had difficulty opening the port required to allow the vendor’s technicians to access the telehealth computer remotely over the internet using Virtual Network Computing (VNC). This difficulty limited the vendor’s ability to remotely troubleshoot and provide needed technical support to one site—an essential component of the project. Repeated attempts were made to establish remote access through the static IP address assigned to the kiosk, but these efforts were unsuccessful. Senior center staff lacked the knowledge and resources to resolve technical issues independently. These circumstances required one of the study nurses to travel to the senior center and address technical issues with the vendor over the phone. Although effective, this solution was suboptimal: The nurse lacked expertise with the equipment, had other study obligations, and was based over an hour from the senior center. Moreover, the site’s technical issues were easily diagnosed by the vendor and could have been resolved in minutes with remote access had the ISP been responsive to the needs of the senior center and the research staff.

Hardware

Prior to enrollment, it was discovered that one site's computer was unable to communicate with the wireless BP measurement device via Bluetooth dongle. Once this problem was identified, a simple software update immediately resolved the problem. During the study, one of the computers froze repeatedly, which led the research team to suspect the cause to be a virus or malware. The vendor thoroughly tested the problematic computer to determine the cause of the freezing. Because the problem persisted after reformatting and reinstalling all software and hardware drivers, the vendor determined the cause was most likely a defect in hardware. At that point, the hardware was replaced by the vendor. Replacement of the hardware inadvertently, but fortuitously, addressed complaints participants had made about sensitivity of the touch screens. A number of users experienced frustration with the touch screens because of a perception of insufficient screen sensitivity. When the hardware was replaced, it contained a newer, more sensitive screen. This enhanced satisfaction among many users and eliminated complaints related to screen sensitivity. In addition, study nurses placed a mouse at the kiosk as an alternative to the touch screen.

The blood pressure cuff presented separate hardware issues. The blood pressure device inflates the cuff to a predetermined pressure, but when inflation is not high enough to accurately measure systolic BP, the cuff deflates and re-inflates to higher level to obtain a better reading. This is a routine device function, but resulted in confusion among users. Some participants removed their arms partially or completely from the cuff between readings, causing the subsequent measurement to fail and produce an error message. In this case, participants must recognize the error and retake the reading. In most cases, an accurate reading was obtained but confusion over this function should be noted. Inaccurate or missing readings undermine the ability of the nurses to provide targeted remote monitoring, and ultimately to assist patients in reaching their disease management goals.

Software

Staff identified several software-related issues that resulted in participant confusion and in some instances disrupted data collection. For example, although the software displayed a "Send" button on the kiosk screen after the device captured the BP measurement, this function was designed for off-line applications that required the user to press "Send" to deliver data to the vendor's server. In this setting, typically BP readings uploaded automatically and were transferred to the server without user intervention. An exception to this process occurred after an internet outage, in which case BP data had to be entered manually into the computer and users needed to press "Send" to transfer the data once internet connectivity was restored. Using the "Send" button at any other time resulted in transfer and storage of duplicate readings in the BP reports, which were easy to identify and correct in the BP database. However, this issue resulted in periodic confusion and frustration among users regarding correct use of the "Send" button.

When a high BP reading was detected, a pop-up message appeared on the screen to alert participants and prompt them to complete an on-screen health questionnaire. After replacement of the hardware at one site (described above), this pop up no longer appeared. The vendor's technical staff enabled this function remotely. Another software issue involved the kiosk going into a default

"sleep mode," which temporarily prevented patients from logging in. To address this issue, the sleep mode was disabled. Although this problem was easy to resolve, it is important to recognize as a cause for confusion and possible loss of data if the problem source had not been discovered quickly. For example, there was a 2-week period during which study staff could not initialize new ID cards at the senior centers. One of the study nurses resolved this issue with telephone-based technical support from the telehealth vendor. However, had this problem occurred during the enrollment period, it would have prevented new participants from enrolling and being monitored. It should be emphasized that no ID cards needed to be reissued during this period, so there was no disruption in monitoring for participants who had started the program. These situations further underscore the importance of basic computer literacy and adequate training among on-site staff and reliable remote technical support from telehealth vendors.

Technology Literacy in Congregate Settings

As expected, participant anxiety and technology literacy, especially in conjunction with internet connectivity, ISP as well as software and hardware problems, were major barriers to compliance and collection of accurate and consistent BP readings. However, despite a perception on the part of study investigators that participants would have limited experience with automatic BP cuffs, 99 percent of participants had used automatic cuffs (and several reported using them hundreds of times) prior to the study. Nevertheless, some participants did experience anxiety as they learned to use the kiosks, and at times when connectivity, software or hardware problems occurred, this anxiety increased and resulted in elevated BP readings. Interestingly, we observed that elevated BP readings appeared to be associated with certain activities that are common at senior centers such as card playing, which was very competitive among those seniors, as we learned from nurse researchers. Some participants who monitored their BP immediately after a card game had high initial measurements that later decreased at the second reading. It should be noted that participants were instructed to take their BP measurements after a period of rest, but they did not consistently follow these instructions.

Cuff Placement and Compliance

Research participants did not always use the appropriate BP cuff size or follow instructions about proper cuff placement consistently, and they often required supplemental instructions by senior center staff. Incorrect cuff placement observed by nurse researchers included placing the cuff on the elbow, and using the cuff over bulky clothes, which prevented a reading from being obtained. If participants made a correction, such as removing the bulky item, the cuff sometimes re-inflated to the point of discomfort. Although proper cuff placement was demonstrated to study participants during training on the use of the kiosk and picture-illustrated instructions on proper cuff placement were posted on both kiosks, study participants needed additional reminders to follow these instructions and periodic supervision to ensure that proper placement was consistent.

As noted in tables 9 and 10, approximately 69 percent of participants used the BP kiosk once a week throughout the study and the sites averaged 13 percent compliance with the health questionnaire. The software was designed to prompt participants to take a second BP reading if the first reading was high, and to complete the questionnaire. During the study, staff observed that compliance with completing the questionnaire and re-measuring BP was low. In response, study

staff changed the pop-up message to instruct users to complete the questionnaire after the first high-blood pressure reading and then retake the BP. However, between 25 and 50 percent of participants did not complete second readings and, as suggested above, 87 percent did not complete the questionnaires. Failure to complete a second reading could result from a number of issues including forgetfulness, frustration over cuff inflation, poor touch screen sensitivity, inconsistent pop-up reminders or any of the other hardware and software issues discussed that had the potential to influence participants' experiences interacting with the technology. Similarly, failure to complete the questionnaire could have resulted from inconsistent pop-up reminders, difficulty navigating the user-interface to access the questionnaire or broader dissatisfaction on the part of users.

Physician Engagement

When a hypertensive participant wished to enroll in the study, his or her primary care physician provided BP thresholds to guide the study nurses' interventions. The 41 participants in the intervention arm of the project were cared for by 30 distinct primary care physicians.

Ideally, physicians would have defined specific BPs at which participants should modify diet or exercise, consider a medication change, consult their physician via telephone, schedule an appointment with their physician, or seek immediate medical attention. Further, these thresholds would be based on the physicians' knowledge of their patients' histories and be aimed at minimizing the need for in-person visits when possible. In practice, however, many physicians asked to be alerted if their patients' readings were over 140/90 and provided no additional instructions to study nurses. Because of these "generic" referral instructions, study nurses were underutilized; if BP readings were high, they called patients and recommended a physician appointment. Eventually, some participants tired of this advice, particularly the subset of participants with consistently high readings. In some cases, these participants refused to answer nurses' calls. Others reported that their physicians had modified their recommendations and set a higher BP threshold but had failed to notify study nurses.

After data collection was complete, a survey was mailed to the primary care physicians of all participants enrolled in the study. The survey was mailed multiple times and followup calls were made in order to maximize responses. There were a total of 31 distinct physicians who provided primary care to the 41 intervention participants in the study. Of these, 11 returned a survey at the end of the study. Table 11 provides a summary of demographic data for these physicians.

Table 11. Demographic characteristics of TEAhM participants' primary care physicians

Characteristic	Number
Sex (Male:Female)	4:7
Age: Under 30	0
Age: 30-39	1
Age: 40-49	3
Age: 50-59	5
Age: 60+	2
Race: White	11
Years working as a physician: <5	0
Years working as a physician: 5-10	3
Years working as a physician: 11-15	3
Years working as a physician: 15+	5

Table 11 caption: The purpose of Table 11 is to show the demographic characteristics of the primary care physicians associated with the participants in the telemonitoring group.

Eight of the 11 physicians who responded to this survey specialized in family practice. Eight respondents reported using a personal computer or handheld device to access their patients' medical information, 10 used computers for personal email and 10 used computers to access health resources such as journals or practice guidelines. A number of questions were posed to physicians that sought to gather data on physicians' impressions of their enrolled patients. Five of the 11 respondents indicated on the survey that they did not know that they had a patient in the study, a finding that was consistent with difficulties that study nurses experienced when trying to speak directly with them. Questions that were aimed at assessing physicians' perceptions of the value of telehealth in chronic disease management were generally positive, with most physicians either agreeing or strongly agreeing with statements such as "Having a BP report will assist me in adjusting medication class/dose" and "A BP report can improve my ability to provide better patient care."

Senior Center Staff Feedback

Structured interviews were conducted with the leadership of the two senior centers in the telehealth kiosks were installed, and from which clients were enrolled into the intervention arm of the study (see Appendix B). These interviews were conducted after the conclusion of data collection for the purpose of collecting qualitative information on organizational and implementation-related issues that have the potential to impact the likelihood that a larger roll-out of this approach is likely to be successful in the future.

Use of existing staff at the senior centers was extremely successful. Center staff were very receptive to WSU researchers coming to center events to recruit participants. Staff at the two intervention centers had a critical role in ensuring that participants have appropriate access to the BP monitoring station. Staff maintained the swipe cards that participants used to log into the station and provided participants with the appropriate sized BP cuff. Staff also helped ensure that the equipment was running correctly, that Internet service was available and adequate, and that participants had privacy when using the BP station. It should be noted, however, that Center staff did not have a clinical role in BP management—their role was to facilitate use of the equipment in the senior center venue. Center directors occasionally joined the research team's calls during initial phase of study to provide feedback on how the project was running in their centers, on one of the center directors met enrollment criteria for the project and was herself a participant in the project.

The two directors of the intervention centers were interviewed at the end of the study period to help clarify the role of the center staff in implementing the intervention. A summary of these structured interviews is provided below.

Background and Organizational Readiness To Support Health Information Technology (HIT)

In both intervention senior centers, the center Director was the main point of contact. When asked, both Directors reported wearing "many hats" including, but not limited to: daily administration of the center; acting as the activities director; overseeing financial issues and budgeting; accountability to a board of directors; supervision of staff; planning trips, education programs, collaborative efforts with other agencies, strategic planning and a host of other responsibilities.

One of the two senior centers was the only senior center in the county, and acted as the hub of senior services for the entire county. These services ranged from activities aimed at preventing social isolation to legal aid, to computer literacy, health screenings, clubs, exercise classes, educational programming and trips. Efforts to enhance computer literacy among seniors was a priority for one of the senior centers, and that center had a computer area in the building and a number of activities aimed at increasing comfort and utilization of technology among clients. This center was especially interested in telehealth technology because it recognized that seniors are becoming increasingly tech savvy and that their needs and expectations for technololgy-enabled services would increase in the future.

The ultimate decision to engage in the project was made by the center directors. However, both directors took the project to their respective boards and solicited support prior to starting the project. The boards of both centers were reported to share the directors' enthusiasm, a factor that facilitated project implementation.

Organizational Context

Both centers reported that start-up activities were somewhat problematic and "choppy" due to internet connectivity issues and in one case, temporary equipment failure. However, both directors also reported that once these initial problems were solved, the technology was generally reliable and the project needed very little maintenance on the part of senior center staff. One center director reported that her phone company was "notorious for causing problems" and that she experienced billing issues with the phone company for the internet connection that took some time to sort out. Thus, the connectivity problems at that center did not come as a surprise to the center director.

Both center directors reported that although the kiosk did not occupy a great deal of space, there were nonetheless important considerations to address when thinking about the specifics of how to set up the device. Both directors pointed to the importance of privacy and security. At one center, the device was set up on a flat desk in the library section of the facility. The center director felt that seniors who used the device did not feel that this set up provided sufficient privacy. As a result, the screen was turned toward the wall in an effort to allow users more privacy. This center director suggested that a carrel, rather than flat desktop would be a better choice in the future in terms of selecting the physical surface on which to set up the device. The second senior center

expressed practical concerns about security of the device. Although the device itself required use of an ID card, there were concerns about systems peripherals “walking away” at times when staff were not in the building. The issue that senior centers are multiple use buildings was raised by both center directors in the context of device security. Many centers rent their buildings to civic and other groups to generate revenue, and these ancillary activities often occur after regular business hours when center staff are not on duty. Directors expressed concern about the security of expensive technical equipment during periods of time when regular staff were not on duty.

Implementation Climate

Both center directors reported engaging in preproject advertising. This involved writing articles for the center’s newsletter, posting flyers, meetings with the area agency on aging advisory board, arranging for articles in the local newspaper, meeting with local groups such as the Lion’s Club, meeting with the center’s board of directors and other activities aimed at promoting and gaining support for the project and encouraging participation on the part of potential participants. Directors reported having limited responsibility for day-to-day operations of the project, and that they saw themselves as helping project staff to do their jobs. They reported that training was adequate for this purpose and that project staff were available when they were needed. When asked about their initial expectations, one director said that the device “looked simple and doable” but that she worried that some of her clients were not computer literate and might have difficulties. She explained that there is always “fear of the unknown when a new program is undertaken.” The same director reported that after training and seeing the device set up and in use, she knew it would be “senior friendly.”

Center directors reported being excited about the idea of having a telehealth research project implemented in their facilities. One said she was motivated to do it to improve on existing services and because the computer-related element of the project extended other programs aimed at computer literacy at her center. This director reported that she was very pleased that there were going to be clinical personnel “at the other end” of the computer, and she recognized that this was a major improvement over home-based monitoring that did not involve feedback from clinical personnel. She added that she was gratified to see some of her clients who did not have computers at home express interest and ultimately participate in the project because this was consistent with her efforts to promote computer literacy and comfort among her clients. As noted above, at both centers, staff were eligible to participate in the study and were enrolled as participants. Both directors repeatedly stated that they were surprised at how easy the device was to use—both for them and their clients—and that they had expected a higher level of demand than actually was the case in terms of system operation. One director pointed out that the written materials that were provided during training were easy to understand, straightforward and useful for both staff and clients.

Center directors reported that their clients were hesitant at the beginning of the project, but achieved a comfort level relatively quickly because the training was appropriate and the device was not difficult to learn. As noted above, one of the two centers experienced serious problems with internet coverage that impacted smooth functioning of the program. The director of the center that experienced these technical problems did express that she had intermittent frustration during the project because it was not her expectation that she would need to troubleshoot technical issues. Indeed, the telehealth vendor, the senior center staff and the project staff all experienced frustration

with the Internet service provider but these frustrations ended up impacting the senior center director most directly because she was onsite with her clients who were unable to follow the study protocol because of these problems. This director said that there was a week where "everyday something was happening" and that she ultimately had to call project staff and say that she was unable to handle dealing with the technical issues, and that she was not aware that this would be her responsibility. The director suggested that clearer communication of expectations, roles and responsibilities as they related to technical issues would have made her part in the project easier.

Facilitators of Study Implementation

Center directors reported that at first, the monetary incentives played a role in facilitating study implementation, but after the project got going, money was not as much a factor. After participants got in the routine of using the device, the added control they felt over their health and wellness, as well as a sense that they were learning something new facilitated study operations.

Barriers to Study Implementation

As noted above, technical glitches introduced some barriers to the project, but all of these were ultimately addressed. Center directors reported no substantive barriers to study implementation other than issues related to the reliability of the technology itself.

Technology Effectiveness

Center directors reported that at the completion of the project, they felt that the telehealth device was easy for seniors to use and that staff were seldom tapped for questions or assistance. One director added that she was pleased that some seniors who were unable to turn on a computer prior to the study were not only able to use this technology, but that they could clearly articulate the benefit and see the value for them on an individual basis. Both directors pointed out that the difficulties they experienced during the start up period were temporary and did not appear to influence seniors' perception of the value of the technology. Both commented repeatedly on the simplicity of the device and how important this simplicity was to day-to-day operations of the project. One director commented that if such a device were regularly available, seniors would use it on a regular basis. She pointed out that her clients felt it was "Easier than having to go to the doctor." The other director felt that the information provided by the technology empowered her clients with information in a setting and context that was tailored for seniors. Both directors felt that the simplicity, ease of use and the flexibility associated with when the device could be used were three key features of the success of the program.

The directors did, however, note a few challenges with the technology. For example, concerns having to do with the security of the device required one director to remove the peripherals at the end of each day and store them in a locked office. She noted that setting up the kiosk in a room that could be locked would have been advantageous to her in terms of saving time associated with removing peripherals at the end of each day.

Participant Reactions

Directors reported overall satisfaction on the part of their clients with the telehealth kiosk. Many participants commented on the convenience of participating in the project since the equipment was set up at the senior center and most participants attended the center on a regular basis for ongoing activities. Thus, participation and ongoing BP measurements did not impose any added burden on seniors beyond the time involved in taking the measurements at the center. One director reported that one of her participants who had a blood pressure measurement device at home repeatedly commented on the difference in measures between the center-based kiosk and the home-based cuff. The director commented that this participant was irritated by the differences in these measures and questioned the value of the project because of these observations. The same director pointed out that other participants repeatedly commented that they became more aware of their blood pressures as a result of using the device, and that they were gratified that study nurses were monitoring "on the other end" and even facilitating the making of appointments with PCPs when high pressures were noted. The other director pointed out that when participants noted a high reading at the center, many went home and called their PCPs themselves, so that when study nurses contacted participants the same day or early the next day after having reviewed the readings remotely, participants would have often already taken care of the issue themselves. This sometimes resulted in participants receiving phone calls from study nurses that participants felt were unnecessary. At times, participants raised this issue with senior center staff who reminded the participants that these followup phone calls were part of the study protocol and that they were described to participants at the beginning of the study. The same director noted that she and her staff received complaints from clients during periods when internet connectivity problems resulted in participants feeling frustrated when they attempted to use the kiosk. Overall, with the exception of the occasional negative comments described above, both directors reported that their participants had positive reactions to the device itself as well as the monitoring and their increased awareness of their blood pressures.

Innovation Value-Fit

Both center directors were emphatic in their belief that chronic disease management facilitated by telehealth was highly consistent with their organizational mission. One director put it simply by saying that one of her center's missions is to "keep seniors living healthier, longer, and independently," and that this project and its potential impact "fit right into this mission" because it "helps seniors to be responsible for their health." She added that baby boomers and the seniors that will follow them will be expecting these types of technologies and that senior centers need to be prepared to meet these changing needs. This director felt that nurse-monitored telehealth was superior to settings such as pharmacies because of the added clinical oversight.

The second center director felt that the focus on blood pressure and chronic conditions in general was highly consistent with her center's many health-related programs and screenings, and reflected the value placed by her clients on managing these conditions effectively. She added that many of her clients didn't feel comfortable taking their blood pressures at home, and felt more secure knowing that the readings were being monitored by professionals. She felt that her clients felt that the program provided them with direct benefit and that these benefits were clear and immediate.

Overall Impressions and Lessons for Improvement

Center directors were asked about various issues associated with how the costs of this type of program could be covered. Directors responded that the first question that would need to be answered was whether the service would be worthwhile to their clients, and if so, how would it initially be fit into the budget and maintained over a period of time? The greatest concern on the part of center directors involved start up costs, including equipment on ongoing internet costs. They felt that if the program was set up similarly to how it was done in TEAhM, staff time could be covered with existing staff since the majority of work was done by clinical personnel. One of the directors explained that she would be more than willing to use her center to permanently set up this type of program, but that she would not be able to cover the cost of equipment installation or maintenance.

Summary of Lessons Learned

Participants

- Most participants had used an automatic blood pressure device of some kind prior to the study.
- Participants were highly compliant with use of the technology, but this use dropped off somewhat over the 10 months of followup.
- A number of very high blood pressure readings were noted during the study period, permitting immediate action to be taken.
- Some participants reported frustration with repeated followup phone calls that occurred as a result of the nurses' being alerted of elevated pressures.
- Ninety-five percent of participants reported being "very comfortable" with use of the telehealth kiosk at the end of the study.

Senior Center Staff

- Staff saw clear value in telehealth, and felt senior centers were an appropriate venue in which this service could be provided.
- Staff felt that their clients were able to see the value added in this service and that they embraced us of this technology after appropriate training was provided.
- Staff said that they would be willing to permanently house telehealth stations, but that the cost of the equipment and its ongoing maintenance would have to come from outside sources.

Primary Care Physicians

- Securing a direct line of communication with physicians was challenging.
- Physicians did not appear to provide 'tailored' referral protocols for their patients.

- A future, office-based telehealth intervention would benefit from closer contact with seniors' primary care providers.

Nurse Monitoring

- Study nurses reported a high degree of satisfaction with the technology, but indicated that having access to the health care portal on a mobile device would have been a good addition to the technology platform.
- Nurses reported making repeated phone calls to certain participants with consistently elevated pressures.
- Nurses were able to provide quick and effective nursing interventions in response to elevated blood pressure readings.
- Greater access to participants' physicians would have helped study nurses utilize the technology more effectively.

Recommendations

The goal of this project was to explore the feasibility of using community-based senior centers as a venue for delivery of telehealth to seniors. Our work strongly suggests that this technology will be embraced by both seniors and senior center staff. Based on these findings, the next logical step is to explore how to move the nurse monitoring aspect of the project into the primary care setting or integrate it into the senior center's stream of services with a direct communications/coordination with the primary physicians' office. Although an office-based approach to nurse management was beyond the scope of this project, this project highlights the potential additional benefits that could be realized by incorporating nurse-mediated management in the office setting. However, this approach only makes sense if the nurse intervention is covered by Medicare or other health insurance; financing is one of the major barriers inhibiting the proliferation of this type of technology. New integrated, medical home, accountable care organizations and other pay for performance models that will be implemented and demonstrated under the Affordable Care Act may be much more conducive to the integration of this type of intervention into primary care practice.

A future study that is powered to evaluate the efficacy and cost-effectiveness of this community-based telehealth approach for chronic disease management, could provide evidence supporting the adoption of this approach into regional or national networks of senior centers. Such a study could involve identifying primary care practices that would be willing to collaborate with senior centers on a 'second generation' telehealth study that builds on TEAhM. The study could also focus on operational and logistical issues associated with building the bridges between physicians who care for seniors and the community-based senior centers that are routinely utilized by these individuals. This line of investigation would make a significant contribution toward advancing community-based, communication-focused technologies for this vulnerable population.

References

1. Golant SM. Aging in place solutions for older Americans: Groupthink responses not always in their best interests. Public Policy & Aging Report 2009;19:33-39.

2. Harahan MF, Sanders A, Stone R. Creating new long-term care choices for older adults: A synthesis of findings from a study of affordable housing plus services linkages. Available at: http://www.aahsa.org/uploadedFiles/IFAS/Publications_amp;_Products/ltc_choices_final.pdf. Accessed April 15, 2011.

3. Young Y, Inamdar S, Hannan EL Comparison study on functional outcomes and perceived quality of life between all-inclusive and fee-for-service continuing care retirement communities. J Am Med Dir Assoc 2010;11:257-62.

4. Kamp BJ, Wellman NS, Russell C. Position of the American Dietetic Association, American Society for Nutrition, and Society for Nutrition Education: food and nutrition programs for community-residing older adults. J Nutr Educ Behav 2010;42:72-82.

5. Moscovice I, Casey M. Overview: a synthesis of current health policy issues of interest for the West Virginia Legislature, October 2010. Available at: http://www.hsc.wvu.edu/wvhealthpolicy/reports/Ira_Moscovice.pdf. Accessed April 15, 2011.

6. Rosenthal TC, Fox C. Access to health care for the rural elderly. JAMA 2000;284:2034-6.

7. National Center for Health Statistics. Health, United States, 2009. Centers for Disease Control and Prevention, Department of Health and Human Services. Available at http://www.cdc.gov/nchs/hus.htm, Accessed April 15, 2011.

8. US Department of Health and Human Services. Hard times in the heartland: health care in rural America, Apr. 2009. Available at http://www.healthreform.gov/reports/hardtimes/ruralreport.pdf. Accessed April 15, 2011.

9. USDA, Rural Transportation at a Glance: 2005. Available at http://www.ers.usda.gov/publications/aib795/aib795_lowres.pdf. Accessed April 15, 2011.

10. USDA. Rural America at a Glance: 2010. Available at http://www.ers.usda.gov/Publications/EIB68/EIB68.pdf. Accessed April 15, 2011.

11. Finlayson SRG, Birkmeyer JD, Tosteson ANA, Nease RFN Jr. Patient preferences for location of care: Implications for regionalization. Medical Care 1999**:**37: 204-9.

12. Improving Health Care for Rural Populations. Research in Action fact sheet. AHCPR Publication No. 96-P040. Agency for Health Care Policy and Research, Rockville, MD.

13. National Academy on an Aging Society. Challenges for the 21st Century: Chronic and Disabling Conditions, 1999. Available at: http://www.agingsociety.org/agingsociety/pdf/chronic.pdf. Accessed April 15, 2011.

14. Jones CA, Parker TS, Ahearn M, et al. Health status and health care access of farm and rural populations. USDA, Economic Research Service, 2009. Available at: http://www.ers.usda.gov/Publications/EIB57/EIB57.pdf. Accessed April 15, 2011.

15. US Department of Health and Human Services. Hard times in the heartland: health care in rural America, Apr. 2009. Available at: http://www.healthreform.gov/reports/hardtimes/ruralreport.pdf . Accessed April 15, 2011.

16. AHRQ. Health care disparities in rural areas: fact sheet. Available at: http://www.ahrq.gov/research/ruraldisp/ruraldispar.htm. Accessed April 15, 2011.

17. Bindman AB, Grumbach K, Osmond D et al. Preventable hospitalizations and access to health care. JAMA 1995;274:305–11.

18. Kannel WB. Blood pressure as a cardiovascular risk factor. JAMA 1996;275:1571-6.

19. Lloyd-Jones D, Adams R, Brown T, et al. Heart disease and stroke statistics—2010 update. a report from the American Heart Association Statistics Committee and Stroke Statistics Subcommittee. Circulation 2010;121:e1-e170.

20. Centers for Disease Control and Prevention. High blood pressure facts, 2010. Available at: http://www.cdc.gov/bloodpressure/facts.htm. Accessed April 15, 2011.

21. American Heart Association. Stroke risk factors. Available at: http://www.americanheart.org/presenter.jhtml?identifier=4716. Accessed April 15, 2011.

22. Lai AM, Kaufman DR, Starren J. Training Digital divide seniors to use a telehealth system: a remote training approach. AMIA Annu Symp Proc 2006:459-63.

23. Botsis T, Hartvigsen G. Current status and future perspectives in telecare for elderly people suffering from chronic diseases. J Telemed Telecare 2008;14:195-203.

24. Woodend AK, Sherrard H, Fraser M, et al. Telehome monitoring in patients with cardiac disease who are at high risk of readmission. Heart Lung 2008;37:36-45.

25. "Use of automated telephony to optimize blood pressure and medication management of hypertensive elderly patients." Dis Manag Advis 2008;14(1):11-12. Available at: http://www.healthleadersmedia.com/HOM-203076-4625/Program-brings-hypertensive-patients-within-BP-ranges.

26. AbuDagga A, Resnick HE, Alwan M. Impact of blood pressure telemonitoring on hypertension outcomes: A literature review. J Telemed eHealth 2010;16:830-8.

27. AHRQ-Funded Projects. Telemonitoring in rural elder nutrition centers: demonstration project of hypertension management. Available at: http://healthit.ahrq.gov/portal/server.pt?open=512&objID=654&PageID=5585&mode=2&cached=false&state=128007

Appendix A: Text of Primary Care Physician Survey

Primary Care Provider Survey

Background Information:

1. What is your gender? (select one) □ □Female □Male

2. What is your age? (select one)
   □Under 30 years
   □30 – 39 years
   □40 – 49 years
   □50 – 59 years
   □60 years and older

3. What is your race/ethnicity? (select all that apply)
   □White
   □African American
   □Hispanic
   □Asian or Pacific Islander
   □Native America or Alaska Native
   □Other (please specify) _____

4. How long have you been working in the health care field as a physician? (select one)
   □Less than 5 years
   □5 – 10 years
   □11 – 15 years
   □More than 15 years

5. What is your main practice area? (select all that apply)
   □Family Practice
   □Internal Medicine
   □Geriatrics
   □Other (please specify) _____

6. Do you use a personal computer (PC) or PC device (such as laptop or handheld device) to access any of the following? (select all that apply)
   □Your patient's medical information
   □Your personal email
   □Health or clinical resources, such as journals and/or practice guidelines
   □Other (please specify): _____

Motivation to Provide BP Referral Criteria:

7. What were the most important reason(s) behind your agreement to provide BP referral criteria for use in our study? (select all that apply)
   - □To better treat my patients
   - □Because I am interested in health information technology
   - □Because I am interested in contributing to research knowledge
   - □Because my patient(s) was/were highly interested in the study
   - □I was ambivalent about participation
   - □Other (please specify)

_____

Actual Use of the BP Telemonitoring in Hypertension Management:

8. On average, how often did your patient(s) who participated in the study discuss their telehealth BP readings during their regular office visits with you?
   - □Very frequently
   - □Occasionally
   - □Rarely
   - □Never
   - □Patient(s) did not visit my office during the study period

9. On average, about how often did this/these patient(s) call you after being referred by our nurse researchers?
   - □Very frequently
   - □Occasionally
   - □Rarely
   - □Never
   - □BP was never beyond my set parameters

10. Do you think your patient(s) experienced improved hypertension management as a result of using the telehealth station?
    - □Strongly Disagree
    - □Disagree
    - □Neither Disagree/Agree
    - □Agree
    - □Strongly Agree
    - □Not Applicable

Future Research and Application

In possible future applications of this study, telehealth technology could electronically generate regular BP (and other vital signs) reports that can be provided to physicians or designated nurses to monitor patients with hypertension. As a result, physicians or nurses can use treatment protocol(s) to intervene in a timely manner to achieve better BP control.

11. The following questions ask about your opinion on how *useful* automatic BP reports would be to you and your hypertensive patients. Circle the number that best describes your opinion on the following statements below.

	Strongly Disagree	Disagree	Neither Agree/ Disagree	Agree	Strongly Agree
a. Having a BP report will assist me in adjusting medication class/dose	1	2	3	4	5
b. A BP report will assist me in gauging patient compliance with treatment	1	2	3	4	5
c. A BP report can improve my ability to provide better patient care	1	2	3	4	5
d. I will continue to rely more on my own assessment of the patient and my office-based readings in managing hypertension	1	2	3	4	5
e. Patient compliance with BP telemonitoring in and of itself will improve patients' disease self-management	1	2	3	4	5

12. The following questions focus on your perceptions of the *use* of BP reports for patients with hypertension in your office <u>in the future</u>. Circle the number that best describes your opinion on the following statements below.

	Strongly Disagree	Disagree	Neither Agree/ Disagree	Agree	Strongly Agree
a. Reviewing BP reports would be disruptive to my schedule	1	2	3	4	5
b. BP reports will be a waste of my time	1	2	3	4	5
c. BP reports will be user friendly	1	2	3	4	5
d. Using the report in managing BP will be easy for me	1	2	3	4	5

13. From a practical standpoint, how often would you prefer to receive BP reports for a hypertensive patient, if you were to participate in a future telehealth study?
    - □Bi-weekly
    - □Weekly
    - □Monthly
    - □Bi-monthly
    - □Other (please specify) _____

14. What would be your preferred method of receiving BP reports?
    - □E-mail
    - □Regular mail (snail mail)
    - □Fax
    - □Other (please specify) _____

15. In the next steps of research to determine the efficacy of telemonitoring for management of hypertension, study nurses who monitor BP remotely would work in collaboration with primary care physicians to achieve continuous BP control. This collaboration would involve the nurse calling the primary care physician (as well as the patient) when an elevated BP alarm is triggered by the kiosk. In your opinion, what *barrier(s)* would challenge physician participation in such a study? (select all that apply)
    - □Physician time is limited
    - □It depended if I am compensated for my time or not
    - □I'd have to see study details first to be able to decide
    - □Other (please specify)

    _____
    _____

16. Thinking about the opinions you expressed in this survey relative to BP telemonitoring, in general how applicable are those responses to telemonitoring for management of other common chronic conditions (e.g., glucose telemonitoring to manage diabetes, etc)?
    - □Highly applicable
    - □Applicable
    - □Applicable for some but not applicable for others
    - □Not applicable
    - □Highly not applicable
    - □Other opinion (please specify)

_____

Senior Centers as a Telemonitoring Setting

17. What is your opinion of the use of senior centers as a venue for remote BP monitoring for older adults (with BP kiosks installed there)? (select all that apply)
    - □Ideal setting to reach older adults
    - □It depends on whether senior center staff is involved or not
    - □Not any better than malls, supermarkets or drug stores
    - □Not an appropriate setting
    - □Other viewpoint (please specify)

_____

18. Please use this section to provide us with any additional comments or suggestions regarding the use or acceptance of BP telemonitoring from your perspective as a primary care provider. These comments will help us better understand your responses overall and may suggest other questions that need to be addressed in future studies.

    _____
    _____
    _____
    _____
    _____

19. Are you interested in receiving the final results for the group-level analysis of this survey from AAHSA?

□*Yes,* send me the final results □*No, I am not interested in the final results*

Thank you for your participation!

Appendix B: Senior Center Director Interview Guide

Introduction

Hello, as you know, WSU has been evaluating a blood pressure/telehealth intervention that was piloted here at [*center name here*]. As part of the evaluation process, we are talking with staff members at the senior centers to learn about their experiences with and opinions about the project. Is this still a good time to talk? This discussion should take about 45 minutes, but please let me know if you need to go earlier.

Before we get started, I wanted to mention that I am going to audio record our conversation so that it can be transcribed later-this way I can pay closer attention to our conversation without having to write everything down while we are talking. Please know that you can choose to not answer any of these questions and you can stop this interview at any time with no problem. Also, none of your comments will be linked with your name, and once the recording of our conversation has been transcribed, the audio recording itself will be permanently deleted.

May we proceed with the interview now?

Thank you again for your time and help. Let's begin!

1) Background & Organizational Readiness to Support Health Information Technology (HIT)

What is your current role at [*center name here*]?

What are your primary responsibilities in that role?

Have you or this center been involved in research projects in the past? If yes, please describe.

Who made the decision to take on this project?

[If response is "me", ask: Did you obtain input from others about participating before going ahead?]

[If response is yes, ask: With whom did you consult before agreeing to participate in the project?]

2) Organizational Context

Do you feel that the *computer/internet* at your center was adequate to support the study?

[If response is no, ask: What would you have needed that you didn't have?]

Do you feel that the *space* to set up and maintain the equipment was adequate to support the project? That is, did you have enough?

[If response is no, ask: What would you have needed that you didn't have?]

Was the study supported by the center's leadership/board and the community at large?

[If response is yes, ask: What form did this support take?]

[If response is no, ask: Why do you think the project did not receive support?]

3) Implementation Climate

How would you describe your role in this project and what are the ways in which you helped in the implementation/ongoing support for the project?

What other staff at your center participated in this study? What was their role?

As senior center staff, what were your *initial* thoughts and perceptions about the technology part of the study? What concerns related to technology came to your mind then?

As senior center staff, what were your expectations about the ease and user-friendliness of the blood pressure station at the time when the study staff explained to you what this study entailed?

As senior center staff, what were your *initial* expectations about the usefulness of this study to your center and its mission?

Do you feel that there was adequate WSU staffing at the senior center to set up and start the study?

Do you feel that there was adequate senior center staff to maintain the project once the initial training and start-up activities were complete?

[If response is no, ask: What types of additional staff support would have been helpful to you?]

Did you have any concerns or issues that affected the implementation of the study that were not addressed by the study staff at the beginning?

[If response is yes, ask: Can you tell me about them?

Did you feel that the training you received from WSU was adequate to prepare you to answer seniors' questions and assist them once WSU staff had departed?

[If response is no, ask: What additional training or resources could have prepared you better?]

Facilitators of Study Implementation

What factors helped and supported the implementation of the project?

[If facilitators listed, ask: Which one of these factors would you say was the most important at your center?]

Barriers to Study Implementation

What do you think were the most significant barriers to incorporating telehealth for management of hypertension in senior centers like yours?

[If barriers listed, ask: How do you feel about how these barriers were addressed by the study team when they were encountered?]

[If barriers not fully addressed ask: How could those barriers be addressed in the future if we continue to refine this approach in senior centers?]

4) Technology Effectiveness

Now that the study is complete, what do you think about the ease and user-friendliness of the blood pressure station from your standpoint as senior center staff?

What are your current perceptions of the usefulness of this technology to your center?

What did you like about the technology (telemonitoring/blood pressure station)?

What did you dislike about the technology?

[If something is noted, ask: Now that the project is done, how could this have been approached differently?

Thinking about the successful aspects of the project—this could be any aspect that you feel was successful—what do you think were the main factors that contributed to these successes?

To what degree do you think this technology served the mission of your center? How?

Participant Reactions

"The next few questions are about your impressions of the seniors' satisfaction with the project. We understand that this is speculative, but we are looking for your impressions only." If you recall some specific examples of participants' reactions related to the following questions, please tell me about them.

In your opinion, how satisfied were participants with the technology?

What aspects of the technology did you feel the participants liked?

What aspects did they dislike?

Is there any part of the study protocol at the center that they you feel should be changed?

How did participants feel about the number of times they used the blood pressure station?

What is your overall impression about how easy the health station was for participants to use?

What is your overall impression about how useful the health station was for participants to use?

What is your impression on the helpfulness of the nurse phone calls when an elevated blood pressure alarm is triggered by the blood pressure station?

"Again, we know that you can't speak for the seniors at your center—we are just looking for your general impressions based on your experience."

5) Innovation Value-Fit

How important was this technology to your center and staff, including you?

[If positive response, ask: What specifically did you feel was important about the project?]

[If negative response, ask: What could have been done differently to create a sense of importance for this project with the staff?]

How important was this technology to the seniors who attend your center?

[If positive response, ask: What specifically do you think the seniors feel was important?

[If negative response, ask: What do you think could have been done differently to create a sense of importance for this project with the seniors who come to the center?]

6) Overall Impressions and Lessons for Improvement

Uniqueness of Setting

Future applications of HIT are likely to include the use of telemonitoring stations in common areas that are frequented by older adults, such as senior centers. What do you think are the unique features about using senior centers for chronic disease management telemonitoring?

Business Case

Overall, do you think the costs of this kind of telemonitoring projects to you (e.g., start-up labor costs connected with administering/managing such a program in their community) match its benefits from the standpoint of your clinic and your clientele?

Lessons Learned

In your opinion, what was the most important lesson that was learned from pilot testing telehealth technology at [*center name here*]?

From your point of view, what resources are absolutely necessary to implement a telehealth program in a setting like this?

[If response offered ask: Why do you feel that this is essential?]

If we started this project over from scratch, what would you suggest we do differently?

[If suggestions offered, probe for detail.]

Are there any aspects of the project itself that you would change?

[If response offered ask, Why would you change that?]

Were there any unintended outcomes as a result of the study—either good or bad?

Those are all the questions that I had. Did you have any additional comments or thoughts to add before we go? Thank you very much for taking the time to talk with us today!