Use of a Remote Patient Home Telemonitoring System (Engage Practice Solutions) in a Rural Health System to Decrease Rural Patients’ Utilization of Acute Healthcare Services: A Quality Improvement Project

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Use of a Remote Patient Home Telemonitoring System (Engage Practice Solutions) in a Rural Health System to Decrease Rural Patients’ Utilization of Acute Healthcare Services:

A Quality Improvement Project

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Abstract

Individuals in rural areas of the U.S. have less healthcare access in large part due to access barriers, and include travel and wait time, distance to a provider, cost, transportation, and social and cultural components. Rural individuals have been found to be in poorer health and have higher rates of being uninsured and having chronic disease. These disparities lead to rural individuals requiring more expensive acute care once they are at the point of receiving care. A significant burden is placed on the individual and health system. The rates of emergency department (ED) use in rural areas increased 70% from 2005 to 2016. In the county where this project will take place the number of hospitalizations was 74.7 per 1,000 population in 2017 (PA Department of Health, 2017). In 2019, there were 526 more preventable hospital stays than the State average (County Health Rankings and Roadmaps, 2019). The County also has a higher prevalence of cardiovascular disease and diabetes when compared to the State average. This project will use a home telemonitoring system to decrease the acute care utilization rate of rural residents in the county by 10%, as well as evaluate chronic disease maintenance and risk reduction of such a program. The project aims to reduce health disparity gaps in a rural, elderly population.

Keywords: rural, elderly adults, telemonitoring, hypertension
Use of a Remote Patient Home Telemonitoring System (Engage Practice Solutions) in a Rural Health System to Decrease Rural Patients’ Utilization of Acute Healthcare Services: A Quality Improvement Project

It is well known that individuals who reside in rural areas do not seek primary or sick care as often as those in more dense geographical areas for a variety of reasons. These reasons include travel and wait time, distance to a provider, cost, transportation, as well as social and cultural components. Individuals in rural areas have been found to be in poorer health, have a higher rate of being uninsured, have lower rates of private insurance, and have a higher rate of chronic disease. This creates health disparities leading to these individuals seeking or needing more expensive acute care that could have been prevented. Not only does this place a significant burden on the individual, but it also drives up healthcare cost. Health disparity gaps may be closed and this tremendous cost burden may be reduced if healthcare access is improved (MacKinney et al., 2014).

This issue of healthcare access is particularly troublesome in rural areas. There is no standardized definition of “rural” within the U.S. Federal Government. The United States (U.S.) Census Bureau has the most commonly accepted definition of the term “rural.” It defines a rural area as any area not within an urban (≥50,000 people) or urban cluster (between 2,500 to 50,000 people) area (United States Census Bureau, 2010). With the barriers stated above, rural individuals are less likely to seek preventive primary care. The original thought was that the technology age would usher in better healthcare for those in rural areas. However, this has not been the case up to this point. Those in rural areas are three times less likely to have an internet connection than those in urban areas (Douthit et al., 2015). Despite these barriers, telehealth services have been one proposed solution to the healthcare disparity gap in rural areas.
Telehealth services refer to telecommunication or information technology services and encompass several types of delivery modes from synchronous to asynchronous. Synchronous service examples are real time telecommunications via smart devices (phone or tablet). Asynchronous services include monitoring patient data (such as vital signs) at points in time through remote monitoring. Remote monitoring or telemonitoring occurs when patient data is uploaded to an online portal for provider viewing. As an example of how this intervention could help this rural health problem, one review study in Australia found that telehealth services provided convenience, lowered patient costs, enabled better specialist care, and decreased hospital admissions (De Groot et al., 2021).

**Defining Healthcare Access**

There are many defining characteristics of the concept healthcare access. A literature synthesis of the concept healthcare access by Levesque et al. (2013) identified many of these characteristics that have developed over the past 40 years. They include time, financial, personal, and structural components among others. The most frequently found and agreed upon characteristics of the concept which can be applied to a rural setting are availability, affordability, acceptability, and accessibility (Levesque et al., 2013). Another similar delineation by MacKinney et al. (2014) includes people, place, provider, and payment.

The characteristics proposed by MacKinney et al. (2014) make it easier to measure the healthcare access concept, which will be used as the concept in this paper. Examples of how the concept can be measured include individuals’ utilization of healthcare (i.e. number of visits, number of prescriptions), travel time and distance to a healthcare office or other services, provider availability, availability of age and gender appropriate services, off-hours availability, accepted insurances, copayments, and fees for specialty services. These would be termed process
measurements. Examples of outcome measurements include monitoring the rate of vaccine preventable diseases, the rate of exacerbations or complications from chronic disease, rates of screening for disease, and rate of mortality (MacKinney et al., 2014).

**Identification of the Practice Problem**

The elderly population is the fastest growing segment of the total population in the United States. Over the next two decades, the number of adults over the age of 65 will increase dramatically as the baby boomer generation reaches retirement age. Rural elderly adults currently account for 25% of all elderly in the nation (Skoufalos et al., 2017). In addition to this, the rates of emergency department (ED) use in rural areas increased 70% from 2005 to 2016 (Rural Health Information Hub, 2020). In the county where this project took place the number of hospitalizations was 74.7 per 1,000 population in 2017 (Pennsylvania Department of Health, 2017). In 2019, there were 526 more preventable hospital stays in this county than the State average. Of the total population in the County, 67.5% of individuals live in an area designated as “rural.” Additionally, the ratio of primary care physicians to individuals in this county is 2,370:1, which is almost double the state ratio (County Health Rankings and Roadmaps, 2019). The County also has a higher prevalence of cardiovascular disease and diabetes when compared to the State average (Emminger, 2018).

The Johns Hopkins Evidence Based Practice (EBP) model was the model used to direct the literature search for this project. The Johns Hopkins EBP model utilizes a three step process in its approach to innovation: practice question, evidence, and translation (Dang and Dearholt, 2017). The practice question of this project in PICOT format is: Can the use of a home telemonitoring system decrease the rate of acute care visits in a rural elderly (≥65 years) population as well as help control chronic disease progression within a three month period?
There will be three goals or objectives of this project: reduce the rates of ED visits, admissions, and readmissions by at least 10% over three months; estimate the cost savings of using a telemonitoring system within the three month timeframe; and evaluate the effectiveness of the home telemonitoring program on chronic disease progression and risk reduction in the three month timeframe. There is evidence to show that telehealth services can improve various outcomes as seen in the literature synthesis below.

The framework used during implementation of this project was the Plan-Do-Study-Act Cycle (PDSA). This type of intervention has never before been used in this rural setting. Telemonitoring itself is considered a novel intervention. The Institute for Healthcare Improvement (IHI) describes the PDSA framework in this way: formulate a plan to test a change, implement the change, evaluate the effects of the change, and make appropriate modifications if the desired outcomes are not achieved (Institute for Healthcare Improvement, 2021). This is the foundation of this project. The plan was to develop a telemonitoring intervention, implement a pilot within the rural County health system, evaluate its effects on the stated objectives, then make necessary adjustments to the intervention as needed.

**Literature Review and Synthesis**

Telemonitoring is a relatively new concept in the world of healthcare. It is one that has been slowly expanding, that is, until the COVID-19 pandemic emerged. Social safety guidelines initiated in response to the pandemic changed the way healthcare was being delivered. Office visits were being limited and the concern was that patient care would decline. This caused the development and rapid expansion of many telemonitoring systems and programs across the world. A qualitative study conducted by Wali et al. (2021) held interviews with 29 participants that included patients, clinicians, and program staff at a heart clinic at Toronto General Hospital.
This was to evaluate the perceptions of the telemonitoring program that expanded due to the pandemic. Four themes were identified and included continuity of care, adaption of telemonitoring to a virtual healthcare system, workflow challenges, and the relationship between providers and patients. Through analysis of these interviews, the authors were able to make recommendations for future telemonitoring care as they saw the utility of this intervention. These included defining the scope of telemonitoring interventions, making it easier for patients to enroll in this type of intervention, and ensuring that the patient-provider relationship is not negatively affected with a more virtual intervention (Wali et al., 2021).

To further synthesize current literature on telemonitoring, a literature search was conducted across several database platforms, including PubMed Central, Cochrane, CINAHL, Ovid, Embase, and Google Scholar. Search terms included “rural,” “elderly OR older adult,” “telemonitoring OR telehealth OR remote monitoring,” “hypertension OR high blood pressure OR HTN,” “cost,” and “health outcomes.” There is a gap in the literature regarding the use of telemonitoring with elderly adults in rural areas, especially in terms of overall healthcare cost. However, there is information on telemonitoring for some chronic diseases as well as some general cost perspectives. The following paragraphs will synthesize research findings to help evaluate the practice question and the stated objectives. The synthesis will be structured by examining acute care usage, cost, and chronic disease monitoring.

**Reduce Acute Care Visits**

As mentioned above, much of the established literature on telemonitoring looks at chronic diseases, specifically heart failure. In one meta-analysis, Tse et al. (2018) looked at 60 different studies of approximately 31,501 patients with heart failure (five cohort and 55 randomized control trials). Their goal was to determine if telemonitoring could reduce the
number of hospitalizations in a heart failure population. Through their analysis, they found that telemonitoring significantly reduced the number of hospitalizations of patients with heart failure in the short term (<6 months) by 24% and in the long term (>12 months) by 27%. Sensitivity analysis, leaving out one study at a time, did not affect the results in any significant way. However, the authors did detect substantial publication bias in the studies that they included in their review (Tse et al., 2018).

Similarly, Inglis et al. (2015) completed a meta-analysis of randomized control trials (RCTs) for patients with heart failure. They collected a total of 43 studies that looked at whether structured telephone encounters or telemonitoring could positively affect all-cause mortality as well as all-cause and heart failure related hospitalizations. Their analysis showed that, separately, telemonitoring and telephone support each significantly reduced all-cause mortality (20% and 13%, respectively) and heart failure hospitalizations (29% and 15%, respectively), but not all-cause hospitalizations. This was based on moderate quality evidence. However, the authors also detected publication bias in the studies included in their review (Inglis, 2015).

A randomized control trial by Ong et al. (2016) examined whether a telemonitoring intervention reduced 180 day readmissions in patients with heart failure compared to usual care. The intervention included home telemonitoring devices and nurse telephone calls at regular intervals. They included 1,437 participants with a mean age of 73. They found that there was no difference between this intervention and usual care for all-cause 30 days or 180 days readmissions nor any difference in 180 days mortality. However, they did find there was an improvement in the quality-adjusted life year (QALY) of those in the intervention group (Ong et al., 2016).
Cost Effectiveness

A significant literature gap exists concerning the cost effectiveness of telemonitoring as an intervention in a rural setting. The cost effectiveness of telemonitoring in general is inconsistent in the existing literature. In the Inglis et al. (2015) meta-analysis of RCTs, 15 of the 43 studies included a cost analysis. Results were mixed. Some studies reported a cost savings of 14% to 86% when looking at the potential saved on hospital admissions, while others noticed an increase in cost of the intervention and medical care. A meta-analysis study by Omboni et al. (2013) looked at 23 RCTs and synthesized results on home blood pressure telemonitoring. They also estimated total healthcare cost of telemonitoring versus usual care. The total healthcare cost was higher for the intervention group, but not when only medical care was measured (Omboni et al., 2013).

Another study by Grustam et al. (2018) looked at data from a previous heart failure study conducted in the United Kingdom, the Netherlands, and Germany. The data of over 1,000 participants with heart failure aged 70 years and older in various New York Heart Association (NYHA) classes was examined. The objective was to see whether home telemonitoring and nurse telephone support improved quality adjusted life years (QALYs) and what the cost associated with these interventions would be compared to usual care. They found that both interventions were more costly than usual care with home telemonitoring being the most expensive. However, both home telemonitoring and nurse telephone support had a significant improvement in QALYs compared to usual care.
Effects of Telemonitoring on Chronic Disease

The usefulness of home telemonitoring had been evaluated as far back as 2007 by Paré, Jaana, and Sicotte. They completed a systemic review of the available literature at that time to evaluate the outcomes of four types of chronic diseases: pulmonary diseases, cardiac diseases, diabetes, and hypertension. They analyzed 65 studies (18 pulmonary, 17 diabetes, 16 cardiac, and 14 hypertension). They decided that the magnitude of using telemonitoring devices could not yet be realized from available literature. However, they did find that patients were compliant with this technology across nations, socioeconomic groups, and age group. The effects on clinical outcomes, such as hospitalizations, were more consistent for patients in pulmonary and cardiac disease studies than for patients with diabetes and hypertension. Lastly, many studies had not commented on the economic feasibility of this type of intervention. The authors recommended that more studies be completed on this intervention, especially randomized control trials (RCTs) (Paré, Jaana, and Sicotte, 2007).

The same meta-analysis study by Omoni et al. (2013) referenced above concluded that there was a significant drop in systolic and diastolic blood pressure in the intervention group (those patients using home blood pressure telemonitoring devices). They also found that the intervention group was prescribed more antihypertensive medications than the control group. There was no difference in adverse events between the two groups (Omoni et al., 2013). Another study by Steventon et al. (2012) looked at telehealth datasets from 3,230 participants with diabetes, chronic obstructive pulmonary disease, or heart failure. The outcomes that this randomized control trial looked at were hospitalizations and mortality. In this study, they found that the telemonitoring patients had lower rates of both hospital admissions and mortality. However, there was a high number of hospital admissions in the control group within the first
three months of the study. The authors speculated on several causes of this not necessarily linked to the intervention. Overall, this limited the usefulness of their results (Steventon et al., 2012).

**Synthesis of Research**

Based on the above evidence, the usefulness of a telemonitoring system on this paper’s objectives could not be ascertained. Several of the studies were conducted in countries outside of the United States. Some of them had significant limitations in terms of study design and statistical comparisons between interventions. Others could not control for unexpected variables. While the level of evidence for the systematic reviews and meta-analyses were high, the level of evidence for the single RCTs was moderate. The quality of evidence for the systematic reviews and meta-analyses were moderate, whereas the single RCTs were moderate to low. A significant knowledge gap has been found with this type of intervention in a rural area.

**Description of Project**

The purpose of this project was to use a home telemonitoring system to help decrease the acute care utilization rate of rural residents in a county health system by 10% as well as evaluate the chronic disease maintenance and risk reduction of such a program. The project aimed to reduce some health disparity gaps with hypertension in a rural, elderly population. The methodology utilized was a quality improvement study. As seen by the county data above, there are many more preventable hospital visits within this rural county. This can put a significant financial burden on the health system and, at times, on the patient. A process measurement outcome included using a telemonitoring system to track different aspects of a patient’s care to help reduce the number of unnecessary acute care visits. Outcome measurements included the reimbursement to the provider for using the devices and the potential patient cost savings in
terms of acute care visits avoided and the maintenance of chronic disease. It also included measuring whether patients were maintained in their current chronic disease states or potentially caused them to improve their chronic diseases. This project started with hypertension management.

Methods

It is usual and customary practice for the county health system to innovate to find new ways to serve its patients, incorporating its own providers in this innovation. The project manager is a provider within this health system. The goal was to identify 15 patients at a rural health primary care office for this pilot project. Patients selected were 65 years of age or older, with at least one of the following chronic conditions: hypertension, heart failure, or diabetes. All patients enrolled in the study had a Medicare Advantage plan so that all costs to the patients would be covered. Once these patients were identified, they were contacted by members of the primary care office. After patients signed a consent form to use the telemonitoring devices, they were contacted by a Care Coach with Engage Practice Solutions (EPS), the telemonitoring company supplying the devices and the case management for the pilot project. These Care Coaches served as patient liaisons for home telemonitoring device setup and training, patient questions, and overall monitoring.

Enrolled patients were mailed a home blood pressure monitor. At least 16 measurements were asked to be taken monthly for each patient (the minimum required for provider reimbursement). The specific devices uploaded readings either through Bluetooth or cellular capabilities. The cellular capabilities allowed patients to enroll who did not have Internet access. It was also expected that the Care Coaches would establish at least 20 minutes of patient contact per month via telephone (minimum required by Medicare for reimbursement). Data was
monitored from January 1st, 2021 to March 31st, 2021. Baseline blood pressure readings from office visits between December 1st, 2019 and December 31st, 2020, were collected via the health system’s electronic medical record (EMR). The number of ED visits for the enrolled patients within the same timeframe was also collected. EPS calculated a Patient Complexity Index (PCI) for each patient. A team of physicians with EPS calculated the PCI using billed outpatient ICD-10 diagnosis codes and a hierarchical formula to determine level of complexity. These complexities were separated into Tier 1, Tier 2, and Tier 3 levels. Patients falling into Tier 1 were deemed to have health risks that could potentially lead to chronic disease. Patients in Tier 2 were patients with chronic disease but without end organ damage. Tier 3 patients had chronic disease with end organ damage.

The blood pressure cuffs monitored blood pressure and heart rate. Parameters were established in three levels. These levels were based upon standards set by the latest American Heart Association (AHA) guidelines. The green level included a systolic pressure of 90-140, diastolic of 60-80, and a heart rate of 60-100. The yellow level included a systolic pressure of 141-179, diastolic pressure of 81-109 or 41-59, and a heart rate of 51-59 or 101-119. The red level included systolic greater than 180 or less than 90, diastolic of greater than 110 or less than 40, and a heart rate of greater than 120 or less than 50. Five consistent readings in the yellow level warranted a call from one of the Care Coaches to assess the patient and ensure correct utilization of the device. Any reading in the red level warranted a call from the Care Coaches for the same reason (see Table 1). Upon assessment, the Care Coaches would refer the patient for an office visit or to the ED for further evaluation if there was a problem.
Table 1

**Blood Pressure and Heart Rate Parameters Used During the Study**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Green Range</th>
<th>Yellow Range</th>
<th>Red Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic pressure</td>
<td>90-140</td>
<td>141-179</td>
<td>≥ 180 ≤ 90</td>
</tr>
<tr>
<td>Diastolic pressure</td>
<td>60-80</td>
<td>81-109</td>
<td>≥ 110 ≤ 40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41-59</td>
<td>≤ 40</td>
</tr>
<tr>
<td>Heart rate</td>
<td>60-100</td>
<td>51-59</td>
<td>≥ 120 ≤ 50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>101-119</td>
<td></td>
</tr>
</tbody>
</table>

Demographic data collected included patient demographics such as year of birth, sex, diagnosis, as well as healthcare service utilization rates and cost, vital sign measurements, and chronic disease indicators. Part of this data was analyzed via the software program developed through HealthClix and licensed through EPS, which included descriptive statistical analysis to describe relationships and categorize findings. Cost savings estimates were calculated based on potential ED visits avoided. To determine whether this intervention affected chronic disease, the PCI of each patient was monitored during the study period and compared to the PCI before the intervention began.

**Implementation**

The planning of this project began in the late Summer/Fall of 2020. The office was identified where the pilot study would take place. EPS led the initiation of the project. The office staff and provider at the office were educated on the pilot study process. The patients from the office practice were loaded into the EPS system in the Fall of 2020. At that point, the 15 patients who qualified for remote telemonitoring were identified and selected by the Medical Director of the office. These patients were then contacted, on-boarded, and educated on the devices by January of 2021. The initial plan was to provide multiple devices to monitor blood pressure,
weight, or blood sugar. However, issues with device capabilities at the time of rollout dictated that patients only received blood pressure monitors. Due to difficulty contacting patients during this time period, only eight patients were enrolled by the time the project monitoring began. Blood pressure readings were recorded between January 1st, 2021 and March 31st, 2021.

Data Management Plan

Data was managed using Excel. Baseline demographic data, as well as acute care visit data, was collected from each patient’s EMR, de-identified, and stored in an Excel file. The PCI information was obtained from the Engage software platform. This was also de-identified and placed in an Excel file. Home blood pressure readings were automatically recorded and uploaded to the HealthClix software platform. This platform compiled these readings into graphs and charts used for data interpretation. Each blood pressure reading was copied into an Excel file for organization and ease of analysis. Care Coaches were to be in contact with patients at least once each month. Cost estimations were made based on the mean patient charge of ED visits, admissions, and readmissions for the patient with the most acute care charges in 2020 and as well as the patient with the most acute care visits in 2020 at this particular county health system. Data before and after project implementation were compared for blood pressure readings and presented in graphs and charts. Initial implementation and data collection for the intervention was evaluated over three months as outlined in the Methods section above. Data analysis occurred during the following three months.

Results

Eight patients were successfully enrolled in the pilot by the time of project initiation. Of the patients enrolled, five were female and three were male with a mean age of 76 years. All
patients enrolled had a diagnosis of hypertension. Fifty percent of patients had a diagnosis of diabetes, and 50% were diagnosed with heart failure. The PCI of the patients ranged from 4.1 to 6.25 with a mean of 5.51. For a better understanding of the complexity of these patients, the PCI of all patients at this office ranged from 0 to 6.3 (see Table 2).

Table 2

Population Characteristics (N=8)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>n=3</td>
</tr>
<tr>
<td>Female</td>
<td>n=5</td>
</tr>
<tr>
<td>Age</td>
<td>Mean</td>
</tr>
<tr>
<td>Hypertension</td>
<td>n=8</td>
</tr>
<tr>
<td>Diabetes</td>
<td>n=4</td>
</tr>
<tr>
<td>Heart failure</td>
<td>n=4</td>
</tr>
<tr>
<td>Patient</td>
<td>Mean</td>
</tr>
<tr>
<td>Complexity</td>
<td>5.51</td>
</tr>
<tr>
<td>Index</td>
<td>(4.1-6.25)</td>
</tr>
</tbody>
</table>

Acute Care Visits

Of the eight patients enrolled in the project, there were three ED visits by three different patients between December 1\textsuperscript{st} of 2019 and December 31\textsuperscript{st} of 2020. These visits were not related specifically to emergencies caused by the three chronic diseases under review in this project. There were two admissions to the health system’s hospital by two of those same patients within this same timeframe. These admissions were not related to their ED visits but were for separate problems at a different time of the year. There were no readmissions by any patients during this timeframe. During the three months that this project took place, January 1\textsuperscript{st} to March 31\textsuperscript{st} 2021, only one patient visited the ED. Again, this ED visit was unrelated to the three chronic diseases being monitored. At the time of this ED visit, the PCI of this patient was 5.15. There were no admissions and no readmissions. If similar timeframes of each year were compared for all
enrolled patients, there were no ED visits, admissions, or readmissions in the first quarter of 2020 and only one ED visit in the first quarter of 2021 (see Table 3).

Table 3

Acute Care Visits by Date

<table>
<thead>
<tr>
<th></th>
<th>ED visits</th>
<th>Admissions</th>
<th>Readmissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dec 1st, 2019-20</td>
<td>3</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>1st Quarter 2020</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1st Quarter 2021</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Cost Estimates of Utilizing a Telemonitoring Intervention

The specific dollar amount for cost to the health system was beyond the scope of this project. However, there are several ways that an estimate can be made for cost to the patient. Organizational cost data was obtained in regards to number of acute care visits in both 2020 and 2021. The patient with the most charges for ED visits and admissions in 2020 had a total charge of approximately $200,553. This patient visited the ED and was admitted a combined 14 times in 2020 (actual visit type was not delineated). While the total charges for each visit varied based on the presenting problem, this patient had an average cost of approximately $14,325 per visit. Additionally, the patient with the most ED visits and admissions in 2020 was seen 90 times and had an approximate total charge of $170,804. This patient’s average cost per visit was approximately $1,897.

Using these high and low end charges, an estimate can be made as to the potential usefulness of this telemonitoring intervention. Of the patients enrolled in this project, the range of patient charges is $9,485 to $71,625 based on the total number of ED visits and admissions in 2020. Within the timeframe of this project, there was only one ED visit. The total charges for
that visit would range from $1,897 to $14,325. Of note, all patients enrolled in this project did not have any copayment for use of the telemonitoring devices due to their supplemental insurance.

**Income for Health System**

Patient remote monitoring is a service that is billable through Medicare. Reimbursement rates are based on several codes: 99453, 99454, 99091, 99457, and 99458. Code 99453 can be billed for initial set-up and patient education on the devices. The reimbursement rate for 2021 is $19.19. Code 99454 can be billed every 30 days as long as there are at least 16 readings in that period. The reimbursement rate is $62.80. Code 99091 can be billed if a provider or other qualified healthcare staff view, analyze, and interpret remote monitoring data for a minimum of 30 minutes in a 30 day period. The reimbursement rate is $56.87. Code 99457 can be billed for an initial 20 minutes of clinical staff interactive communication regarding remote monitoring management services. The reimbursement rate for that is $50.94. Lastly, code 99458 can be billed for an additional 20 minutes of interactive communication during a 30 day period. The reimbursement rate is $41.17. These are based on a single patient and only one billing provider per month (PYA, 2021).

Each patient could have been billed a 99453 code, which would total $153.52 over the course of the project. Eight patients were monitored for three months during this project. Out of the 24 total months of monitoring, there were 21 months (87.5%) where at least 16 readings were taken. Code 99454 could have been billed 21 times totaling $1,318. It is unknown if 99091 was actually billed during this pilot; however, if it had been, the total reimbursement could have been $1,365. Code 99457 could have been billed three times during the timeframe of the project.
There were no instances where the 99458 code could have been billed. The total estimated reimbursement for the health system was approximately $1,625 (see Table 4).

**Table 4**

*Maximum and Actual Reimbursement Estimates for Project Timeframe*

<table>
<thead>
<tr>
<th>Billing Code</th>
<th>Reimbursement Rate</th>
<th>Maximum</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>99453</td>
<td>$19.19</td>
<td>$153.52</td>
<td>$153.52</td>
</tr>
<tr>
<td>99454</td>
<td>$62.80</td>
<td>$1,507.20</td>
<td>$1,318.80</td>
</tr>
<tr>
<td>99091</td>
<td>$56.87</td>
<td>$1,364.88</td>
<td>$0</td>
</tr>
<tr>
<td>99457</td>
<td>$50.94</td>
<td>$1,222.56</td>
<td>$152.82</td>
</tr>
<tr>
<td>99458</td>
<td>$41.17</td>
<td>$988.08</td>
<td>$0</td>
</tr>
<tr>
<td><strong>Total:</strong></td>
<td></td>
<td><strong>$5,236.24</strong></td>
<td><strong>$1,625.14</strong></td>
</tr>
</tbody>
</table>

**Effect on Chronic Disease**

Of the patients enrolled in this project, there were 52 blood pressure readings taken at office visits throughout 2020. The average blood pressure of one patient during that timeframe was in a normal range (<120/80). The average blood pressure of four patients fell into the elevated level of hypertension. The average blood pressure of two patients fell into the Stage I hypertension level. One patient had an average blood pressure that fell into the Stage II hypertension level. Again, levels were based on the AHA staging guidelines.

Over the timeframe of this project, 654 blood pressure readings were taken (see Table 5).
Table 5

Average Blood Pressure Readings and Total Blood Pressure Counts by Patient

<table>
<thead>
<tr>
<th>Patient</th>
<th>Mean Systolic Quarter</th>
<th>Mean Diastolic Quarter</th>
<th>Mean Systolic Jan</th>
<th>Mean Diastolic Jan</th>
<th>Mean Systolic Feb</th>
<th>Mean Diastolic Feb</th>
<th>Mean Systolic Mar</th>
<th>Mean Diastolic Mar</th>
<th>Total BP Readings Quarter</th>
<th>Total BP Readings Jan</th>
<th>Total BP Readings Feb</th>
<th>Total BP Readings Mar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient 1</td>
<td>130</td>
<td>82</td>
<td>135</td>
<td>86</td>
<td>127</td>
<td>79</td>
<td>126</td>
<td>80</td>
<td>79</td>
<td>32</td>
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</table>

Note. Listing of average blood pressure readings of each patient for each month of the project timeframe, the average blood pressure reading of each patient for the length of the project timeframe, and the total blood pressure count of each patient by month and the project length.

When comparing the average blood pressure readings of enrolled patients in the year 2020 to the average blood pressure readings in the first quarter of 2021, five patients saw their hypertension level increase. The other three patients remained in the same stage (see Table 6).

Table 6

Average Blood Pressure Readings and Stages of Hypertension by Patient

<table>
<thead>
<tr>
<th>Mean</th>
<th>2020</th>
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<td>P2</td>
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<td>Elevated</td>
<td>Elevated</td>
</tr>
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<td>136/76</td>
<td>140/85</td>
<td>Stage I</td>
<td>Stage II</td>
</tr>
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<td>133/75</td>
<td>Normal</td>
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<td>132/78</td>
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<td>152/82</td>
<td>Stage II</td>
<td>Stage II</td>
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</table>

Throughout the project, it was noted that four of the eight patients had a negative downward trend of their systolic blood pressures and four had an upward trend. It was also found
that six patients had a negative downward trend of their diastolic blood pressures and two had an upward trend (see Figure 1 and Figure 2).

**Figure 1**

*Systolic Trend Lines per Patient*
There were a total of 18 blood pressure medications prescribed for the patients enrolled during the first quarter of 2021. One of these medications was discontinued in February for one patient due to low home blood pressure readings. There were three blood pressure medication dose increases for three separate patients; two of the increases were in February and the other was in March. The patient who had a dose increase in March had another medication started just after this project’s completion. The Care Coach had contacted the office due to this particular patient having consecutive blood pressure readings in the yellow zone for five days. It was interesting to note that this patient had called the office the day before the Care Coach and was started on a medication that day. It is not clear if the other dose increases were in response to
Remote Patient Home Telemonitoring System

There were one hour and 37 minutes of Care Coach contact time throughout this project. These calls included patient education on devices, patient education on blood pressure, assessment of symptoms of high or low readings, and recommendations on further care.

Discussion

Acute Care Visits

When comparing total acute care visits of enrolled patients in 2020 to the total amount of visits during the first quarter of 2021, there was a decrease in the number of visits. However, if only the first quarter of 2020 were compared to the first quarter of 2021, there was one visit more during the project timeframe. It is to be noted that these visits were considered all-cause visits and were not related to the chronic diseases monitored in this project. It cannot be stated whether the telemonitoring intervention decreased the amount of acute care visits. It is likely, however, that because of the frequent monitoring and the contact made by the Care Coaches, that patients were guided as to how to proceed with their care. This may have prevented patients from panicking and unnecessarily presenting to the ED.

Estimation of Cost

The cost estimation of this project shows that by decreasing the amount of acute care visits in this rural health system, a wide range of charges to patients and insurance companies can be avoided. While the true solution to decreasing acute care visits is likely multifactorial, frequent monitoring via remote monitoring and healthcare staff contact can support patients in their health, thereby potentially lowering the threshold for patients presenting to the ED.

Following specific dollar amounts of patient charges throughout this project was outside of the
scope of this project. However, not only can telemonitoring possibly lower acute care visits, it can bring in revenue to a health system. The total dollar amount of charges was not realized during this project. This can be attributed to the novel change in procedure for patients, office staff, and Care Coach staff. A longer project length would likely show an increase in revenue for this service. Additionally, an increase in patient enrollment would increase the total amount of revenue per month.

**Effect on Chronic Disease**

It was noted that several patients fell into a higher hypertension stage during the telemonitoring intervention. There are several likely reasons for this. First, there were over 12 times as many blood pressure readings in the first quarter of 2021 than there were total at office visits in 2020. The increased number of readings allowed for more variation in readings due to extraneous variables. Also, it was noted that several patients’ readings were at the high end of their starting hypertension stage. A few points change would put them in the higher stage (see Table 6).

The results that indicate whether this intervention can assist with chronic disease maintenance are the trends of systolic and diastolic blood pressures. Four of the eight patients had downward trends of their systolic blood pressure, while six of the eight patients had downward trends of their diastolic pressure. While it may not have changed the stage of hypertension that these patients fell into, the trends give a clearer picture of variations in blood pressure over a specific timeframe. This can be incredibly useful for a provider who is managing blood pressure in an outpatient setting.
The PCIs of each patient did not change throughout the project. This is due to high PCIs at the start of the project and a lack of length of time for PCIs to possibly change. With more total diagnoses, the PCI was not likely to change. The usefulness of this outcome in this project was not high. However, for patients with a newer diagnosis of hypertension, the PCI may be incredibly useful as those patients may not have other comorbidities at the time of diagnosis. It would be more useful to track this over time in patients with a PCI of less than four.

The use of Care Coaches and their contact time with patients likely contributed greatly to patient use of the telemonitoring devices. While specific outcomes of patient contact were not measured in this project, topics of discussion between patients and the Care Coaches included patient education on blood pressure monitoring, education on how to manage hypertension, assessment of possible symptoms of high or low blood pressure, and assessment of other potentially acute problems. Two Care Coach calls resulted in the primary care office being contacted and blood pressure medication changes. There was some variation in Care Coach contact minutes per patient over the course of the project. It is unclear as to why this happened, though it was seen that for patients who had readings in the yellow or red ranges (moderate to acutely elevated), the Care Coaches did contact the patients.

As this was the first time this intervention has been used by this health system, the idea is to take what was learned in the project and apply it to the PDSA cycle. Additional chronic disease monitoring, such as using glucometers to monitor blood sugar readings and weight scales to monitor weight for patients with heart failure, will likely be added in the future. More patients will likely be enrolled as well. A more in depth look at overall cost of this intervention will also be studied.
Limitations and Recommendations

There were several limitations in this project. First, a small, convenience sample of patients was selected. All patients had a Medicare Advantage insurance plan, which excluded those patients with Medicare part B coverage or with commercial insurance. Second, the patients selected for this project were not chosen based on degree of blood pressure control nor on the number of acute care visits. If this criteria had been considered, the results may have shown better improvement on outcomes measured. Third, the comparison between outcomes was not robust. The timeframes of blood pressure readings was different in 2020 and 2021. Acute care visits were also not monitored across similar timeframes and for similar reasons. Fourth, the duration of patient monitoring was limited. More data could have potentially changed outcomes as there would have been more time to respond to elevations in blood pressure. It may also have affected the number of acute care visits. Finally, the COVID-19 pandemic could have potentially skewed some results in 2020. All of these reasons lower the generalizability of this project.

One ethical dilemma that could have possibly arisen in the project is the mishandling of patient data. There were no instances where this occurred in this project, but with EMR use, there is always the chance for protected health information to be lost or exposed. Additionally, there may have been many patients who qualified for this intervention outside of those with a Medicare Advantage insurance plan. A more standardized process for enrolling patients into a program like this need to be created. This process also needs to include an opportunity for those who have a copayment for the devices to enroll without cost hardship.

There are many recommendations that can be made as a result of this project. First, a larger sample size will most likely affect results. Second, more randomized control trials in rural areas should be conducted that specifically compare each outcome from this project: acute care
visits, cost, and effects on chronic disease. Third, if this intervention can truly be seen to affect acute care visits, it should be tailored to patients who have a certain number of previous acute care visits. Fourth, the utility of healthcare staff contact with patients during an intervention like this must be studied in greater detail. It would also be of benefit to conduct qualitative studies on patients’ comfort with devices, reported provider utility, and satisfaction of both patients and providers with this intervention.

**Conclusion**

There is a noticeable healthcare disparity gap in rural areas. One way to affect outcomes is through telemonitoring services. This pilot project shows that the use of a telemonitoring program in a rural setting may help decrease acute care visits, lower costs, and manage chronic disease in elderly populations. There are still many gaps in the research as to how effective this type of intervention may be in a rural area, but it does show promise. Findings of this project are also useful information that insurance companies and policy makers need to take into account when forming their policies.

**Funding**

This project did not use any direct funding. However, Engage Practice Solutions was contracted with the health system to help develop and implement this pilot project by funds obtained through the Rural Health Initiative.
References


http://www.ihi.org/resources/Pages/Tools/PlanDoStudyActWorksheet.aspx

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