

The Examination of Home-Based Cardiac Rehabilitation Program Implementation in  
Middle Tennessee

By

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## ABSTRACT

Cardiac rehabilitation is essential in providing supervised programs in which patients can utilize exercise, behavior modification, and patient education to improve quality of life and reduce morbidity and mortality rates following a cardiac event. Two forms of delivery that are being utilized by facilities, facility-based cardiac rehabilitation (FBCR) and home-based cardiac rehabilitation (HBCR). The purpose of this study was to examine how FBCR and HBCR programs are implemented in Middle Tennessee. A total of 5 facilities completed an interview with 10 closed-response and 35 open-response questions. The top barriers to FBCR reported were location of the facility, transportation, insurance, time, motivation, and fear of COVID. The top barriers to HBCR included lack of safety, accountability, motivation, equipment, and resources, as well as learning the technology. Interestingly, the only program with a recently implemented HBCR program only reported technology as a barrier to program implementation, indicating discord between anticipated and actual barriers to HBCR implementation.

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## **Chapter I**

### **Introduction**

Cardiovascular disease has been a persistent concern throughout the United States for decades. In fact, while there has been a decline in CVD mortality rates over the past 4 decades, cardiovascular disease is the leading cause of death in the United States (Wall et al., 2018). There are external factors that contribute to CVD. These factors can be characterized as modifiable and non-modifiable risk factors. Modifiable risk factors, such as hypertension, high-cholesterol, obesity, inactivity, smoking, elevated blood glucose levels and stress, can all be altered due to lifestyle changes made by the individual (Thomas et al., 2019).

Exercise has been shown to be effective in reducing the risk factors associated with CVD (Wang et al., 2017). Different forms of exercise have been used in reducing CVD risk factors and improving overall cardiovascular function, in which there is research examining how each form affects heart health. Aerobic exercise has been shown to improve blood pressure, blood lipid profile, and overall body composition (Fagard et al., 2001; Jakicic et al., 2001; Ross & Janssen, 2001). While aerobic exercise has been shown to improve functionality of the cardiovascular system, there is evidence that resistance training is also effective in the reduction of risk factors associated with CVD and improving the heart's health. In patients who are prehypertensive or hypertensive, resistance training has been found to reduce systolic and diastolic blood pressure values (De Sousa et al., 2017). When using resistance training as a stand-alone program, there is

an increase in aerobic exercise capacity and improvement in patient quality of life (Giuliano et al., 2017).

Being that exercise plays an essential role in the reduction of risk factors associated with CVD and has been shown to be effective in improving overall cardiovascular health, cardiac rehabilitation programs are implemented to emphasize and expand on these components. The purpose of cardiac rehabilitation is to provide a supervised program that incorporates exercise, psychological intervention, and patient education in hopes of reducing morbidity and mortality rates following a cardiovascular event (Shields et al., 2018). In establishing progression throughout cardiac rehabilitation programs, many facilities utilize a form of sub-maximal exercise testing, which is known as the 6 minute walk test (6MWT). The 6MWT is a valid and reliable test used to measure aerobic exercise capacity. This assessment tracks baseline values when entering the program and post-interventive values to show overall aerobic fitness changes (Cacau et al., 2016; Hayta & Korkmaz, 2017).

Cardiac rehabilitation has been expanded over the past decade to not only utilize facility-based cardiac rehabilitation (FBCR) programs, but also home-based cardiac rehabilitation (HBCR) programs. Research on FBCR concludes that these programs can effectively prevent a cardiac event in patients with CVD and reduce morbidity and mortality rates (Thomas et al., 2019). While FBCR has been shown to have positive outcomes, there are significant barriers associated with these programs. Barriers to these programs include transportation issues, insurance coverage issues, and the facility being a substantial distance from the individuals homes (Bakhshayeh et al., 2021). These barriers

are reflective on the programs completion rates, which is why HBCR programs have been implemented to improve patient satisfaction and participation (Kraal et al., 2017).

Home-based cardiac rehabilitation programs have not only given patients freedom to complete their visits remotely, but have also been shown to be an effective alternative to FBCR programs when comparing baseline to post-intervention values in FBCR programs and HBCR programs (Uszko-Lencer et al., 2017). Patients have associated HBCR programs with being more cost-effective than FBCR due to patients not having to miss work and risk a reduction in their income in order to make appointment obligations (Kraal et al., 2017). Due to the COVID-19 pandemic, many facilities closed their doors in an effort to maintain patient and staff safety, which left patients without a properly structured FBCR program (Drwal et al., 2020). When FBCR programs became unavailable during COVID-19, this promoted the use of HBCR programs to be used as an effective alternative. HBCR has been able to expand upon areas that have limited FBCR, including adherence to the program which has been found to be a barrier associated with FBCR (Dalal et al., 2010).

Patients' adherence to a program is reflective of their overall outcomes in the program, which in cardiac rehabilitation can be the difference in the prevention of a future cardiac event. Adherence within a HBCR program can be characterized by having a proper sense of self-management and motivation, which can in the long-term determine a more permanent lifestyle change than those of FBCR (Marchionni et al., 2003). Previous literature explains the core values and principles that can be predictive in increasing a patient's outcomes in the program, but little is known on general instrumentation, protocols and procedures used in HBCR outside of research. When

considering the equipment affiliated with HBCR, studies have concluded that adherence improved when patients were supplied with the necessary equipment (O'Connor et al., 2009).

While studies have concluded similar findings, there is limited research on the provision of equipment in regards to functional gains, adherence, and program outcomes in HBCR programs. This implies there is great importance in understanding the implementation, protocols and procedures being used in HBCR programs when determining their efficacy. In addition, although we know that there is evidence that home-based cardiac rehabilitation is effective, we do not know how consistent these programs are with what has been shown to work in research. The original purpose of this study was to examine the implementation of HBCR programs in the Middle Tennessee region, but due to limited availability of participants in the Middle Tennessee region with an implemented HBCR, the purpose of the study was adjusted. The adjusted purpose of this study was to examine the implementation of both FBCR and HBCR programs in the Middle Tennessee region. The areas of examination include program inclusion criteria, program duration, baseline measurements, progression measurements, minimum standards for a program to be effective, perceived barriers in both delivery types, and resources provided both in the program and upon graduation.

## **Chapter II**

### **Literature Review**

This review begins with a precis of the prevalence of cardiovascular disease and the risk factors associated with the disease. This includes exhibiting the correlation between the risk factors of cardiovascular disease and the genesis of atherosclerosis. The review then transitions to the effects exercise has on cardiovascular disease, explaining the benefits and decrease of risk factors exercise can yield. Next, the significance of cardiac rehabilitation is expressed, which leads to the discussion regarding home-based cardiac rehabilitation (HBCR) in comparison to facility-based cardiac rehabilitation (FBCR). This section is followed by the inclusion of barriers associated with FBCR that patients have experienced. The review then transitions to HBCR, explaining the value of HBCR and how it may be a tenable alternative to FBCR. Accompanying this, the review discusses the methodology, adherence and efficacy found in HBCR program. The literature review concludes with an overall summary.

#### **Prevalence and Risk Factors of Cardiovascular Disease**

Cardiovascular disease (CVD) is the leading cause of death in the United States. There are many factors that influence this disease, such as atherosclerosis and the established risk factors (May et al., 2012). Detection of atherosclerosis is of vital importance (Frostegård, 2013). According to Ley et al. (2011), in atherosclerosis macrophages and smooth muscle cells accumulate oxidized LDL-C, causing a foam cell to form releasing cholesterol around the cell. The accumulation of oxidized LDL-C and formation of foam cells are apparent in the observation and detection of atherosclerosis (Ley et al., 2011).

While detecting atherosclerosis is a pivotal part of preventing CVD, having knowledge of the risk factors is also imperative.

There are some risk factors that are non-modifiable, including age, sex, race, and genetic components (UCSF Health, 2020). However, one study found that atherosclerosis and CVD can be prevented with specific approaches targeting modifiable risk factors (Song et al., 2020). These modifiable risk factors include high blood pressure, high cholesterol (LDL-C), obesity, inactivity, smoking, type 2 diabetes, diet, and stress (Thomas et al., 2019). According to Alexander (1995), high blood pressure, also referred to as hypertension, poses a significant risk for CVD when considering the damage incurred by the interior wall of the artery with tempestuous blood flow (Alexander, 1995). A few additional risk factors that lead to CVD by damaging the vessels include use of nicotine, hypercholesterolemia, and hyperglycemia (Previtali, 2011). While there are pharmacological methods to manage hypertension, hypercholesterolemia, and hyperglycemia, these are only a temporary means of management. Alternatively, exercise has been found to have a positive effect in decreasing many of these risk factors leading to CVD (Ahmed et al., 2012).

### **The Effects of Exercise on CVD Risk Factors**

Some exercise approaches have been found to improve heart function and facilitate the reduction of CVD risk factors. As Wang et al. (2017) explains, aerobic exercise is the most commonly used method of exercise in patients with coronary heart disease (CHD). Aerobic exercise can consist of walking, jogging, running, leisure time activity, and swimming. Research exhibits regular aerobic exercise can decrease blood pressure (Fagard, 2001), blood triglycerides, body mass and body fat content (Jakicic et al., 2001;

Ross & Janssen, 2001) while increasing high density lipoprotein cholesterol (Leon, 2000; Leon et al., 2000) and improving glucose metabolism and insulin sensitivity (Kelley & Goodpaster, 2001). It can also decrease the risk of type II diabetes in patients who have abnormal glucose tolerance (Tuomilehto et al., 2001). One study exhibited a decrease in systolic blood pressure and myocardial oxygen intake, while also increasing the limit of exercise-induced ischemia and overall physical functionality (Zimmer, 2015).

Furthermore, aerobic exercise improves function and reduces remodeling of the ventricles in patients who recently had a myocardial infarction (Wang et al., 2017). While aerobic exercise is beneficial to heart health, resistance training is another form of exercise that aids in the reduction of CVD risk factors such as blood pressure.

Resistance training can also be an effective means of improving modifiable risk factors, as it has been shown to effectively reduce diastolic and systolic blood pressure in prehypertensive and hypertensive participants (De Sousa et al., 2017). In a meta-analysis of randomized controlled trials that evaluated the chronic effects of resistance training on prehypertension and or hypertension, Cornelissen et al.(2011) found that dynamic resistance training at moderate intensity and isometric resistance training at low intensity can be effective in reducing systolic and diastolic blood pressure. Another meta-analysis conducted by Giuliano et al. (2017) examined the effectiveness of using resistance training as a standalone program, which found resistance training can have a positive impact on increased aerobic exercise capacity and quality of life. By utilizing resistance training, patient gains in aerobic exercise capacity and quality of life could influence their recovery in cardiac rehabilitation programs and post-program maintenance.

While resistance training is an effective modality in patient recovery, a combination of aerobic and resistance training programs has been shown to be most effective. Schroeder et al. (2019) conducted a study which concluded a combination of aerobic and resistance training was even more effective in improving diastolic blood pressure and cardiorespiratory fitness than aerobic or resistance training programs alone. The participants of the study were randomly assigned to groups, such as no-training control, aerobic training only, resistance training only, and a combination of resistance training and aerobic training. By combining the two exercise methods, positive results were seen in as little as 8 weeks (Schroeder et al., 2019).

### **Cardiac Rehabilitation Programming**

#### ***The Utilization of Sub-Maximal Exercise Testing in Cardiac Rehabilitation***

In assessing functional capacity for patients in cardiac rehabilitation, the six-minute walk test (6MWT) is commonly utilized to track baseline values, as well as progression and regression (Cacau et al., 2016; Hayta & Korkmaz, 2017; Schopfer et al., 2020). The 6MWT has been shown to be valid with patients undergoing cardiac surgery (Chen et al., 2018), as well as both valid and reliable with individuals diagnosed with CHF (Uszko-Lencer et al., 2017). The protocol for the 6MWT in the following study included instructing the patients to walk at their maximum pace on a 30 meter walkway in an attempt to cover as much distance within the 6 minutes as possible (Hayta & Korkmaz, 2017). In using the 6MWT for pre- and post-testing measurements, the distances at which the patient traveled is reviewed to gauge improvements made overtime. One study ( $N = 56$ ) focused on data collected for 3 consecutive months in a cardiac rehabilitation program for individuals who had undergone a coronary artery bypass graft (Hayta &

Korkmaz, 2017). The findings of the study suggest that cardiac rehabilitation not only improves the reliability of the 6MWT, but also improves the reliability of other functional capacity measures.

### **Facility-Based Cardiac Rehabilitation**

Cardiac rehabilitation takes into account health-related behavior modification, patient education, and exercise to create an intervention that will assist in the prevention of a cardiac event in patients with CVD (Thomas et al., 2019). Thomas et al. (2019) explains it is evident that cardiac rehabilitation reduces mortality and morbidity in patients with heart failure, ischemic heart disease, or cardiac surgery. While facility-based cardiac rehabilitation is shown to be effective, there are barriers experienced within this program. Barriers have been found as a result of traditional protocol implementation in previous literature, which affected the outcomes of the program.

Carlson et al. (2000) created a 6-month program focusing on phase II and III rehabilitation utilizing 3 exercise sessions a week with ECG monitoring for the initial 3 months, educational instruction regarding on-site exercise along with risk factor management, but with minimal education in off-site independent exercise. With the traditional FBCR program in the study, it was found that significantly more participants in this group dropped out due to barriers consistent with facility-based program (Carlson et al., 2000). According to Bakhshayeh et al. (2021), the most common barriers reported by patients included transportation issues, lack of insurance coverage for rehabilitation, significant distance from the rehabilitation facility, and cost of travel. The study also suggested that individuals who were more than 30 minutes away from the facility were

less likely to attend the training sessions (Bakhshayeh et al., 2021). Consequently, completion rates of FBCR programs is a consistent issue.

In a systematic review conducted by Zwisler et al. (2016), it was apparent that completion rates of FBCR trials were surprisingly lower than those of HBCR. With FBCR programs being provided in numerous locations such as hospitals, community sports facilities, and university gymnasiums (Anderson et al., 2017), this still poses an issue for individuals living in isolated areas or during the pandemic. With cardiac rehabilitation being vital to many individuals' health, an alternate program is necessary to overcome the barriers of FBCR. Bakhshayeh et al. (2021) revealed while FBCR barriers hinder patient participation, HBCR programs is an effective alternative that has been positively reported in regards to patient participation.

### **Home-Based Cardiac Rehabilitation**

Home-based cardiac rehabilitation is a novel cardiac rehabilitation strategy that allows patients to complete their rehabilitation remotely. This program design has been shown to improve patient participation and adherence (Thomas et al., 2019). The protocols and procedures associated with these programs consist of a remote monitoring program tailored to the patient's specific diagnosis. According to the study conducted by Kraal et al. (2017), HBCR would be best used with patients who are moderate or low risk patients enrolled in cardiac rehabilitation. One study utilized a HBCR program consisting of nine 30-minute phone sessions within a 12 week period, in which the initial patient exercise intensity ranged from 60% to 75% of the peak heart rate reached from their 6MWT with the frequency and duration being tailored to the individual's specific diagnosis (Rohrbach et al., 2017). The HBCR phone visits included discussing topics such as behavior

management/modification, medication, nutrition, and weight management. These elements have been found in the literature to be a standard in the development and delivery of these programs and in indication of program efficacy.

Home-based cardiac rehabilitation programs are able to be accessed by patients at any given time and allow the patient to overcome barriers that would make completing a traditional FBCR program more difficult. Home-based cardiac rehabilitation has not only been found to be an effective alternative to FBCR, but can also be more cost efficient for patients because they do not risk missing work to schedule appointments (Kraal et al., 2017). While schedules are one reason HBCR may be a viable alternative to the traditional FBCR, the overall accessibility and convenience of HBCR programs has been reported as a positive characteristic of these programs (Grace et al., 2005).

Beyond the ability to overcome many of the barriers frequently associated with FBCR, during the COVID-19 pandemic many on-site cardiac rehabilitation centers closed their doors, leaving patients without the structured FBRC program needed to improve their health. Drwal et al. (2020) found that HBCR programs provided patients with care while allowing them and their healthcare providers to remain safe within their homes. Research conducted by Wakefield et al. (2014) supports the claim, similar to that of Zwisler (2016), that HBCR has a higher completion rate than FBCR. When comparing baseline and post-intervention outcomes following the HBCR program, it was suggested the HBCR program was an effective alternative to FBCR programs (Uszko-Lencer et al., 2017). While HBCR is an effective alternative to FBCR, some patients fear returning to exercise after experiencing a cardiac event (Rohrbach et al., 2017). If a patient does not

feel safe exercising and self-monitoring, this could make them more hesitant to participate in a HBCR program.

### ***Adherence in Home-Based Cardiac Rehabilitation***

A key factor in assessing the success of a HBCR program would be how well the participants adhere to the program. The literature states a patient's core values or principles can be successful in increasing the patient's motivation and adherence to a program that assists in risk factor modification (Epton & Harris, 2008). Due to HBCR patients being remotely monitored, patients who have a positive relationship with technology-enabled intervention are more likely to demonstrate better adherence in lifestyle behavior modifications (Claes et al., 2019). Claes et al. (2019) also concluded that a familiarization period enhanced patient engagement with the platform, yielding prolonged use. In a study conducted by Ge et al. (2019), two thirds of their HBCR participants ( $N = 1,033$ ) adhered to the program. Additionally, the results of this study found patients 65 years of age and older adhered better to the program than younger individuals, with men adhering better to the program than women (Ge et al., 2019). Ultimately, Ge et al. (2019) concluded patients with greater amounts of program knowledge, family support, and motivation adhered best in the program than those without these characteristics.

While program adherence is influenced by self-management, motivation, and self-efficacy, research shows that participants must also make lifestyle changes to experience lasting outcomes. Marchionni et al. (2003) suggest that with proper self-management and motivation, participants in HBCR can have a more permanent effect on lifestyle changes than those in FBCR. However, Jolly et al. (2005) found that while some home-based

cardiac rehabilitation programs are able to measure patient adherence, many trials do not report adherence due to the subjectivity. Adherence is a vital component in a successful HBCR program, which is why patient adherence to the protocol/procedures and care plan can influence the overall efficacy of the program and its implementation.

### ***Efficacy of Home-Based Cardiac Rehabilitation***

Schopfer et al. (2020) revealed in a pragmatic trial of 237 patients enrolled in the 12-week HBCR programs, patients who participated in HBCR programs showed improved functionality, self-efficacy, physical activity, and quality of life. The participants included in the study included patients who had been recently hospitalized for myocardial infarctions, percutaneous coronary interventions, or coronary artery bypass grafts (Schopfer et al., 2020). While we know HBCR can be effective, it is important to understand how to produce this desired outcome. As reported by Rohrbach et al. (2017), there was specific study inclusion criteria for HBCR participation, including acute myocardial infarction, coronary artery bypass graft surgery, obstructive coronary artery disease, stable angina, cardiac valve repair or treatment, cardiac transplantation, and congestive heart failure. It is important to understand the inclusion criteria for participants so methods of rehabilitation that pose a benefit to that population can be identified.

With the notably impressive adherence rates and at least equivalent efficacy, it is important to consider the importance of providing exercise equipment in HBCR programs for patient success. During HBCR, participants are instructed by clinicians how to self-monitor exercise intensity with a continuous heart rate monitor and taught how to use the 6-20 Borg dyspnea scale (Rohrbach et al., 2017). This is essential in not only

assessing exercise intensity, but also assuring patient safety. In one study, participants were supplied with home exercise equipment necessary for HBCR, such as heart rate monitors, cycle ergometers and treadmills, which was associated with program adherence (O'Connor et al., 2009). However, this study did not include an intervention with a group that was not supplied with exercise equipment. It appears that there is minute research regarding HBCR interventions targeting those who are supplied with exercise equipment and those who are not (Thomas et al., 2019).

While there is limited research on the provision of exercise equipment in comparison with non-provision of exercise equipment on functional gains, adherence, and program outcomes, there is research regarding the use of electronic tracking devices to assist in HBCR. A study conducted by Vogel et al. (2017) suggests that wearable smart tracking devices have potential to assist in improving the health of cardiac rehabilitation patients suffering from CVD. While many HBCR programs also use questionnaires, diaries, and phone-based interventions (Rawstorn, 2018; Frederix et al., 2017; Hwang et al., 2017; Maddison et al., 2011; Frederix et al., 2016; Rohrbach et al., 2017), many HBCR assessment tools lack the ability to share measurements and data with clinicians in real-time, which is possible within FBCR programs (Dor-Haim et al., 2019). While many assessments used in HBCR programs can represent progression, there is evidence that some assessments may not be a true reflection of progress. A study conducted by Freene et al. (2014) suggests unless the participants have a good understanding of exercise intensity, diaries used to log physical activity should be read circumspectly.

Some HBCR programs have been observed as using wearable activity monitors to aid in tracking physical activity, monitoring heart rate or other components that could be

associated with rehabilitation. When considering wearable activity trackers, it is important the devices' usability can be obtained by all ages. In terms of wearable activity trackers, most older adults were found to be accepting and to have a more clear understanding of its significance (Puri et al., 2017). Puri et al. (2017) also found that the equipment that could be characterized as comfortable, aesthetically pleasing, and cost effective were considered when assessing the impact of acceptance. In a study conducted by Preusse et al. (2017), findings suggest steps such as communicating personal benefits with the older population, creating tutorials, adding navigation of the platform to help the user, and allowing a trial-use period could be essential in helping wearable activity trackers appeal to the older population.

Due to the limited research associated with the provision of equipment in HBCR programs, further research is needed to understand if the techniques used to implement HBCR programs in facilities align with what has been shown to be effective in the literature for this type of program. The original purpose of this study was to examine the implementation of HBCR programs in the Middle Tennessee region, but due to limited availability of participants in the Middle Tennessee region with an implemented HBCR, the purpose of the study was adjusted. The adjusted purpose of this study was to examine the implementation of both FBCR and HBCR programs in the Middle Tennessee region. The areas of examination include program inclusion criteria, program duration, baseline measurements, progression measurements, minimum standards for a program to be effective, perceived barriers in both delivery types, and resources provided both in the program and upon graduation.

## **Summary**

Overall, research suggests HBCR programs can yield improvements such as exercise/functional capacity and quality of life (Chen et al., 2018). There are various approaches to the implementation of HBCR programs, which primarily include using phone visits or telemedicine to connect with patients regarding their progress in the program. According to Rohrbach et al. (2017), a HBCR program would be valuable as a standalone program or in addition to a FBCR program (hybrid program). Study evidence suggests that HBCR can result in higher exercise adherence and patient satisfaction compared to FBCR (Kraal et al., 2017), which expresses the positive outcomes of the program. While these HBCR benefits are crucial, it is vital to understand if the protocol/procedures, instrumentation, and implementation shown in the literature to be beneficial are being implemented within HBCR programs.

## **Chapter III**

### **Methodology**

#### ***Participants***

The Middle Tennessee region consists of the 33 counties located east of the Tennessee River (“*Middle Region*”, *n.d.*). Data was collected from cardiac rehabilitation facilities in Middle Tennessee counties, which included Davidson, Dekalb, Coffee, and Putnam county. Data was used to examine the procedures protocols, advantages, and barriers to HBCR and FBCR programs. Inclusion criteria includes facilities in these Middle Tennessee areas who have HBCR and/or FBCR programs implemented prior to time of recruitment and have had patients enrolled in the program, who have completed the program, or knowledge of the implementation of the program in order to give an accurate perspective. Facility recruitment occurred by contacting the facility by email or phone call and discussing the purpose of the study, which would then be followed by scheduling a virtual interview.

#### ***Procedures***

A survey was developed to determine the specifics of their home-based and/or facility program including the inclusion/exclusion criteria, proportion of patients enrolled in HBCR, if equipment is provided, and if so what equipment, what baseline measurements are taken, if progression measures are taken or if only pre/post measurements are taken, and how often the patients are reporting their progress in the program. Another aspect that was incorporated into the survey included if the facility utilizes telemedicine for their home-based programs and how the home-based program was delivered. A copy of the full survey is included in Appendix B. The survey was

administered on a video call with a cardiac rehabilitation facility nurse or exercise physiologist. These individuals needed to have adequate insight on the working of the program and methodology being provided to patients in completing the program successfully. If the nurse or exercise physiologist did not have proper insight on the program, a staff member who does have this knowledge completed the interview process.

### ***Statistical Analysis***

The questions provided in the interview were used to determine how FBCR and HBCR programs were being implemented and the barriers associated with each form of cardiac rehabilitation delivery. The interview conducted give insight on the inclusion/exclusion criteria for the individuals referred, program duration for optimal outcomes, resources provided to the patients to help with adherence to lifestyle changes, while also assessing the changes facilities witnessed during the COVID-19 pandemic in relation to what previous research findings have found to be consistent. The data collected from the interview were then used to determine if implementation of the programs were consistent throughout the five facilities in the Middle Tennessee area and identify barriers associated with the two types of program delivery. With a limited sample size, data are provided for each facility for each question. For the open-response format questions, themes were identified within the participant responses. Then, two independent researchers review the responses and tallied the frequency of each theme. Next, researchers reviewed their tallies with a minimum of 90% agreeance. This yielded the final frequency data for open-response questions.

## Chapter IV

### Results

#### *Program Characteristics*

The five facilities included in the study were located in different counties in Middle Tennessee, including Davidson ( $n = 2$ ), Dekalb ( $n = 1$ ), Coffee ( $n = 1$ ), and Putnam ( $n = 1$ ) counties. While all of the facilities currently had a well-established FBCR, none of the facilities reported a currently implemented HBCR program. One facility, however, did have a HBCR program during an 8-week shutdown period of the COVID-19 pandemic.

In regards to the duration of the programming at each facility, four of the five facilities reported an ideal program duration of 36 sessions, which would be accomplished with either 3 weekly visits for 12 weeks or 2 weekly visits for 18 weeks. In contrast, one facility reported a program duration of 8 to 12 weeks at 2 to 3 sessions per week. Throughout the four facilities consisting of the 36 sessions with 3 visits per 12 weeks or 2 visits for 18 weeks, it was noted by these facilities that three sessions a week yielded the most optimal outcomes and health related benefits in their experience. One facility in the study mentioned Centers for Medicare & Medicaid Services (CMS) guidelines require a minimum of 24 sessions, in which the number of visits per week and overall program duration is specific to the patient's diagnosis. While most programs were able to attain the 24-session minimum duration, it is also notable that one facility found that some individuals on Medicare were only approved for one exercise session a week. While duration is vital when implementing an effective program, the characteristics of the patients who qualify to be enrolled in the program is equally important.

Understanding the previous interventions/procedures and conditions will determine if a patient is suitable to benefit from a cardiac rehabilitation program.

### ***Patients Referred to Cardiac Rehabilitation***

There are many stipulations on the conditions and procedures that deem cardiac rehabilitation a necessity and vital to ensure optimal patient health outcomes. Facilities reported numerous conditions and procedures that are referred in their program, in which they must also consider CMS guidelines. In regard to CMS guidelines, there are many requirements that need to be met to qualify for coverage. Table 1 gives a detailed record of the reported criteria for program eligibility at each facility.

### ***Baseline and Progression Measurements***

Each facility reported several baseline measurements that would be used to establish the starting point and appropriate progression for their rehabilitation process (see Table 2). Exercise capacity was a measurement all facilities measured upon patient intake, but the method of assessment varied by facility. Two facilities (40%) had the patients perform stress tests using the modified Bruce protocol for either the treadmill or recumbent bicycle. Two facilities (40%) utilize the 6MWT as their secondary means of assessing exercise capacity, while two other facilities (40%) use this as their primary means of exercise testing. One facility (20%), however, did not have the space within their gym to properly execute the 6MWT protocol, therefore they obtain their baseline exercise capacity based on other means of the patients initial assessment. When considering when progression measurements are reported, three facilities (60%) report patient progress each visit, while two of the facilities (40%) report patient progress every three visits or every 30 days with a physician as shown in Table 2.

**Table 1*****Patient Criteria for Program Eligibility***

Patient Criteria	001	002	003	004	005
Myocardial Infarction	✓		✓	✓	✓
Coronary Stent	✓	✓	✓	✓	✓
Coronary Artery Bypass Graft (CABG)	✓	✓	✓	✓	✓
Valve Repair/Replacement	✓	✓	✓	✓	✓
Aneurysm Repair	✓				
Aortic Arch Repair	✓				
Congestive Heart Failure (CHF)*	✓		✓	✓	✓
Stable Angina with Ischemia	✓			✓	
Heart Transplant		✓	✓	✓	✓

*Note.* \*35% or less ejection fraction

**Table 2*****Baseline Measurements Recorded Upon Intake***

	001	002	003	004	005
Risk Factor Assessment	✓			✓	✓
Previous Procedures	✓	✓	✓	✓	✓
Barriers to Treatment				✓	
Tobacco Use	✓	✓		✓	✓
Medications	✓	✓		✓	✓
Fall Risk Assessment	✓			✓	✓
Cognitive Function					✓
HR (Exercise and Resting)	✓	✓	✓	✓	✓
BP (Exercise and Resting)	✓	✓	✓	✓	✓
Oxygen Saturation (SpO2 Monitoring)		✓	✓	✓	✓
Waist-to-Hip Ratio	✓				
Height and Weight	✓	✓		✓	✓
BMI (Body Mass Index)	✓			✓	✓
Lipid Profile		✓		✓	✓
Hemoglobin A1c		✓		✓	✓
RPE/RPD/METs (Rate of Perceived Exertion/Dyspnea)	✓	✓	✓	✓	✓
Telemetry Monitor	✓	✓	✓	✓	✓
Stress Test	Modified Bruce				Modified Bruce
PHQ-9 Questionnaire (Psychosocial)	✓	✓		✓	✓
Rate Your Plate Questionnaire (Nutrition)	✓	✓		✓	✓
Six-Minute Walk Test (6MWT)	Alternative to Modified Bruce	✓	✓	No Space for 6MWT	Alternative to Modified Bruce
When Progression Measurements are Taken	Every 3 Sessions	Every Session	Every Session	Every 30 Days	Every Session

### ***Advantages and Barriers in the Delivery of Cardiac Rehabilitation***

When participants were asked to provide an open-ended description of the barriers and advantages of FBCR, as well as barriers of HBCR, the researchers identified several key themes among the answers. A detailed breakdown of the frequency of the themes for each question are detailed in Table 3. When these five facilities were asked about what they consider to be barriers associated with FBCR delivery the most prominent barrier reported was the location of the facility ( $n = 3$ ; 60%). In addition to asking about barriers to success in FBCR programs, there are also perceived advantages with the in-person delivery of the program. For example, 80% of facilities ( $n = 4$ ) reported a key benefit of FBCR was safety and confidence. A detailed account of the reported advantages is provided in Table 3. With these advantages and barriers in mind, facilities were then asked about barriers they associate with HBCR. Regarding the most prominent barrier facilities associated with HBCR, four barriers were equally debilitating, including lack of patient safety ( $n = 2$ , 40%), lack of accountability ( $n = 2$ , 40%), lack of motivation ( $n = 2$ , 40%), and lack of equipment ( $n = 2$ , 40%). A detailed account of the themes identified is provided in Table 3.

### ***Resources Provided in Cardiac Rehabilitation***

Individuals were also asked to reflect on the bare minimum elements for a successful FBCR program, the training provided to participants in FBCR, and the resources provided upon “graduation” from the FBCR program in an open-ended question format. As with each of the open-ended questions, key themes in the answers were identified and frequencies were tallied. Table 4 gives a detailed account of the responses for each facility.

**Table 3*****Advantages and Barriers Associated with Home-based Cardiac Rehabilitation and Facility-Based Cardiac Rehabilitation***

		001	002	003	004	005
Barriers to FBCR	Transportation	✓	✓			
	Location	✓	✓			✓
	Fear of COVID		✓			
	Insurance	✓	✓			
	Time		✓		✓	
	Motivation			✓	✓	
Advantages to FBCR	Physical assistance	✓				
	Accurate measurements (BP/HR/O2)	✓				✓
	Support/Relationship-Building	✓		✓		
	Safety/Confidence	✓	✓		✓	✓
	Communication		✓			
	Education		✓			
	Accountability			✓		
Barriers to HBCR	Lack of safety (physician, technology)	✓			✓	
	Lack of accountability	✓		✓		
	Lack of motivation	✓		✓		
	Lack of equipment			✓		✓
	Lack of resources (staff/reimbursement)					✓
	Learning technology		✓			

**Table 4*****Resources Necessary for Effective Program Outcomes***

		001	002	003	004	005
Bare Minimum for Effective FBCR program	Education	✓				
	Motivation			✓		
	Promoting patient exercise	✓		✓	✓	
	Knowledgeable staff		✓			✓
	Understanding and following CMS guidelines				✓	✓
Patient Training for FBCR	Familiarization with the facility	✓			✓	✓
	Familiarization with the equipment	✓	✓	✓	✓	✓
	Identifying enjoyable exercise/motivation			✓		
Resources Provided Following “Graduation”	Education (stress, nutrition, etc.)	✓				
	Give workload for each exercise to continue on their own	✓	✓	✓		✓
	Understand when to reach out for medical assistance (“stoplight system”)	✓				
	Helping them find places to exercise prior to graduation	✓				✓
	Determine patient home access to equipment	✓				✓
	Provide home exercise program		✓	✓		
	Access to facility wellness gym/program (monthly fee)	✓		✓	✓	✓

### ***The Impact of COVID-19 on Cardiac Rehabilitation***

All facilities experienced changes during the COVID-19 pandemic, in which three facilities were forced to shut down due to safety concerns. Facility 001 noted being shut down on three separate occasions, which resulted in a shutdown between March 2020 to May 2020, July 2020 to August 2020, and a few weeks in September of 2021. Similarly, facility 005 had to close their doors for seven months in early 2020 and 7 weeks in 2021. The shutdown facility 002 experienced only lasted for 8 weeks in 2020, but during their shutdown they implemented a HBCR program. Facility 003 was unable to provide information regarding any closures the facility witnessed due to the COVID-19 pandemic. Unlike the facilities mentioned above, facility 004 did not shut down, but rather taught patients to disinfect their equipment, social distance, and wear a mask while in the facility. The facilities were also limited on the number of patients they could have in the facility at one time, in which one facility explained class size went from roughly 16 to 10 patients per class.

When asked about changes in enrollment, four of the five facilities indicated a drastic change in the program enrollment rates. Physicians were also limiting the number of procedures and patients being seen, which affected overall patient referral to the cardiac rehabilitation centers. While two facilities are just starting to witness an increase in patient enrollment nearing normal rates, one facility in this study currently has a wait list of 150 to 200 patients. One of the five facilities was unable to provide details on the changes witnessed in patient enrollment rates due to the COVID-19 pandemic.

When assessing if the overall outcomes of the program were compromised by COVID-19, four out of the five facilities reported seeing a change in program efficacy.

More specifically, three facilities noted that progress was negatively affected by the intermittent shutdowns and limited attendance. One facility emphasized that when the facility has opened their doors again prior to the shutdown, patients still felt limited comfort in attending their sessions. According to the staff of one facility, a HBCR program was implemented to ensure patients had proper intervention during the 8-week shutdown for COVID-19.

### ***Home-based Cardiac Rehabilitation Implementation***

The facility that implemented the HBCR program consisted of 20 to 30 participants enrolled throughout the 8-week period the program was offered. Based on the diagnosis of the patient, the patient would be scheduled to meet with a nurse or exercise physiologist one to two times a week through the patient portal for virtual meetings. The patient would undergo an online orientation in which they would be given the same forms and educational information used for the FBCR program. The forms were sent to the patient virtually and discussed in conjunction with instructions on how to use equipment to self-monitor throughout the program. Patients also accessed education information and were able to directly contact the facility about questions or concerns through the patient portal.

The facility explained that all virtual meetings were 30 minutes to an hour as a weekly progress check-in, but the patient was encouraged to exercise daily with the home exercise program provided to them. While no equipment was provided to the patient by the facility, this program took into account anything the patient may have in their home that would be useful. The facility noted that while only some patients had a treadmill at home, inclusion criteria for program eligibility included having access to a blood pressure

cuff and oxygen saturation monitor. The patients were familiarized during their initial orientation on how to monitor their blood pressure and oxygen saturation using these devices. If patients did not have a treadmill, walking or body weight exercises were encouraged and prescribed. The Rate Your Plate and PHQ-9 questionnaires were used to measure dietary habits and psychosocial factors, while the patients would self-monitor their resting/exercising heart rate and blood pressure.

While learning the technology was a reported barrier associated with the HBCR program, the facility found that the bare minimum required to effectively implement a HBCR included good communication with the patient, proper education, technology, and staff comfortable with the delivery of the program. The facility did find that while patients did express that they valued FBCR due to the overall outcomes and the relationships made throughout the program, patients desired HBCR during COVID-19 over FBCR. The facility also reported that during the time the HBCR program was being implemented patient adherence was 93%, which shows that this program is effective in relation to patient adherence. Therefore, while both forms of delivery have advantages and disadvantages, this HBCR program showed to have high adherence and reported positive outcomes.

## Chapter V

### Discussion

A key finding of this study is that while there are areas in which all facilities exhibited similarities in program implementation, there were also several differences, specifically in the barriers and advantages programs associated with FBCR and HBCR programs. The majority of facilities reported that in order to implement a successful FBCR program in yielding positive patient outcomes, the main focus is to promote patient exercise. It is equally important when providing training to the patients and proper resources to familiarize the patient with the equipment they will be using in the program, as reported by all facilities. Resources provided upon graduation are also an area that is vital in instilling long-term adherence to the program, in which facilities reported giving patients the workload for the machines being used to continue progress at home ( $n = 4$ ), while also offering patients the opportunity to exercise at their facilities wellness center for a monthly fee ( $n = 4$ ). Facilities who did not have an implemented HBCR program prior to recruitment had anticipated barriers associated running an effective HBCR program. However, it is notable that the only facility with a recently implemented HBCR program only reported learning the technology as a barrier, which no other programs reported on in this study. While there are similarities in resources and treatment such as these, there are areas in which facilities differ with baseline and progression measurements being one of those areas.

One important aspect of this study was understanding the program characteristics of each facility to establish similarities and differences in implementation. Regarding baseline measurements taken upon intake, only three facilities reported assessing fall risk

, which is dependent on diagnosis and age of the patient, as well as any procedures or interventions that had been completed. With an older patient population for cardiac rehabilitation, this fall risk assessment is crucial in determining the safest way for the individual to exercise with minimal risk. One facility elaborated on this by explaining that, with a typical patient age range of 55 to 60 years old, the fall risk assessment is vital. Another important baseline measurement included in the verbal description of programming was the assessment utilized to assess cardiorespiratory fitness and determine appropriate starting exercise intensity. Two facilities reported utilizing a modified Bruce protocol to complete a stress test and another group that solely used the 6MWT to assess exercise capacity. One facility did not have ample space for patients to complete 6MWT, basing the starting exercise capacity values on their initial assessment of the patient including risk factor assessment, previous procedures, activity level, and health related questionnaires. It was also an interesting finding to learn that only three facilities report patient progress each visit. The two other facilities had periodic reporting of patient progress, with one facility reporting patient progress every three visits and the other every 30 days, where a physician reevaluates the patient's exercise plan.

In addition to the baseline measures of physical performance, four of the five facilities used the PHQ-9 and the Rate Your Plate questionnaires. The PHQ-9 questionnaire is used to assess the mental aspects of patient health due to the large number of patients who experience depression after a cardiac event (Silber et al., 2015). The Rate Your Plate questionnaire on the other hand is used to assess the patients' usual dietary habits such as the intake of fat and cholesterol (Gans et al., 2000), which is essential in individuals recovering from a cardiac procedure and would like to make

lifestyle changes to better their health. Thus, there does appear to have been consistency in measures of mental status and dietary habits among the interviewed facilities.

Beyond addressing patterns in initial assessment protocols among facilities, it is also important to understand the aspects of FBCR that staff see as necessary to attaining proper program outcomes. These “bare minimum” qualities were crucial in understanding how to implement an effective program. The predominant response from facilities was simply to get the patient exercising ( $n = 3$ ), which could also be described as “any exercise is better than no exercise.” By ensuring the patient is exercising, this would promote healthy habits and lifestyle changes (Rohrbach et al., 2017). While it is important to understand the bottom line of what is effective in yielding positive outcomes for the patients' health and quality of life, it is equally important to provide resources as patients transition from the programming to managing their exercise and health habits on their own.

By transitioning patients into the program in a way that is easy to understand and by allowing them to visualize how their daily exercise sessions will begin, this could in turn help encourage patients to attend and how to continue making progress once the program has concluded. It is notable that following graduation, 4 facilities made sure the patients had access to the workloads needed to continue making progress, while four different facilities provided access to a facility wellness gym for a monthly fee. By giving patients these resources, this would help in encouraging the patient to continue exercise, thus promoting long-term adherence. By providing these resources, such as physical access to the wellness facility, patients are able to work out safely at their own convenience. Resources like this are one of the great advantages that FBCR has to offer

patients who want to continue to progress even after the completion of their time in cardiac rehabilitation.

When discussing other advantages associated with FBCR programs, one advantage that was emphasized by four facilities ( $n = 4$ ) was safety and confidence. Four facilities ( $n = 4$ ) expressed that patient safety is the primary concern when implementing a cardiac rehabilitation program, which was explained by the ability for a physician or cardiac rehabilitation specialist to aid a patient if they experienced a cardiac event during training associated with the programming. The suggestion from these facilities is that FBCR is safer, which may lead one to wonder if safety is a common obstacle in HBCR programs. However, there is evidence that HBCR programs are a safe and effective alternative to FBCR programs (Bravo-Escobar et al., 2017; Drwal et al., 2020). Bravo-Escobar et al. (2017) reported that HBCR programs with mixed surveillance were found to be just as safe and effective in low to moderate risk patients. Secondary to safety, accurate measurements ( $n = 2$ ) and relationship building ( $n = 2$ ) were reported as advantages of FBCR. One facility emphasized that the individuals working in cardiac rehabilitation are able to accurately monitor and measure patient values to ensure that they are exercising at safe levels. Building relationships with other patients participating in group exercise was also an advantage discussed, due to the promotion of accountability and motivation between patients. Future research is warranted on this topic, as the social component of FBCR programs remains to be thoroughly studied.

While there are advantages to FBCR, the facilities also reported barriers associated with FBCR. Location was found to be the most reported barrier throughout the five facilities ( $n = 3$ ), but other barriers such as transportation ( $n = 2$ ), insurance ( $n = 2$ ),

time ( $n = 2$ ) and motivation to attend ( $n = 2$ ) were also reported to have an effect on the adherence to the program. One facility explained that if an individual is having to travel a long distance to the facility for their session, they will most likely stop attending. The location of the facility had a direct impact on the distance patients are traveling to make their appointments, which in rural areas might not be as time- or cost-effective. Similar to the perceived barriers of FBCR programs in participants of the current study, Bakhshayeh et al. (2021) found that transportation, lack of insurance, time, and motivation were consistent barriers that impacted program completion rates and attendance. More specifically when it comes to time, Bakhshayeh et al. (2021) concluded that individuals commuting 30 minutes or longer to a session were less likely to attend.

Two facilities reported time as a barrier in association with two facilities, particularly for those who were currently employed during their time enrolled in the program, in which their sessions would conflict with their work schedules. As mentioned by one facility, the average age of patients enrolled in the program is between 55 and 60 years of age, in which many of these individuals need to continue working to provide their income. With these scheduling conflicts and patient safety concerns surfacing, the attendance and completion of FBCR programs was affected. It is encouraging that Grace et al. (2005) found that HBCR was optimal in patients who experienced time restraints such as these, in which patients could complete their sessions on their own time. Thus, HBCR does appear to be a viable solution in these instances, where patients can experience effective programming without the same time constraints.

A unique additional barrier presented by the COVID-19 pandemic that was addressed by participants in this study was that their location in the hospital specifically

deterred patients from participating or enrolling during this time in fear of contracting COVID-19, which directly affected program enrollment and completion rates. The fear of COVID-19 as a barrier to implementation of FBCR was only mentioned explicitly by one facility, which may have been the result of the open-ended question format. This specific facility reported decreased enrollment in 2019 to 2020 from 110 patients enrolled to only 70. The facility not only witnessed this decline in enrollment during these time periods, but claims that patients are often still afraid to attend their sessions in the facility. One study examined the impact of COVID-19 on cardiac rehabilitation, which discovered that delivery of FBCR was affected due to patients who were fearful of COVID-19 or could not access the facility (de Melo Ghisi et al., 2021). Furthermore, Gokseven et al. (2022) revealed older individuals are at more risk for fear and psychological disorders due to older adults being considered the high-risk group for contracting COVID-19. Thus, while only one facility mentioned the fear of COVID-19 as a barrier to FBCR implementation, one could presume that if a more specific question was asked about this, more facilities would have expressed this as a unique challenge.

Keeping the aforementioned barriers to FBCR in mind, facilities reported perceived barriers associated with HBCR to be lack of safety ( $n = 2$ ), lack of accountability ( $n = 2$ ), lack of motivation ( $n = 2$ ), and lack of equipment ( $n = 2$ ). While lack of equipment was reported by two facilities as a barrier, the facility in this study with an established HBCR program did not provide equipment to the patients, all patients had blood pressure cuffs and SpO<sub>2</sub> monitors prior to the start of the program. There has been limited research regarding the provision of equipment for HBCR participants. For example, Vogel et al. (2017) found that by using wearable activity trackers that were

provided to patients enrolled in home-based cardiac rehabilitation programs, patients were able to accurately self-monitor their time spent exercising, sedentary behavior, and steps taken. Additionally, Thomas et al. (2019) provided more exercise equipment to their participants, including home treadmills, stationary cycles, and heart rate monitors to help in self-monitoring resulted in the most adherence to the program. While there are research studies addressing the efficacy of HBCR programs when equipment is provided, the external experimental validity of that study format is limited. Thus, further research on this topic is needed.

While accountability ( $n = 2$ ) and motivation ( $n = 2$ ) were reported as perceived barriers associated with HBCR within the study, Marchionni et al. (2003) found that by promoting self-management and motivation, the outcomes of HBCR programs can yield comparable long-term changes as FBCR programs. One qualitative study found that nurse mentors who instilled hope and motivation for daily exercise in patients enrolled in their HBCR program saw greater relationship-building capabilities between patients and mentors, while also holding them accountable throughout their time in the program (Frohman, Lin & Chaboyer, 2017). Lack of resources and learning technology were only reported by one facility as a barrier, in which it was explained that older patients may have a harder time learning the technology needed to effectively implement HBCR. They went on to note that lack of resources was also a barrier due to limited staff and reimbursement to implement an effective HBCR program.

Although the facilities that have not recently implemented HBCR identified the previously mentioned barriers, it is noteworthy that the only barrier indicated by the one facility that has implemented an HBCR program during the COVID-19 pandemic was

technology. This barrier was attributed to the older population of patients enrolled in the program, who had a difficult time learning how to access the facilities patient portal for weekly check-in sessions. It is important to note that regardless of this barrier, the program reported 93% adherence of patients during the 8-week HBCR implementation. While this data is for a short duration HBCR that was forced due to the COVID-19 pandemic, it is encouraging to see that a larger-scale study ( $n = 1,033$ ) reported that two-thirds of individuals adhered to the HBCR program, although nothing was discussed regarding the provision of equipment (Ge et al., 2019). Thus, while the 93% adherence for the 8-week emergency HBCR may not be fully representative of what a normal program could expect, a majority of patients do seem to adhere to HBCR programs. Furthermore, Ge et al. (2019) reported that individuals 65 years of age and older adhered better to the HBCR program than younger individuals, although this study did not report levels of safety felt by the participants. This could suggest that once individuals become more comfortable with the technology that greater levels of adherence can be witnessed.

Adherence to a program does not only represent long-term modifications that can better patient health, but can also improve the overall efficacy of the program. When implementing a program, overall program efficacy is vital in ensuring the patient gets proper intervention to instill adherence of the program, thus resulting in the improvement of the patient's quality of life. Schopfer et al. (2020) found that improvements in self-efficacy and independent functionality can be witnessed by patients who participate in HBCR programs. The facility within this study that had an implemented HBCR program during COVID-19 concluded that while FBCR was able to provide positive outcomes and promote relationship building aspects from in-person delivery, HBCR was an effective

alternative to FBCR in yielding positive program outcomes and keeping the patients safe within their homes. Not only is this remote delivery important in times such as the COVID-19 pandemic, but also for those individuals who live in rural areas or do not have reliable transportation. There is evidence that individuals living in rural communities would benefit from a remote delivery of cardiac rehabilitation due to their limited number of neighboring facilities (Blair et al., 2011).

The non-provision of equipment could be conceived as a barrier, but for the program discussed with this facility, minimal equipment was needed. Equipment plays a partial role in the implementation of the program, but the structure of the program and instruction provided is vital to yield program outcomes. The resources available to the facilities, including staff and reimbursement, can affect a program's proper implementation. It was noted by one facility that due to a lack of staff and reimbursement they were unable to implement a program during their shutdown period, but if they had proper reimbursement and ample staff they would. By facilities closing due to the COVID-19 pandemic, patients were going without proper intervention needed to have positive outcomes following their procedures.

These findings can be applied by emphasizing that HBCR programs would not only help in situations such as the COVID-19 pandemic, but also to target those who are unable to attend FBCR due to the barriers previously noted. Once barriers associated with HBCR and how to avoid these barriers have been identified, this could lead to more HBCR implementation and utilization. By applying the findings obtained from an implemented HBCR program, the use of an in-depth familiarization period to understand the platform being used for older adults could eliminate the difficulty in learning the

technology. The implementation of these HBCR programs would not only give patients the option to complete their program without experiencing some FBCR barriers, but could also build long-term adherence to the program. The only barrier that the implemented HBCR program reported was the difficulty with older individuals adjusting to the technology being used, but once the familiarization period and orientation was complete the program yielded program adherence of 93%. Not only does this support that HBCR can be effective, but that FBCR program barriers can be overcome with the implementation of a HBCR program to improve program completion rates and outcomes.

This study is mindful of limitations, which primarily includes the sample size. Since only 5 facilities were interviewed and only one facility had previously implemented a HBCR program, a more thorough description of FBCR and HBCR program implementation is warranted. Another limitation to this study would include that facility 003 was unable to provide information regarding any closures the facility may have witnessed during the COVID-19 pandemic or any changes in enrollment rates during this time. Finally, the open-ended response format may have resulted in some facilities leaving off information they would have mentioned had the questions been more focused/targeted.

In conclusion, the findings of this study emphasize that the barriers and disadvantages associated with both FBCR and HBCR are important when considering how to adapt the program to minimize patient discomfort, as well as to maximize program adherence and outcomes. There were programs who experienced extensive shutdowns throughout the COVID-19 pandemic, with one program implementing an effective HBCR program with positive outcomes. In consideration with the HBCR

program that was implemented, the only barrier reported by the facility was learning the technology by the older patients, which is notable in comparison with the anticipated barriers reported by facilities without an established HBCR program. It is important to establish the ability HBCR programs have in overcoming barriers such as transportation, location, and time that have been associated with FBCR. These findings suggest that by implementing the appropriate number of weekly check-ins and resources to patients in a HBCR program, proper adherence can be attained and barriers associated with FBCR can be overcome. There are anticipated barriers associated with HBCR programs, but it is important to understand that those implementing the program within the study did not report the majority of anticipated barriers. Home-based cardiac rehabilitation programs have been shown in previous literature, but also within this study to result in positive program outcomes.

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APPENDIX A

**IRB**  
**INSTITUTIONAL REVIEW BOARD**  
 Office of Research Compliance,  
 010A Sam Ingram Building,  
 2269 Middle Tennessee Blvd  
 Murfreesboro, TN 37129  
 FWA: 00005331/IRB Regn. 0003571



**IRBN001 - EXPEDITED PROTOCOL APPROVAL NOTICE**

Friday, March 18, 2022

**Protocol Title**                    **The Examination of Home-Based Cardiac Rehabilitation Program Implementation in Middle Tennessee**  
**Protocol ID**                        **22-211 7qv**  
**Principal Investigator**        **Jamie Lynn Judkins** (Student)                    *Faculty Advisor: Samantha Johnson*  
**Co-Investigators**                Vaughn Barry  
**Investigator Email(s)**        *jjj9c@mtmail.mtsu.edu; Samantha.johnson@mtsu.edu*  
**Department**                      Exercise Science  
**Funding**                             NONE

Dear Investigator(s),

The above identified research proposal has been reviewed by the MTSU IRB through the **EXPEDITED** mechanism under 45 CFR 46.110 and 21 CFR 56.110 within the category (7) *Research on individual or group characteristics or behavior*. A summary of the IRB action is tabulated below:

<b>IRB Action</b>	<b>APPROVED for ONE YEAR</b>		
<b>Date of Expiration</b>	<b>2/28/2023</b>	<i>Date of Approval: 3/8/22</i>	<i>Recent Amendment: 3/18/22</i>
<b>Sample Size</b>	TWENTY FIVE (25)		
<b>Participant Pool</b>	<i>Target Population:</i> Primary Classification: <b>General Adults (18 or older)</b> Specific Classification: <b>Currently active HBCR program member</b>		
<b>Type of Interaction</b>	<input type="checkbox"/> Non-interventional or Data Analysis <input checked="" type="checkbox"/> Virtual/Remote/Online interaction <input type="checkbox"/> In person or physical interaction – Mandatory COVID-19 Management		
<b>Exceptions</b>	Qualtrics data collection done within the Zoom session is permitted		
<b>Restrictions</b>	1. <b>Mandatory ACTIVE Informed Consent.</b> 2. <b>Other than the exceptions above, identifiable data/artifacts, such as, audio/video data, photographs, handwriting samples, personal address, driving records, social security number, and etc., MUST NOT be collected. Recorded identifiable information must be deidentified as described in the protocol.</b> 3. <b>Mandatory Final report (refer last page).</b> 4. <b>NOT approved for in-person data collection</b>		
<b>Approved Templates</b>	<i>IRB Templates:</i> Zoom Informed Consent <i>Non-MTSU Templates:</i> Email and telephone recruitment scripts		
<b>Research Inducement</b>	NONE		
<b>Comments</b>	NONE		

## APPENDIX B

### The Examination of Home-Based Cardiac Rehabilitation Program

#### Implementation in Middle Tennessee

Q28 Protocol ID:

The Examination of Home-Based Cardiac Rehabilitation Program Implementation in Middle Tennessee

PI: Jamie Judkins

Faculty Advisor: Samantha Johnson

Approval Date: 03/08/2022

Expiration Date: 02/28/2023

\*Questions without response options were open-ended questions.

Participant ID

#### Q1 What county is your facility located in?

- |                                      |                                     |
|--------------------------------------|-------------------------------------|
| <input type="radio"/> Davidson (2)   | <input type="radio"/> Cheatham (7)  |
| <input type="radio"/> Rutherford (3) | <input type="radio"/> Robertson (8) |
| <input type="radio"/> Williamson (4) | <input type="radio"/> DeKalb (9)    |
| <input type="radio"/> Wilson (5)     | <input type="radio"/> Coffee (10)   |
| <input type="radio"/> Sumner (6)     | <input type="radio"/> Putnam (11)   |

#### Q2 Does your facility have a home-based cardiac rehabilitation program?

- Yes (1)
- No (2)
- I don't know (3)

#### Q3 Has your facility ever had a home-based cardiac rehabilitation program?

- Yes (1)
- No (2)

I don't know (3)

**\*Q4 Researcher notes of previous implementation:**

**\*Q5 What type of patients are usually referred to this program and why?**

**\*Q6 How many weeks does the typical FBCR program last?**

**\*Q7 How many weekly sessions are patients expected to perform in your FBCR program?**

**\*Q8 Are baseline measurements taken? If so, which measurements.**

**Q9 Are progression measures taken intermittently during the program or is it solely pre/post measurements?**

Pre/Post measurements taken (1)

Progression measurements taken (2)

**\*Q10 How often is patient progress reported or checked in on?**

**\*Q11 What would you consider barriers associated with FBCR?**

**\*Q12 What are advantages established in FBCR that are not available in HBCR programs?**

**\*Q13 What are barriers you would associate with HBCR programs?**

**\*Q14 What would you say is the "bare minimum" for an FBCR program being effective?**

**\*Q15 Could you please explain any training your patients go through to be able to participate in your FBCR program.**

**\*Q16 What resources are provided to the patient when they have "graduated" from your FBCR program to continue to make progress at home?**

**\*Q17 Did your facility offer CR during COVID-19? If so, how did this change the daily function of the program?**

**\*Q18 Did COVID-19 affect the amount of people being enrolled in the program?**

**\*Q19 If yes, when? For how long? How much would you say it changed? If no, was there a particular reason for that?**

**\*Q20 Did your program offer a home-based alternative during COVID-19?**

**\*Q21 If so, can you explain the elements used in the home-based alternative program?**

**\*Q22 Do you think COVID-19 affected the overall outcome for patients enrolling during this time?**

**\*Q23 Can you estimate how long your facility has implemented a HBCR?**

**\*Q24 Researcher notes: (has it been consistent?)**

**\*Q25 Currently, what type of patient is referred to the HBCR program and why?**

**\*Q26 Can you estimate the proportion of patients enrolled in your HBCR program?**

**\*Q27 For how many weeks does a typical HBCR last at your facility?**

**\*Q28 How many weekly sessions are patients expected to perform in your HBCR program?**

**\*Q29 How does the duration and number of weekly sessions compare to your FBCR?**

**\*Q30 Is equipment provided to patients in the home-based cardiac rehabilitation program?**

Yes (1)

No (2)

**\*Q31 If equipment is provided, please explain the equipment being provided.**

**\*Q32 Are baseline measurements taken? If so, which measurements.**

**\*Q33 Are progression measures taken intermittently during the program or is it solely pre/post measurements?**

Progression measurements are taken (1)

Pre/post measurements are taken (2)

**\*Q34 How often is patient progress reported or checked in on?**

**\*Q35 What barriers do you think there are for HBCR programs in general?**

**\*Q36 Do you know of any barriers to your facility's HBCR?**

**\*Q37 What would you say is the "bare minimum" for an HBCR being effective?**

**\*Q38 Could you please explain any training your patients go through to be able to participate in your HBCR program.**

**\*Q39 Do you think HBCR and FBCR are similarly effective? Please explain your reasoning.**

**\*Q40 Did you provide HBCR prior to COVID?**

Yes (1)

No (2)

**\*Q41 Did HBCR change during COVID?**

Yes (1)

No (2)

**\*Q42 If yes, how did it change? If no, why not?**

**\*Q43 At any point, did COVID affect how many people were referred to HBCR over FBCR?**

Yes (1)

No (2)

**\*Q44 If yes, when? For how long? How much would you say it changed? If no, was there a particular reason for that?**

**\*Q45 Do you think patients desired HBCR more during COVID?**

Yes (1)

No (2)