THE EFFECT OF TELEHEALTH ON 30-DAY READMISSIONS IN MEDICARE BENEFICIARIES FOLLOWING ISOLATED CORONARY ARTERY BYPASS GRAFT SURGERY

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By

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ABSTRACT

Cardiovascular disease (CVD) is the leading cause of death in 45.1% of Americans. Each year in the United States, 790,000 suffer myocardial infarction as end organ damage from coronary disease. Coronary artery bypass graft (CABG) surgery is a life-saving procedure for many patients with severe coronary artery disease. However, hospital readmissions for complications within 30 days after CABG discharge pose substantial burden to patients, families, and the healthcare system. This scholarly project examined the effect of a telehealth (TH) program in addition to usual discharge care on 30-day readmissions in Medicare isolated CABG patients. A retrospective case-controlled analysis of TH program data was conducted at a single project site. Medicare patients who participated in a TH program after discharge to a home setting following isolated CABG surgery from 5/1/17-4/30/18 were compared with a causal comparison group receiving usual care from 5/1/16-4/30/17. A total of 83 cases (51 control; 32 treatment) met inclusion criteria. No statistically significant differences were noted in 30-day all cause readmission (p=0.568), emergency room encounters (p=0.785) or readmissions specifically related to atrial fibrillation, heart failure, or pleural effusion. The treatment group showed a trend toward timely follow-up to cardiology appointments, with a reduction from 19.8 to 13.7 days (p= 0.062). The treatment group experienced no failures to show for surgical follow-up appointments. Treatment interventions due to TH primarily consisted of medication initiation and titration. Therefore, one practice recommendation is to incorporate a diuretic script into the discharge plan with instructions for use. A second recommendation is to remove barriers

to surgical follow-up by utilizing nurse practitioners to evaluate these postoperative patients within one week of discharge. A final recommendation is to evaluate best practices for discharge care post isolated CABG surgery for incorporation into the American Hospital Association (AHA)/American College of Cardiology (ACC) guidelines. Reducing hospital readmissions from siloed care represents an opportunity to reduce cost and improve transitions of care practices.

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DEDICATION

With unending love and gratitude to my mother, Catherine Shaughnessy, forever my biggest fan, who purchased my first childhood “nurse kit” that sparked my lifelong love and desire to care for others. To my husband, Wayne Brumer, for your love, support, and endless patience as I pursued yet another degree. To my daughter Katerina, (my study buddy), may you never be afraid of the hard work necessary to pursue your dreams!

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Chapter I-Introduction

Cardiovascular disease (CVD) is a group of acute and chronic diseases that affect the heart or blood vessels. CVD of the blood vessels includes peripheral vascular disease, cerebrovascular disease, aortic artery aneurysms, and coronary artery disease (AHA, 2018). In the United States (US), CVD is the leading cause of death in 45.1% of Americans, and the cause of death in over 836,547 people annually (AHA, 2018). While overall cardiovascular mortality rates have declined over the past ten years, CVD continues to significantly impact individuals in the US. This results in the financial costs of CVD totaling more than $320.1 billion, including direct health care costs and indirect costs, such as lost productivity (Williams, Walker, & Egede, 2016).

A form of cardiovascular disease, coronary artery disease (CAD) is caused by an increase of cholesterol-rich plaque within the inner lining, or endothelium, of the coronary arteries. These plaque deposits narrow the arterial lumen, which may lead to ischemia or reduced oxygen and blood flow to the cardiac muscle, or myocardium. In many individuals, this ischemia causes chest pressure (angina) and may result in a myocardial infarction (MI). An estimated 790,000 adults experience a myocardial infarction (MI) each year and approximately 370,000 die from this event annually (American Heart Association, 2018). To avoid these life-threatening events, CAD is treated with a combination of lifestyle modification (diet, exercise, tobacco cessation), medical therapy, and percutaneous interventions. If these measures fail and angina is progressive, or arteries have significant stenosis (>70% narrowing of the lumen), then large areas of myocardium are at risk of injury or necrosis, and surgical intervention may be warranted (National Heart, Lung, and Blood Institute, 2016).

Coronary artery bypass graft (CABG) surgery is an intervention that can improve mortality and morbidity for many individuals with severe CAD. The CABG procedure involves repositioning an internal mammary artery from the chest, or radial artery from the forearm, or greater saphenous vein from the leg, to serve as conduits rerouting oxygen-rich blood past the arterial blockage to improve blood flow to the ischemic areas of the heart. Surgical access may be obtained via sternotomy, thoracotomy, or minimally-invasive robotic approach. The procedure may be performed with cardiopulmonary bypass or beating heart technique (Bojar, 2011).

In 2016 there were 156,931 CABG procedures performed in the US (Society of Thoracic Surgery [STS], 2017a) for patients with the following clinical presentations: symptomatic left main artery disease, triple vessel disease, more than 70% proximal stenosis of the left anterior descending artery (LAD), greater than 70% stenosis of the left circumflex artery, with either ejection fraction (EF) less than 50% or demonstrable ischemia on noninvasive testing. While considered a life-saving procedure for many patients, CABG is a major surgery and post-procedure complications may occur following surgery and after hospital discharge. The goal after CABG is to transition the patient to home at the end of hospitalization without readmission for complications from the surgical stay. Whenever a patient experiences a complication causing hospital readmission, this situation creates a financial, physical, and emotional burden for the patient, their family, and the healthcare system.

Statement of the Problem

According to the Medicare Payment Advisory Commission (MedPAC), nearly 20% of all Medicare beneficiaries discharged from a hospital return within 30 days at an approximate cost of $17.4 billion annually (American Hospital Association, 2011). For the CABG population,

readmissions occur for a variety of reasons, such as arrhythmias, heart failure (HF), and pleural effusions. These problems are often attributed to unresolved issues from the original hospitalization and provide opportunities for mitigation (Bojar, 2011). Due to rising costs related to health expenditures, preventing 30-day readmissions has become a top priority for hospitals nationwide in the era of health care reform. Since the Patient Affordable Care Act became law in 2010, requirements for health care facilities to reduce unintended readmissions have been established. CABG surgery ranked highest (13.5%) for potentially preventable readmissions within 15 days following discharge as well as the second-highest average Medicare payment ($8,136) per readmission (Report to the Congress, 2007). In 2008, the 30-day potentially preventable CABG readmission rate was 18.1%, accounting for $215 million of a total $12 billion dollars (1.8%) of Medicare readmission spending (Medicare Payment Advisory Commission [MedPAC], 2008).

Established by a provision in the Affordable Care Act (ACA), the Hospital Readmissions Reduction Program (HRRP) requires Medicare to reduce payments to hospitals with relatively high readmission rates for patients with traditional fee-for-service Medicare insurance (Boccuti & Casillas, 2015). High readmission rates and costs associated with the medical diagnoses of MI, HF, and pneumonia were initially targeted for payment penalties. Beginning on October 1, 2016, patients readmitted within 30 days after isolated CABG (without concomitant valvular procedures) surgery were added to the calculation of a hospital's readmission payment adjustment factor. The 3% penalty imposed for 2017 CABG procedures is based on retroactive performance measures from July 2012 through June 2015 (Centers for Medicare and Medicaid Services, 2016).

Significance of the Problem

The 30-day transition period from hospital to home after CABG is characterized as a vulnerable time for many patients. A patient's health status continues to evolve after discharge from the hospital and in-patient treatments continue to have an effect on their physiology (Soundarraj, Singh, Satija, & Thakur, 2017). During transitions of care, medical instability and lack of care coordination contribute to unexpected events affecting outcomes for many patients, including rehospitalizations.

Since the HRRP selected Medicare patients undergoing isolated CABG procedures as a target population to reduce expenditures for readmission, appraisal of the project site's performance was conducted. A review of the procedures performed at the project site for 2016 included: isolated CABG procedures (58%), isolated aortic valve replacement (21%), combined aortic valve replacement/CABG (12%), mitral valve replacement (MVR) (4.6%), combined MVR/CABG (0.4%), and mitral valve repair (3.4%) (STS, 2017a). In addition, the project site performed 56 trans-aortic valve replacements (TAVR) and 11 left ventricular assist device (LVAD) implantations in 2016, which are not included in the STS adult cardiac surgery database procedure registry.

In 1989, the STS began collecting data from each institution performing cardiac surgical procedures to compare outcomes, and to improve quality and patient safety throughout the nation. One of the first measures evaluated by the STS was the 30-day readmission rate for adult patients greater than 18 years old following isolated CABG surgery.

For the basis of this project, the baseline for comparison was the average national STS 30-day readmission percentage for isolated CABG of 10% for calendar year 2016 (STS, 2017a) compared to the study institutional readmission rate of 14.1%. The STS adult cardiac surgery

database provides quarterly institutional and national reports on readmission rates as well as delineating reasons for the readmission. The project site's three primary causes of readmission included atrial fibrillation (AF) arrhythmia, HF, and pleural effusion (STS, 2017a). The STS report (2017a) also revealed that the national percentage of patients aged 65 and over undergoing isolated CABG was 55.5%, compared to this project site's institutional age rate of 65.7%. This age discrepancy suggests that the older and potentially more complicated patients treated at this project site may benefit from a patient-centered strategy that identifies problems earlier and provides opportunities for timely corrective action to decrease readmission rates.

The key for reducing readmission rates depends on delivering high quality care in the inpatient setting and improving the transitional care upon discharge. Discharge planning and care coordination were identified as essential elements to achieve successful transitions after discharge following CABG surgery and to prevent unnecessary readmissions (Bojar, 2011). A systematic review conducted by Fasken, Wipke-Tevis, and Sagehorn (2001) reported on 1000 patients who underwent CABG surgery and identified 629 readmissions. Many of the readmissions reported in the systematic review occurred within 14 days of discharge. Fasken and colleagues (2001) identified three common reasons for readmission: arrhythmias, volume overload (pleural effusions and HF), and wound infections. Shahian et al. (2014) developed a clinically based risk model which identified common CABG readmission predictors including dialysis, creatinine level greater than two, severe chronic lung disease, recent MI, female gender, age per 10-year increase, obesity in women, low body surface in men and preoperative AF. These authors recommended careful discharge planning, patient education, and coordination of follow-up to mitigate these events. Similar to the findings from Fasken and colleagues, the

project site experienced AF and HF/volume overload as prime causes of patient readmission, although the infection rate of 0% is better than the national infection rate benchmark of 0.3%.

Provision of appropriate care at the right time is an ethical obligation of the healthcare team as well as the expectation of the patient. Transition from hospital to home can be challenging and stressful for patients and families. New medications, dietary restrictions, wound care, and lifestyle behavior changes, coupled with physical limitations and recovering from a major surgery and hospitalization, can be daunting to manage. Patient anxiety plus poor communication among home care services, hospital, and providers can lead to disjointed care and increase the risk of readmission from unaddressed needs (Bojar, 2011).

Unplanned readmissions affect patients and their support systems, the healthcare system performing the procedure, and society at large when unnecessary costs are expended to correct complications. Hospital readmissions negatively impact healthcare organizations performing CABG procedures as additional time, money, and resources are utilized. Therefore, early identification of potential complications and reduction of unplanned readmissions following CABG surgery through the use of evidence-based initiatives is crucial to reduce cost, enhance patient safety, and improve patient outcomes. Today's advances in technology and computerization have allowed initiatives such as telehealth (TH) to flourish. The use of TH with post-discharge, isolated CABG patients may foster patient recovery and stability in the home setting.

Telehealth

Since the ACA incentivizes providers to reduce readmissions, hospitals are seeking innovative technology to deliver health care services and information that improves the quality, safety, access, efficiency, and costs of care (Agency for Healthcare Research and

Quality, 2008). Telecommunications methods such as the phone (telemedicine) have been used in medical care for decades (American Telemedicine Association, 2016). Indeed, the terms telemedicine and TH are often used interchangeably. According to the American Telemedicine Association (2016), TH involves the remote delivery of health care services and clinical information using telecommunications technology. This technology includes the internet, wireless, satellite, and telephone media. TH services are divided into three modalities: Asynchronous (store and forward), synchronous (live consultations), and remote patient monitoring (RPM). Examples of RPM tools include weight, vital signs, and electrocardiograph recordings**.** Telehealth is used to provide services such as "basic medical care (primary care), specialty care (e.g., stroke, cardiology, dermatology, and mental health), patient monitoring (e.g., in intensive care units or at a patient's residence), case management, education, and off-site interpretation of medical images (Medicare Payment Advisory Commission [MedPAC], 2018, p. 475).

The merits of TH have been studied most frequently as a component of disease management and readmission prevention in combination with nursing support. With this approach, nurses are the front-line health professionals to identify signs and symptoms of clinical deterioration and intervene to make appropriate referrals and provide patient education. These interventions are initiated with a goal of improving patient self-care. Self-care is believed to correlate with a positive effect on quality of life (QOL) and to reduce depression and frequent readmissions associated with heart failure (Delaney & Apostolidis, 2010).

Schwamm et al. (2017) issued recommendations for TH implementation in cardiovascular and stroke care based on the American Heart Association (AHA) policy statement. The statement proposes that TH can reduce cardiovascular burden and improve

accessibility to care. Schwamm et al. (2017) states that the AHA consensus recommendations should guide the development of programs specific to disease-based use of TH. For this scholarly project, the use of TH was evaluated as a possible method to reduce readmission in the CABG population and achieve the Institute of Medicine's six domains of quality care (Agency for Healthcare Research and Quality, 2016). These domains include the categories of safety, timeliness, efficiency, effectiveness, equity, and patient-centered care. TH facilitates the safety domain by promoting frequent or continuous monitoring of patients with specific, well defined conditions. Timeliness is achieved when TH interventions improve access to important health information between traditional health visits, and permit earlier detection of adverse trends. The AHA endorses TH as a modality to improve efficiency by potentially reducing the use of transportation and for brick-and-mortar exam rooms. By incorporating a larger amount of data in a more timely and efficient manner, TH offers an opportunity to detect clinical deterioration earlier, allowing for prompt intervention and patient-centered care (Schwamm et al. 2017). TH was proposed as an addition to current discharge care for isolated CABG patients as a method to screen and intervene for potential problems.

Barriers to Telehealth Implementation

While TH is a promising modality to improve patient outcomes, large-scale implementation is challenging in terms of budget (cost of technology and infrastructure to monitor), educating patients in the use of devices, training providers in the collection and interpretation of results, as well as incorporating the remote patient data into routine clinical practice. Another barrier to implementation has been the lack of financial reimbursement for TH services (Center for Connected Health Policy, n.d.). However, this aspect is changing. In January 2015, CMS created a new chronic care management billing code, which provides for

non-face-to-face consultation. By not defining the codes as TH services, these services are not subject to the restrictions other TH services currently experience, including geographic and location limitations, and prohibitions on the use of asynchronous technology in most cases (Center for Connected Health Policy, n.d., para. 6).

In 2018, CMS also began reimbursing clinicians for the interpretation of medical information collected through RPM technology. CMS will compensate clinicians to review and interpret these data, but will not compensate clinicians for two-way video visits using RPM (Medicare Payment Advisory Commission [MedPAC], 2018, p. 482). The AHA policy statement (Schwamm et al. 2017), and changes to the Medicare reimbursement code are increasing options for utilization as additional TH methodologies prove their effectiveness in enhancing outcome measures.

Organizational Needs Assessment

This scholarly project focused on a single non-profit suburban teaching institution in a mid-Atlantic state that performed 236 cardiac surgeries, including 137 isolated CABG in calendar year 2016 (STS, 2017a). The implementation of Centers for Medicare and Medicaid (CMS) penalties for CABG readmissions beginning October 2016 led to an evaluation of readmission etiologies and rates. The institution recognized the urgency to lower its isolated CABG readmissions from a baseline rate of 14% in calendar year 2016 to align with the national STS benchmark of 10% or less. While this government mandate has vast financial implications, preventing unnecessary readmissions from poor care coordination is the correct and ethical course of action.

Implementing organizational change can be difficult to accomplish. Prior to executing change, the project site's organizational culture was assessed, including the organization's

perceived need for change and readiness to adapt to new methods of delivering care. Schein's cultural theoretical framework was referenced to evaluate the culture of the study organization. Schein (2010) described three levels of culture affecting an organization's ability to implement and adapt to change, including artifacts, espoused values, and basic assumptions.

Artifacts

Schein (2010) defines artifacts as aspects of the organization that are easily discerned, yet difficult to understand, such as dress and mannerisms. The artifacts noted in the organization of interest includ a spacious office and adequate quiet space for the nurses responsible for monitoring transmitted telehealth data. Easy access to the STS Adult Cardiac Surgery database and hospital electronic health records (EHR) exist for timely patient data review. Collegial relationships exist among the cardiac surgeons, nurse practitioners (NPs), referring cardiologists, and nurses to provide guidance and intervention when needed. The cardiac surgery office staff is friendly and accommodating to patient schedule preferences, frequently securing appointments for urgent concerns on the same day.

Values

The second level of organizational culture, "espoused values," are the conscious strategies, philosophies, and goals of the organization (Schein, 2010). The values of patient safety and communication of critical information are ingrained in the study institution's detailed discharge processes. For example, a discharge summary of the patient's hospitalization, including procedures performed, complications, medication reconciliation list, and follow-up appointments are provided to the patient and distributed to the providers with whom the patient will follow. Therefore, to promote the organization's value of being "the most trusted healthcare

partner in the region," evidence of excellent outcomes, including the reduction of readmissions, needs to be demonstrated.

Assumptions

Basic assumptions are deeply embedded in the organizational culture and are experienced as self-evident and unconscious behavior used to successfully navigate problems (Schein, 2010). This institution's basic assumption is that detailed processes and group decision-making will improve outcomes. To successfully affect change, allies within the hospital hierarchy who recognized the need for change were identified and engaged in developing new methods for reducing readmissions. The Chief of cardiac surgery was focused on reducing readmissions and was identified as a champion for change. Isolated CABG readmission rates are outcome measures publicly reported by the STS and Pennsylvania Health Care Cost Containment Council (PHC4), and results are easily compared with other institutional rankings.

Project Site Discharge Practice Overview

The project site's discharge practice includes evaluation of CABG patients by a case manager (CM) on the second post-operative day to determine discharge disposition (home versus inpatient rehabilitation facility). Four acute-care certified NPs assume responsibility for all cardiac surgery patients from hospital admission through discharge. The NPs assist in coordinating the following discharge needs with CMs and social service workers: home health services, durable medical equipment, rehabilitation, and skilled facility placement. In the hospital setting, the NP follows established best-practice through completion of discharge instructions via an electronic health record. This process includes completing an electronic medication reconciliation form, providing prescriptions for a 30-day supply of medications, scheduling follow-up lab work, and informing surgeons and referring providers of unresolved

issues. On each discharge form, the NP lists provider names (primary care provider [PCP], cardiologist, surgeon, and consultant) and recommends the period of time for outpatient follow-up visits. Patients are requested to schedule a postoperative visit with their cardiologist and primary care provider within two weeks of discharge. Prior to hospital discharge, postoperative visits are scheduled with the cardiac surgeon within two to four weeks of the date of discharge. This timeframe is flexible, depending on surgeon availability. The NP dictates the discharge summary within 24 hours of discharge. The discharge summary is then transcribed and electronically distributed to the identified PCP, cardiologist, surgeon, and all consultants within 24 hours.

All CABG patients discharged to the home setting are offered visiting nurse home care services. The majority of home care visits are provided by the institution's visiting nurse home care service. This program provides six nurse visits within a four-week period to assist the patient in transition from hospital to home. The visiting nurse responsibilities include: monitoring of vital signs, physical assessment, medication and disease management instruction, and intervention for any identified problems.

Development of a Telehealth Program for Coronary Artery Bypass Graft Patients

Despite these targeted efforts, unplanned readmissions remained challenging to mitigate, and the project site prioritized the improvement of outcomes in this post-CABG population. With budgetary constraints as a primary barrier within the organization, a significant challenge of implementing any intervention was to accomplish the goal within a budget-neutral process, utilizing only existing personnel.

Extending TH efforts to all cardiac surgery patients was not feasible as the project site's finances and effort were focused primarily on penalties for the Medicare population discharged

to a home setting (Boccuti & Casillas, 2015). Despite these challenges, several champions within the organization were identified: namely, the Chief of cardiac surgery, the cardiovascular (CV) service line administrator, the home care administrator, the bundled payment director, and the project site's president who prioritized readmission reduction as a strategic endeavor.

Since interdisciplinary teams and group decision-making were two established cultural norms within the institution, the Readmissions Reduction Interdisciplinary Team (RRIT) was identified as an ideal partner to assist with change implementation. The team conducts monthly meetings to discuss populations at risk for readmission penalties, primarily those patients with MI, HF, and pneumonia (PNA). The RRIT is comprised of the nurse managers of the cardiac intensive care and telemetry units, the home health care administrator, the bundled payment director, the patient experience-and-quality representative, this Doctor of Nursing Practice (DNP) student, and two nurse navigators to review CABG readmissions. These nurse navigators were already following patient populations discharged with diagnoses of PNA, MI, and HF. In May 2017, these existing nurse navigators were assigned to also follow the post-discharge CABG patients.

Nurse Navigators

Nurse navigators for this program are registered nurses experienced in the care provided to cardiac patients who provide structured phone support and suggested intervention based on patient concerns or report of biometric abnormalities. The nurse navigator is "a patient advocate who provides care in a highly supportive and personal manner and serves as a liaison to ensure that patients receive resources and services when needed as a link between inpatient and outpatient care" (Monza & Shaw, 2015, p. 539). The team members identified and listed above

bring varied perspectives to the efforts required to prevent hospital readmission and are best able to evaluate strategies aimed at improving defined outcomes.

Research Question

Because of disparate follow-up care after hospital discharge and the high rate of readmission after CABG, the focus of this project was to evaluate the effect of TH in addition to usual care on the 30-day unplanned hospital readmission rate for Medicare beneficiaries discharged to home following isolated CABG surgery. The PICOT question format is an approach for summarizing evidence-based practice questions that explore the effect of clinical interventions. The PICOT question includes the population of interest, the intervention, the comparative or control group, the outcome, and timeframe of measurement (Melnyk & Fineout-Overholt, 2015). The PICOT question for this project was: In Medicare patients undergoing isolated CABG surgery (P), how does the addition of TH to standard discharge care (I) compared to standard discharge care (C) effect unplanned all-cause readmissions (O) within 30 days of hospital discharge (T)?

PICOT Components

Population (P): Medicare patients aged 65 years or older who underwent isolated CABG surgery at a large suburban teaching hospital in a mid-Atlantic state and who were alive at time of discharge. This population INCLUDED patients discharged to home, who possessed the physical ability to stand on a scale and the cognitive ability to follow directions. This population EXCLUDED any patient requiring a concurrent procedure at the time of CABG surgery, any patient who did not survive to discharge, any patient with a discharge destination other than home, and any patient with a discharge date prior to 5/1/16 or after 4/30/18.

Intervention or Variable of Interest (I): Medicare patients aged 65 and older who underwent isolated CABG, were discharged to a home setting, and used a TH remote patient monitoring device to provide follow-up support, education, and intervention, in addition to standard discharge care between 5/1/17 and 4/30/18.

Comparison or Control (C): Medicare beneficiaries who underwent isolated CABG between 5/1/16-4/30/17. This population received standard discharge care including: written discharge instructions incorporating electronic medication reconciliation, as well as contact information for the primary care provider, cardiologist, and surgeon with specific follow-up timeframes. All patients were offered standard visiting nurse intervention consisting of six visits within a four-week period.

Outcomes (O): The primary outcome was to evaluate the unplanned all-cause 30-day readmission between patients receiving standard discharge care compared to patients receiving TH in addition to standard discharge practice care. Secondary aims were to evaluate the number of emergency room (ER) encounters, to assess the number of readmissions specifically for HF/volume overload, AF, and pleural effusions, and to measure adherence to follow-up cardiology and surgery appointments both prior to and after project implementation.

Theoretical Framework

Efforts to change practice should be guided by conceptual models or frameworks (Melnyk & Fineout-Overholt, 2015). A theoretical framework assists in "identifying and categorizing various components of a project" (Moran, Burson, & Conrad, 2017, p. 133). The framework utilized for this scholarly project was Kotter's change model (Kotter & Cohen, 2002). This framework was selected because of the project's need to implement and execute new strategies to reduce readmission rates below the current level. There are eight steps in this

change model. The first three steps involve creating a climate for change, the next three steps require engaging and enabling an organizational change, and the final two steps emphasize implementing and sustaining the change.

Step One: The first step was to establish that change is necessary and urgent. This step was accomplished through a meeting with the project site's quality improvement committee and bundled payment director in August 2016 to review the CMS proposed penalty structure to be implemented in October 2016. The meeting incorporated a review of current practice and identified a gap between the STS benchmark and the project site's readmission rate. The study site had a readmission rate of 14.1%, exceeding the national benchmark of 10% for CABG readmission.

Step Two: The next step was to assemble a powerful guiding coalition. The Chief of cardiac surgery and the RRIT were approached as allies in this opportunity to improve outcomes. The Chief of cardiac surgery was supportive of this proposed project as care outcomes bore financial impact. The institutional outcomes are publicly reported through the Pennsylvania Health Care Cost Containment Council (PHC4) as well as the STS Adult Cardiac Surgery database.

Step Three: This step involved creating a vision of the future that motivates people. The vision for this project, created by the interdisciplinary team, was the belief that changing post-discharge care delivery would improve patient outcomes.

Step Four: The next step was to communicate the vision to stakeholders and send a clear, credible message about the direction of change. Communication began verbally with the Chief of cardiac surgery, CV service line administrator, the cardiac intensive care unit and telemetry unit nurse managers, the home health care administrator, the bundled payment director,

the patient experience-and-quality representative, and the nurse navigators as key stakeholders. A review of current performance and the STS national benchmark for readmission was communicated to raise awareness of the gap in practice. The RRIT gathered monthly to review progress and reviewed each readmission to determine problem etiology, treatment rendered, and assessed the degree to which the problem was preventable. Ongoing communication with the Chief of cardiac surgery and cardiovascular service line administrator occurred through a quarterly 30-minute face-to face briefing. This DNP student created a video educating the home visiting nurse team on the five most common post-operative CABG problems: AF, pleural effusion, HF/volume overload, deep vein thrombosis, and incision site infections.

Step Five: This step empowers others to act on the vision by removing barriers. This step was accomplished by breaking down the siloed approach to care by facilitating the collaboration of the NPs, visiting nurses, interventional radiology team members, and navigators to alert each other of subtle patient changes which allowed for the possibility of early intervention. Support from the Chief of cardiac surgery was garnered to permit the STS database manager time to retrieve requested queries. Ongoing conversations occurred with the Chief of cardiac surgery, CV service line administrator, home care administrator, and bundled payment director to garner continued funding for this project. The TH intervention was implemented in this step.

Step Six: This step creates short-term wins to diffuse skepticism. This DNP student reviewed a daily CABG readmission report to identify the primary diagnosis, any interventions performed, and the number of days since hospital discharge. The outcomes were reported during weekly cardiac surgery operational team meetings to celebrate progress. Recognition of the nurse navigators for their contribution was valuable in sustaining enthusiasm.

Step Seven: This step involves consolidating improvements and producing additional change. Control of the improvement process was accomplished as the interdisciplinary team monitored results from this project.

Step Eight: This step institutionalizes new approaches by rooting behavior in reshaped organizational culture. An organization's culture changes only after people have tried out new behavior and are convinced of its success. This step is achieved as institutional outcomes from process improvement efforts are evaluated.

Definition of Terms

Coronary artery bypass graft (CABG)-surgery in which a healthy artery or vein from the body is connected, or grafted, to the blocked coronary artery. The grafted artery or vein bypasses, or goes around, the blocked portion of the coronary artery. This new pathway allows oxygen-rich blood to flow to the heart muscle.

Isolated CABG-CABG surgery, regardless of the number of grafts or the origination of conduit site, without concomitant procedures (i.e. valvular or other major cardiac or vascular procedures) performed during the original coronary operation.

Medicare Beneficiary-person aged 65 and older who possesses Medicare fee-for-service or Medicare managed care primary insurance at the time of CABG procedure.

Nurse Navigator-"patient advocate who provides care in a highly supportive and personal manner and serves as a liaison to ensure that patients receive resources and services when needed as a link between inpatient and outpatient care" (Monza & Shaw, 2015, p. 539). The navigator reviews patient parameters from the TH monitor daily and provides follow-up telephone support to further assess outlier biometric parameters. The nurse navigator is an additional resource, beyond the usual home health care nurse.

Visiting Nurse or Home Healthcare Nurse-a registered nurse (RN) who provides in home physical assessment, disease process education, and medication review with the patient. The term visiting nurse and home healthcare nurse are used interchangeably in the paper. The visiting nurse is a different resource than the nurse navigator.

Standard Discharge Care-defined as care coordinated by NPs in preparation for discharge through implementation of home health care nurse services that provide care to the patient after CABG surgery. Responsibilities include monitoring of blood pressure (BP), heart rate (HR), respiratory rate and auscultation of lung sounds, pedal edema, and medication management and compliance. Usual care also includes care coordination with other providers and caregivers. All patients receive similar written and verbal discharge instructions as well as written medication information from the staff nurses on the unit as part of standard care.

Telehealth-remote delivery of health services and clinical information utilizing telecommunication technologies such as internet, wireless modalities, satellite, and telephone media (American Telemedicine Association, 2016). The operational definition of TH used in this study refers to the use of RPM devices that record, track, and transmit blood pressure, heart rate, pulse oximetry and weight to the nurse navigator to review and contact the patient to investigate deviation from predetermined outlier parameters.

Thirty-day readmission-an unplanned, unscheduled admission to any hospital for any reason on or before the 30th day of hospital discharge following isolated CABG, as captured on the STS Adult Cardiac Surgery database.

Conclusion

This chapter introduced the topic of CABG readmissions and the significance of the problem for patients, providers, and institutions performing CABG surgery. A proposed TH

intervention was introduced as a strategy to further mitigate readmission in this population. The PICOT question was detailed, and individual components further delineated. An organizational needs assessment of readiness to change was provided. Kotter's eight-step change model was selected as the theoretical framework to inform this scholarly project. Finally, a definition of terms for the project components was articulated. The next chapter will provide a review and synthesis of the current body of knowledge related to the topic of study.

Chapter II-Review of the Literature

A review of the literature provides an integrated scholarly description including summary and critical appraisal of the available knowledge regarding TH in the cardiovascular and cardiac surgery populations. This chapter will introduce the search strategy methodologies, a critique of individual studies, the synthesis of the overall body of evidence, and supply a rationale for the proposed scholarly project based on this literature.

Introduction to Search Criteria

Boolean operators were used to combine searches using the following key terms from the PICOT question: telemedicine, TH, readmission, patient readmission, and coronary artery bypass. Key terms were combined with the Boolean operator "AND" to obtain relevant articles. The University Library was used to search the Cumulative Index to Nursing and Allied Health (CINAHL), Medical Literature Analysis and Retrieval System Online (MEDLINE Ovid), Google Scholar and Cochrane databases. Articles limited to English language and published between 2012-2018 were reviewed for inclusion and exclusion criteria. The quantity of relevant studies was not robust with a five-year search; thus, the date range was expanded to a 10-year period. Each of the articles retrieved was assessed for relevance by evaluating the abstract and using specific inclusion and exclusion criteria to accept or reject papers relevant to the review.

Inclusion criteria for this review were: publication dates from 2007-2018, CABG surgery population, adult subjects, and studies that included TH as the focused intervention. Papers were excluded if: the study population was pediatrics, the articles were duplicates or written in a foreign language, the studies included a telephone-only intervention, populations other than CABG surgery were the focus.

The CINAHL search produced 13 studies. Nine studies were eliminated as telephone-only interventions. Nine articles specifically addressed the use of a telemonitoring device. Four articles were retained as the population and intervention were exact matches. The four retained articles were a pilot study (Kleinpell & Avitall, 2007), a descriptive repeated measure experimental design (Barnason et al., 2009) and two single-site randomized studies (Keeping-Burke et al., 2013; McElroy et al., 2016).

The MEDLINE database was searched using the key terms TH and coronary artery bypass. This search produced 16 studies. Five studies were eliminated as the study population was not a match. Six articles were eliminated as telephone-only interventions. The remaining five articles were eliminated as duplicates, thus yielding no new literature.

Because of the limited results specific to the CABG population, a second MEDLINE search using the terms telecommunication or telehealth "AND" patient readmission yielded 65 articles. Most articles were eliminated as a TH device intervention was not the focus, the population was not cardiac, or the articles were duplicates of literature already obtained. Much of the literature for these search terms referenced interventions for the HF population. Since HF is a primary cause of readmissions post-CABG surgery, and TH interventions are more widely studied int his population, four additional articles were retained from this population, including one quasi-experimental (Maeng et al., 2014), two randomized controlled trials (Blum & Gottlieb, 2014; Chaudhry et al., 2010), and one meta-analysis (Klersy et al., 2011).

A Google Scholar search using the terms TH and readmission yielded an additional 397 articles. One randomized controlled trial (Ong et al., 2016) and one level 5 qualitative study (Fairbrother et al., 2013) focusing on the HF population were retained.

A search of the Cochrane database of systematic reviews produced one additional study (Inglis et al., 2015) evaluating the effect of telephone support or TH devices on varied outcomes in the HF population.

Critique and Synthesis of Previous Evidence

For the purposes of this literature review, each study was appraised according to the Let Evidence Guide Every New Decision (LEGEND) appraisal criteria (Clark, Burkett, & Stanko-Lopp, 2009). The LEGEND system for point-of-care clinicians facilitates the appraisal of the strength of the evidence of each article, and the body of evidence, reliably and objectively. Within the LEGEND tool, there are seven domains of clinical questions: (1) intervention, (2) diagnosis/assessment, (3) prognosis, (4) etiology/risk factors, (5) incidence, (6) prevalence, and (7) meaning. Currently, there are 19 study designs: (1) systematic review/meta-analysis, (2) meta-synthesis, (3) randomized controlled trial, (4) controlled clinical trial; (5) psychometric study, (6) qualitative, (6) prospective cohort, (7) retrospective cohort, (8) case control, (9) longitudinal, (10) cross-sectional, (11) descriptive/epidemiological case series, (12) quality improvement, (13) mixed methods, (14) economic/decision analysis or computer simulation, (15) guidelines, (16) case reports (N of 1 study), (17) bench study, (18) published expert opinion, and (19) local consensus/published abstracts (Cincinnati Children's, 2012).

The domain of clinical question designated as intervention and the study design stratifies articles into specified rankings, on a scale of one to five, with one signifying the highest strength of evidence. Systematic reviews, meta-analysis and meta-syntheses earn level-one distinction. Level-two evidence includes randomized control trials. Prospective cohort studies receive a rank of level-three evidence. Qualitative, retrospective cohort, case control, longitudinal, cross-sectional, descriptive, and quality improvement are level four evidence. Decision/economic

analysis, computer support analysis, guidelines, case report, bench study, published expert opinion, and local consensus/published abstracts are assigned level-five evidence. The strength of recommendation is further delineated according to the study quality. A designation of "a" is for higher quality studies and a designation of "b" is for lesser quality studies. For example, each study is leveled with a number and a letter, such as 2b.

With this appraisal tool, the quality of the overall body of evidence is assigned grades of high, moderate, low, or grade-not-assignable. A high grade is associated with a sufficient number of superior-quality studies with consistent results. A moderate grade correlates to multiple studies of lesser quality or with inconsistent results. A low grade reflects case reports or case studies and general reviews. Grade-not-assignable is applied when all studies are of insufficient design or execution, there are too few studies, or when there are inconsistent results in the body of evidence (Cincinnati Children's , 2012).

Of the eleven journal articles reviewed, four (Barnason et al., 2009; Keeping-Burke et al., 2013; Kleinpell & Avitall, 2007; McElroy et al., 2016) specifically addressed the issue of TH in the CABG population and seven studies (Blum & Gottlieb, 2014; Chaudhry et al., 2010; Fairbrother et al., 2013; Inglis et al., 2015; Klersy et al., 2011; Maeng et al., 2014; Ong et al., 2016) focused on TH intervention in the HF population. An early pilot study conducted by Kleinpell and Avitall (2007) specifically evaluated TH as a strategy in monitoring post-discharge CABG patients. Four studies (Barnason et al., 2009; Blum & Gottlieb, 2014; Chaudhry et al., 2010; Ong et al., 2016), were randomized controlled trials (RCT), and two studies (Keeping-Burke et al., 2013; McElroy et al., 2016), were single-site RCTs which evaluated varied primary outcomes, including physical function and healthcare utilization, patient and caregiver anxiety or depression, and all-cause readmission at 30 to 180 days post-hospital discharge. One qualitative

study (Fairbrother et al. 2013) reported patient and provider perceptions of technology in self-care management. One study (Maeng et al., 2014) was a single-site quasi-experimental design examining data claims for readmission. One meta-analysis (Klersy et al., 2011) of 21 RCTs evaluated the economic impact of remote patient monitoring (RPM) in reduction of hospital readmissions. The study by Inglis et al. (2015) was a systematic review that evaluated 41 RCTs using structured telephone support and/or TH and quality of life (QOL), mortality, and hospital readmissions in the HF population. Common qualities evaluated were: age, gender, race/ethnicity, marital status, comorbidities, and New York Heart Association (NYHA) HF classification. This study was included because the population demographics and comorbidities were similar to those of the CABG population, and the intervention focus was TH.

Practice Guidelines for Coronary Artery Bypass Graft

In addition to the research articles, the 2011 *American College of Cardiology Foundation (ACCF)/American Heart Association (AHA) Guideline for Coronary Artery Bypass Graft Surgery* was reviewed (Hillis et al., 2011). The statements, written by volunteer scientists and healthcare professionals, are supported by scientific studies published in recognized journals and undergo a rigorous review and approval process (Hillis et al., 2011). The guidelines were reviewed to assess existing best-practice for the care of CABG patients. While the guidelines do not address post-discharge care or readmission reduction, strong recommendations exist for the perioperative management of medications such as antibiotics, antiplatelet agents, HMG-CoA reductase inhibitors (statins), hormone (blood glucose) control, and beta-blockers. These best-practice medications are crucial for effective and successful transitions to home. Collaborative care for patients with clinical depression and formal cardiac rehabilitation upon discharge are

addressed and included as recommended practices. The guidelines encourage public reporting of outcomes through state, regional, and national clinical data registries to improve results.

Telehealth in Coronary Artery Bypass Graft

Overall, limited published evidence exists for TH utilization specific to the CABG population. Support for TH use in this population was gleaned from available research and studies conducted in other disease management cohorts, specifically the HF population. The HF and CABG populations have similar challenges regarding medication adherence, symptom management, self-care behaviors, and readmission burden. Thus, reasonable comparisons can be made between the two populations. HF and CABG are related CV conditions, often occurring in the same patient. Therefore, the HF population was selected for evidentiary review due to the high rate of readmissions in the post-CABG patients for HF, and for the plethora of studies evaluating similar TH modalities used in managing hospital readmission.

Four studies employed varied TH devices to evaluate physical functioning, psychological impact, or biometric abnormalities and the responses to those measures, in the CABG population (Barnason et al., 2009; Keeping-Burke et al., 2013; Kleinpell & Avitall, 2007; McElroy et al., 2016). Barnason et al. (2009) examined the effect of a symptom-management TH intervention on physical activity and functioning of patients 65 years or older. The study by Keeping-Burke et al. (2013) explored the impact of TH on patient and caregiver anxiety as a primary outcome. Kleinpell and Avitall (2007) evaluated interventions required after abnormal parameters detected from TH monitoring. McElroy and colleagues (2016) examined the relationship between abnormal biometrics, interventions, and readmissions. Of these, two studies evaluated healthcare utilization as a secondary outcome (Barnason et al., 2009; McElroy et al., 2016).

A three-month pilot study was conducted by Kleinpell and Avitall (2007) in ten elderly CABG patients in two Midwestern medical centers, to evaluate the effect of TH as a strategy for patient management after discharge. The outcome of interest was to assess TH as a strategy for early identification of complications. The TH strategy was a RPM modality which required patients to enter HR, BP, weight, and pulse oximetry twice daily using a TH device. Patients then transmitted the information to a secure password protected Internet server via a telephone line connection. Data were obtained from device alarm review. Detail of necessary interventions for abnormal alarm parameters was analyzed. Monitor alarms were most frequently related to abnormalities of BP (66.5%), HR (18.5%) or weight (12.5%). Significant alarms were received for six of ten patients requiring contact with a physician or NP for medication adjustment or follow-up office visit. The remaining four patients were stable. Readmission rate was not examined as an outcome measure. The authors suggested that TH use in elderly CABG patients was an effective strategy for early identification of complications based on changes on BP, weight, pulse oximetry, or HR. The authors also suggest that TH was a positive experience for patients. However, the small sample size of this pilot study limits generalizability of these findings. The authors recommended further studies of cost-benefit analysis for new technology in promoting optimal patient outcomes. According to the LEGEND appraisal tool, this pilot study received evidence level 4b (Cincinnati Children's, 2012).

Healthcare utilization was assessed as a secondary outcome in studies conducted by Barnason et al. (2009) and Keeping-Burke et al. (2013); both studies relied on patient or caregiver recall of hospitalization events. Barnason et al. (2009) conducted a descriptive repeated measure experimental design which recruited post-CABG patients aged 65 and older to evaluate a TH intervention on the primary outcomes of physical activity and functioning. As a

secondary outcome, use of healthcare services within a 6-month timeframe was assessed. There were 109 patients allocated to the intervention and 123 allocated to the usual care groups. The intervention consisted of a six-week program utilizing a TH device which provided daily reminder messages regarding adequate rest, pain management and physical activity, plus a RT3 accelerometer, to record the number of daily steps. The TH intervention was a RPM modality that captured data entered by the patients. The intervention was performed in addition to usual care of formal cardiac rehabilitation (CR) program attendance. Assessment of physical activity was conducted at hospital discharge (baseline), at three and six weeks, then three and six months postoperatively. Physical activity data were collected using the Modified 7-Day Activity Interview for baseline assessment. The RT3 accelerometer and the Physical Activity and Exercise Diary were evaluated at the specified time points to capture assessment of physical activity. Improvement in activity was assessed by patient self-report on the Medical Outcomes Short Study Form-36 (MOS SF-36). This tool is designed to measure physiological functioning, role limitations caused by physical problems, and perceptions of vitality.

According to Barnason et al. (2009), the intervention group demonstrated greater physical functioning at the three-week post-discharge time period as evidenced by a higher mean kilocalorie/kilogram/day expenditure as measured by the RT3 accelerometer. The three-week timeframe was significant as the intervention corresponds to the time before most subjects started a CR program. Ultimately, both groups increased physiologic and psychosocial functioning over time and there was no statistical difference in hospital readmissions within the 6-month study period. One limitation of this study was the subjective diary method used to assess physiologic functioning at baseline, compared to an objective (Medical Outcomes Study Short Form [MOS SF 36]) method assessment in the follow-up period. Another limitation of this

study was that healthcare use was captured by patient recall rather than objective record review. This study highlights the need for consistent methodologies of data measurement and the need for objective identification of readmissions. This RCT study received a grade of 2b using the LEGEND tool (Cincinnati Children's, 2012).

Keeping-Burke and colleagues (2013) conducted a single-site RCT implementing a TH program for 182 CABG patients during the first week post-hospital discharge to assess levels of anxiety and depression of patients and caregivers as the primary outcome. A secondary outcome assessed was healthcare utilization. The intervention and control group each contained 91 participants. On the day prior to surgery, the control group received two 30-minute instruction sessions from a nurse and physical therapist regarding postoperative recovery. Each hospital day, the physical therapist conducted a 30-minute class on physical recovery and exercise after surgery. A cardiac nurse reviewed written materials with the patient and family prior to discharge. In addition to standard care, the intervention group received two hours of instruction regarding operation of the TH monitoring equipment.

The TH intervention implemented by Keeping-Burke et al. (2013), was a combination of RPM (data entered by patients) and synchronous (daily audio-visual interaction with an RN) modalities. The TH nurse obtained daily transmitted recordings of the patients' BP, electrocardiogram (EKG), and oxygen saturation. During interactive sessions, the nurse reviewed patient concerns from the prior 24-hour period and focused on repetition or clarification of post-operative instructions. The State Anxiety subscale of the State Trait Anxiety Inventory (S-STAI) assessed patient and caregiver anxiety levels. The Center for Epidemiologic Studies Depression Scale-10 (CESD-10) measured changes in patient and caregiver depressive symptoms. These measures were evaluated at baseline and three weeks post-discharge. In the

study period of three weeks, there were no group differences in reported patients' anxiety and depressive symptoms; however, patients in the TH group had statistically significant fewer (n=30 vs. n=43) physician contacts (p=0.04). In the intervention group, female caregivers of male patients demonstrated a statistically significant decrease in anxiety (p<0.001) and caregivers of both genders in the intervention group had greater decrease in depressive symptoms (p=0.03). Healthcare utilization was assessed based on caregiver recall and was similar between the groups. This study illuminated the importance of assessing caregivers' anxiety level and the ability to assist the patient in transitioning care from hospital to home. The study also introduced an association between reduced anxiety and less physician contacts. This RCT was graded as 2b evidence according to the LEGEND appraisal tool (Cincinatti Children's, 2012). Similar to the conclusion obtained by Branson et al. (2009), Keeping-Burke et al. (2013) agreed that objective computerized data would add validity to the readmission statistics provided.

McElroy et al. (2016) conducted a single-site randomized study of adult cardiac surgery patients. This study received an evidence ranking of 2b according to the LEGEND appraisal tool (Cincinnati Children's, 2012). There were 416 patients enrolled in formal readmissions reduction program (RRP) as usual care. The intervention assessed the additional benefit of audiovisual capable RPM digital health kits (DHK) on 30-day readmissions for 27 patients, as well as patient and provider satisfaction. The DHK intervention required patients to wirelessly upload daily weight, BP, HR, and oxygen saturation to a secure internet server. Patients also completed a daily health survey targeting HF symptoms, nonadherence to medications, and poor wound healing. Abnormal biometrics triggered automatic notifications to the healthcare team. The highest number of alerts in the DHK group occurred between days five and nine post-discharge. Similar to the results noted by Kleinpell and Avitall (2007), there was a significant

correlation between abnormal biometrics and the number of interventions by healthcare providers (p<0.001). Additional synchronous patient education by nurses was required in 76% of the interventions, and medication adjustments were required in 14% of cases. Both patients and providers were highly satisfied with the DHK technology rating at 4.9 +/-0.5 and 4.9 +/-0.2, respectively, on a 5-point Likert scale (1=disagree, 5= agree). This finding contrasted with Fairbrother et al. (2013), who reported patient, but not provider, satisfaction with TH intervention. No correlation was noted between interventions and health survey responses or missed digital check-ins. The DHK intervention was not associated with decrease in readmission. A significant limitation in this study was the small sample size receiving DHK (n=27) and the ability to monitor only five patients simultaneously. Although patients in the RRP group were readmitted for a range of cardiovascular and pulmonary complications, the two DHK participant readmissions were due to either amiodarone toxicity or a syncopal episode. The association that DHK readmissions were not related to cardiovascular complications is a major finding for this study and supports further investigation with other CABG populations.

Synthesis related to TH in CABG. This body of evidence was limited in breadth but confirms patient satisfaction with the TH technology in the CABG population (Fairbrother et al., 2013; McElroy et al., 2016) and the demonstrated ability of TH to promote early physical function post-discharge. TH intervention resulted in fewer physician contacts from patients and demonstrated a statistically significant decrease in female caregiver anxiety and overall caregiver depressive symptoms (Keeping-Burke et al., 2013). The studies reported significant correlation between abnormal biometrics and interventions which suggests additional opportunities for patient education and prevention of complications (McElroy et al., 2016). However, TH failed to demonstrate significant reduction in hospital readmission during the six-month study period

(Barnason et al., 2009). The quality of the overall body of evidence for this section is assigned a moderate grade according to Cincinnati Children's (2012) as findings of healthcare utilization were not consistent.

Telehealth in Heart Failure

Overall, limited published evidence exists for TH utilization specific to the CABG population. Support for TH use in this specific population is informed from research conducted in other disease management cohorts, specifically the heart failure population. The HF population was selected for evidentiary review due to the high rate of readmissions due to HF in the post-CABG patients and for the plethora of studies evaluating similar TH modalities used in managing HF hospital readmission.

Chaudhry and colleagues (2010) conducted an RCT of 1653 HF patients in varied cardiology practices in the US from 2006-2009 to evaluate the effect of an automated TH approach on the primary outcome of all-cause readmission and death within 180 days of program enrollment. There were 826 patients randomized to TH and 827 patients randomized to the usual care (UC) group. The study compared UC provision of a scale and traditional education materials on HF to the addition of TH to UC. The intervention group was instructed on daily toll-free calls to the TH system. This system was an interactive voice response system that collected daily information about weight and symptoms. All questions had predetermined responses with triggered variances to obtain clinicians' attention. For example, a patient report of feeling "much worse compared to yesterday," would generate a variance trigger for the nurse to call the patient. The data were securely downloaded daily to an Internet site and reviewed by practice site coordinators, who contacted patients if their responses generated variances. Use of TH failed to demonstrate a statistically significant difference in death or readmission within 180

days of enrollment. Subgroup analysis of age, gender, left ventricular ejection fraction (LVEF) or NYHA classification did not identify a group in which telemonitoring was more effective on these outcomes.

A prominent weakness of this study by Chaudhry et al. (2010) was the patient requirement to complete daily toll-free calls to the system to respond to questions regarding HF symptoms. As a result, almost 50% of the subjects did not routinely utilize the TH system daily as required for the entire 180-day time-period. Fourteen percent of patients never accessed the TH system. The authors conceded that an intervention utilizing a singular approach was insufficient and recommended the importance of combined disease management strategies. These investigators questioned whether simultaneous home care nursing would have improved adherence and strengthened the study results. Experience gleaned from Chaudhry's study illuminates the need for a multi-pronged approach to improve readmissions outcomes. This RCT was awarded level 2a evidence (Cincinnati Children's, 2012).

A study by Ong and colleagues (2016) reviewed a combined coaching telephone and TH strategy (intervention) compared to pre-discharge education and post-discharge phone call (usual care) implemented on a random sample of 1437 HF patients in six academic institutions. This RCT randomized 715 patients to the intervention group and 722 patients to the UC group. This RPM strategy required patients to use the electronic equipment daily to collect information about BP, HR, symptoms, and weight. Readings that were outliers informed the nurses to investigate the triggered event. Centralized registered nurses conducted TH reviews and phone calls. The scheduled coaching phone calls occurred nine times within a six-month time period. The authors assessed 180-day all-cause readmission as a primary endpoint. Secondary outcomes were all-cause readmission within 30 days, all-cause mortality at 30 and 90 days, and QOL at 30 and 180

days. The study reported that the intervention did not reduce 30 or 180-day readmissions, nor reduce mortality. Likewise, subgroup analysis of age, gender, race/ethnicity or NYHA classification showed no significant difference in these outcome measures. The authors findings concur with Blum and Gottlieb (2014) that the recent focus of Medicare penalties for the HF population have improved adherence to well-described medical therapy. Ong et al. (2016) suggests that prior study improvements were attained from interventions to optimize medical therapy, thereby mitigating the TH intervention in this study.

The study by Ong et al. (2016) reported a significant difference in 180-day QOL scores between intervention and control participants (p=0.02). Ong et al. (2016) state that similar types of TH interventions could demonstrate effects among patients who have not previously been the focus of readmission efforts. A major limitation of this study, similar to Chaudhry and colleagues (2010), was that telemonitoring adherence greater than 50% of days was documented in only 55.4% of the intervention group for the entire study period of 180 days. Ong conceded that patients were not precluded from exposure to other readmission reduction or chronic disease management programs implemented by other health plans or physician groups and that use of other personnel in addition to registered nurses could have affected study outcomes. The effectiveness of care transition and TH interventions "may be highly dependent on how they are integrated and adhered to in practice" (Ong et al., 2016, p. 315). According to Cincinnati Children's (2012), this RCT is considered level 2b evidence.

A qualitative study conducted by Fairbrother and colleagues (2013) used semi-structured interviews with 18 HF patients and five professionals to understand their perceptions of acceptability and usefulness of TH in HF management. Five main themes were identified: (1) information, support, and reassurance; (2) compliance and dependence; (3) changes and

challenges; (4) determining the criteria for patient applicability to telemonitoring; and (5) continuity of care. Patients appreciated TH for the reassurance provided in terms of surveillance. However, providers voiced concern with the extra time requirements, equipment cost, and continued dependency in care management. The authors recommended future evaluation of TH in subgroups of patients. This research illustrated the need to assess the quantity of personnel and work-flow processes required to successfully implement a TH intervention. The study also explored the concept of patient-centered care as a primary concern. The voice of the patient was clearly identified as an important consideration in implementing a readmissions reduction strategy. This qualitative study received a ranking of level 2a-evidence according to Cincinnati Children's (2012).

In addition to CM for Medicare Advantage HF patients, Maeng et al. (2014), implemented a single-site RPM (scale and interactive voice response) intervention on a sample of 541 patients. This quasi-experimental design reviewed data claims from 2007, the baseline comparison, through 2012, to assess all-cause readmission, 30 and 90-day readmission rates, and cost of care. The TH strategy employed use of Bluetooth scales with an interactive voice response system designed to detect changes in physical condition. Nurse case managers identified patients with biometric readings out of specified ranges and sent alerts to each patient's primary care provider for evaluation. The authors concluded that TH intervention significantly reduced all-cause admission (odds ratio [OR] 0.77; $p<0.01$), 30 and 90-day readmissions (OR 0.56, 0.62; $p<0.05$), and cost of care (1.3%; $p<0.05$). The return on investment (ROI) was 3.3. The ROI is interpreted as follows: for every $1 spent to implement the program, there was $3.30 in cost savings accrued to the institution. The odds of 30-day and 90-day readmission in the intervention group were 44% lower and 38% lower respectively. The

authors commented on the importance of bundling the TH and CM rather than utilizing a singular approach, as Chaudhry et al. (2010) suggested. This study evaluated ROI which is an important determinant when evaluating implementation of new programs. According to Cincinnati Children's (2012), this quasi-experimental study received a grade of level 4a evidence.

In a similar study, Blum and Gottlieb (2014) conducted an RCT to identify effects of TH on 30-day readmission, cost, mortality, and QOL. The sample size was 206 community-dwelling HF patients. Two subjects declined to continue after signing consent and one participant declined to accept the monitoring equipment. These subjects were eliminated from data analysis, leaving 203 participants for analysis. There were 101 patients randomized to usual care and 102 patients randomized to the intervention group. The TH intervention was a RPM modality using noninvasive physiologic recording of weight, BP, HR, and 15-second heart rhythm strip. Physiologic parameters were wirelessly transmitted to an NP who intervened if abnormalities outside individually-set parameters were identified. To maintain contact, the NP called the patient if no variances were noted in a month. Most patients (81-87%) were identified as NYHA Class III. Medicare claims data were analyzed to identify hospitalizations during the study period. The authors concluded there was no notable difference in length of stay, emergency department expenses, QOL, or mortality. The authors reported a statistically significant primary outcome of lower 30-day readmission rate for the monitored group (35%) compared to 43% in UC group ($p<0.05$). However, this decrease in 30-day readmissions in the first year did not decrease total cost or improve outcomes long-term. The authors commented that recent studies failed to demonstrate significant difference because the monitored and usual care groups were both on well described-medical therapy for HF. An important point to

illustrate is the difference between the HF population, frequently on well prescribed medical therapy, and the CABG population of interest, who for a variety of reasons, is often not discharged on optimal medication dosages. This RCT study received a level 2a evidence score (Cincinnati Children's, 2012).

Klersy and colleagues (2011) performed a meta-analysis of 21 RCTs including a total sample size of 5715 patients, to evaluate the effect of RPM as an adjunct to usual post-discharge care in reducing HF and all cause readmissions. Outcomes for HF readmissions were assessed in 17 studies. RPM was associated with a significantly lower number of hospitalizations for HF (incident rate ratio [IRR] 0.77, 95% CI 0.65-0.91, $p<0.001$) and for any cause (IRR 0.87, 95% CI 0.79-0.96, $p=0.003$). In this European study, direct costs for HF hospitalization were approximated by diagnostic related group (DRG) tariffs in Europe and North America and were used to populate an economic model. The cost difference between RPM and usual care ranged from €300 to €1000 ($345 to $1151), favoring RPM. This study was graded as a 1b according to Cincinnati Children's (2012).Error! Bookmark not defined.

A systematic review by Inglis et al., (2015) graded 41 randomized controlled trials (17 new/24 in prior review), evaluating Structured Telephone Support (STS), TH, and two studies evaluating both interventions. Twenty-five studies evaluated STS and included a total sample size of 9332 participants. Eighteen studies evaluated TH and included a sample size of 3860 participants. These strategies were compared to standard practice for individuals with HF, to quantify the effects of these interventions over and above usual care. The intervention or UC could not include protocol-driven home visits or more intensive than usual (four to six weeks) clinic follow-up. Telehealth reduced all-cause mortality (Risk Ratio [RR] 0.80, 95% CI 0.68 to 0.94; n=3740; studies = 17) and HF-related hospitalizations (RR 0.71, 95% CI 0.60 to 0.83; n=

2148; studies = 8). The authors used the GRADE criteria in appraising these findings as moderate-quality evidence. Seven of nine studies reported significant improvements in HF knowledge and self-care behaviors, crucial skills required to potentially avoid rehospitalization. Adherence to TH was rated between 75 to 98.5% and 55.1 to 65.8% for STS in the studies that reported this outcome. The study implications were that STS and TH reduced both mortality and HF-related hospitalizations. The practice implication was that structured phone support and TH should be considered evidence-based strategies to improve the quality of care and outcomes for patients with HF. This systematic review was graded as level 1a according to Cincinnati Children's (2012).

Synthesis Related to Telehealth in Heart Failure. Two studies failed to demonstrate reduction in readmission or mortality in a 180-day period (Chaudhry et al. 2010; Ong et al. 2016); however, four studies including a meta-analysis and systematic review, demonstrated reduction in 30-day readmissions (Blum and Gottlieb, 2014; Klersy et al., 2011; Inglis et al. 2015, Maeng et al., 2014). Fairbrother et al. (2013) reported patient satisfaction with the increased surveillance that RPM TH provided. A qualitative study reported provider concern regarding time and cost of the intervention (Fairbrother et al., 2013); however, a meta-analysis (Klersy et al., 2011) and another quantitative study (Maeng et al., 2014) demonstrated cost savings with a TH program. The systematic review demonstrated reduced mortality and HF related hospitalizations in the HF population with TH intervention (Inglis et al., 2015). The quality of the overall body of evidence for TH usefulness in both the CABG and HF populations is assigned a moderate strength of recommendation according to the LEGEND appraisal tool (Cincinnati Children's, 2012).

Rationale for Project

Findings from these studies allow several observations regarding the incorporation of TH into a disease management program to reduce hospital readmissions. A primary component of TH is the pairing with nursing intervention, which is essential and necessary to impact and reduce hospital readmissions. TH was shown to reduce patient and caregiver anxiety which is crucial for learning self-care behaviors (Inglis et al., 2015; Keeping-Burke et al., 2013). A systematic review conducted by Inglis et al. (2015) supported the use of TH as an effective strategy to prevent hospital readmission in the HF population. Studies conducted by Blum and Gottlieb (2014), Inglis et al. (2015), Kleinpell and Avitall (2007), Maeng et al. (2014), and McElroy et al. (2016), focused attention on early problem recognition by telehealth services as a potentially effective modality to reduce readmission rates. HF is frequently the primary reason for readmissions in the CABG population. Therefore, a TH program in addition to usual discharge care for the CABG patient was proposed as a method to impact unplanned readmissions.

Implications for this scholarly project are drawn and supported from a gap analysis of the literature. CMS penalty implementation for 30-day CABG readmission, as well as the STS and ACCF/AHA recommendation to publicly report this measure are driving organizations to analyze results and improve outcomes. Therefore, the doctoral project was well poised for scholarly inquiry to add to the body of evidence-based research and practice. The purpose of this project aligned with the Institute of Medicine's six aims to improve health care quality (AHRQ, 2016). The goal of this project was to evaluate TH as a safe, timely, effective, efficient, patient-centered strategy to improve the quality of the transition period for the CABG patients from

hospital to home by reducing 30-day readmissions and improving the institutional performance with CMS-mandated measures.

Conclusion

A moderate grade strength of recommendation was assigned to the overall synthesis of the body of knowledge related to the use of TH in the CABG and HF populations as a strategy to reduce hospital readmissions. Monotherapy and combined use of TH with CM methods were examined in relation to their impact on readmissions. Based on critique of the literature and lack of research specific to the CABG population, a sound rationale for this project was identified.

Chapter III-Methods

In this chapter, methods to implement and collect the data are detailed. This section describes the processes to evaluate the effectiveness of a TH program in addition to usual care for CABG patients. The primary outcome measure was 30-day all cause readmission, secondary measures included evaluation of the number of ER encounters and readmissions specifically for HF/volume overload, AF, and pleural effusions, and measurement of adherence to cardiology and surgery follow-up appointments. Detailed information on the research design, implementation plan, sample population, outcome measures, and data analysis plan are discussed. Protection of human subjects and maintaining the confidentiality of data are delineated.

Project Design

This study did not include the implementation of the TH program with isolated CABG patients, which was instituted on 5/1/17 by the project site. This quality improvement project employed a retrospective case-controlled analysis design of the TH program from a single project site. Medicare patients undergoing isolated CABG surgery who selected the project site's home health service upon discharge were eligible to participate in the TH program. A causal comparison data group of Medicare patients discharged to home following isolated CABG surgery from 5/1/16-4/30/17 served as the pre-program control group. This design was chosen because "a causal comparison design occurs under similar circumstances and has attributes similar to the intervention group. However, all measures and outcomes occurred at a previous point in time when the intervention did not exist" (Sylvia & Terhaar, 2014, p. 41).

Telehealth Program Implementation

The implementation of a TH program was not part of the Institutional Review Board (IRB) application for this DNP scholarly project. This study was a retrospective chart analysis to assess outcomes of the TH program. The following description of the TH program is included to provide context and clarity. During the TH hospital program, the nurse navigator reviewed the telemetry unit's daily patient census list and verified those patients who underwent isolated CABG procedures with the cardiac surgery NP. The nurse navigator identified Medicare and managed Medicare insured patients for TH program participation once verification of a home discharge and agreement to utilize the project site's home health service was obtained. The nurse navigator was responsible for explaining details of the TH program and for obtaining patient consent to participate in the program.

TH patients were supplied with Health Harmony™ TH kits consisting of a Blue-tooth enabled pulse oximeter, HR monitor, BP cuff, and scale. The kits were delivered to each patient's house within 48 hours of discharge. Each participant was instructed on the use of the TH kit by a home care nurse during the first visit, which occurred within 48 hours of discharge. The visiting nurses were familiar with the TH kits from their use in the HF population from the study institution. The patients were instructed to weigh themselves daily in the morning and obtain BP, HR, and pulse oximetry readings. The encrypted data was wirelessly transmitted to the nurse navigator's computer for review. The nurse navigators reviewed the data on a daily basis and contacted the patients via phone on a weekly basis to monitor each patient's recovery. Patient concerns elicited during the phone calls were forwarded to the cardiac surgery NPs. Patients who failed to submit data for 48 hours were contacted via phone by the nurse navigators.

Abnormal biometrics (oxygenation saturation <91%, HR<60 or >100 beats per minute, systolic BP<100 or >160mmHg, or weight gain more than two pounds in one day or five pounds in one week) triggered an automatic notification to a nurse navigator. Patients with abnormal biometrics were contacted by a nurse navigator via telephone to discuss the abnormal findings. The nurse navigator notified additional care providers if further intervention was warranted. All CABG patients, both before implementation of TH (prior to 5/1/17) and after implementation of TH (after 5/1/17) received standard discharge written instructions provided by the assigned telemetry unit nurse.

Project Sponsors and Resources

The scholarly project was supported by the project site's Chief of cardiac surgery, CV service line administrator, home care administrator, and the bundled payment director. To maintain budget neutrality, the project utilized existing resources. One cardiac surgery NP, who also served as the STS data manager, was used to extract and query results as part of her usual work responsibilities. One university statistician participated in data analysis.

Cost and Benefit Analysis

Unplanned readmissions for Medicare beneficiaries cost $17.4 billion annually (American Hospital Association, 2011). Readmissions add to the overall cost of care through additional days spent in the hospital. In the project state site, 1,126 patients (10.2%) who underwent CABG surgery between January 1, 2014 and August 31, 2015 were readmitted to the hospital within 30 days of discharge, adding an average length of stay of 5.6 days and resulting in a mortality rate of 2.5%. The average hospital charge for a CABG procedure at the project site is $181,730 (PHC4, 2017).

Improved patient contact after discharge is advocated as a means for early problem recognition and intervention, which may lead to reduced readmissions. However, the "absence of a cohesive body of rigorous economic evaluation studies may be one of the key obstacles to the widespread adoption, proliferation, and funding of TH programs" (Akiyama & Yoo, 2016, p. 184). While literature remains scarce on cost-benefit of TH utilization specific to the CABG population, a meta-analysis of 21 RCTs conducted by Klersy et al. (2011) demonstrated that management of HF patients by remote monitoring decreased cost. This decrease was attributed to a substantial reduction in healthcare resource utilization mostly driven by a reduction in the number of HF hospitalizations. Since the TH program had previously been implemented at the project site, this project sought to evaluate the outcomes. The expenditures incurred for the project were minimal as the data extractor was a salaried employee performing usual duties within the project site. The RPM kits were already in existence and no additional RN navigators were employed. The university statistician charged $25/hour for data analyses with an approximate total time of 4 hours estimated ($100).

Population: Sample and Setting

The convenience sample of study participants were subscribers of Medicare fee-for-service or managed Medicare insurance at the time of isolated CABG surgery. The study population had a designated home destination upon hospital discharge between 5/1/17-04/30/18. A causal comparison group was created from data of Medicare patients having isolated CABG and discharged to a home environment between 5/1/16-4/30/17, prior to the TH program. Identical timeframes were selected for the pre-TH group (control) and the TH group (intervention) to create equitable comparisons before and after the implementation of TH. The sample size to adequately power this project was estimated to be N=102 with 51 patients in each

group. The sample size was further limited by the study time frame and inclusion/exclusion criteria listed below.

Inclusion criteria: 1.) Male and female patients aged 65 and older; 2.) subscriber of traditional fee-for-service Medicare or managed Medicare insurance; 3.) underwent isolated CABG surgical procedure; 4.) discharged to a home environment; 5.) possessed the physical ability to stand on a scale; 6.) possessed the cognitive ability to follow directions.

Exclusion criteria: 1.) any patient who did not survive to discharge; 2.) any patient with a discharge date prior to 5/1/16 or after 4/30/18; 3) any patient with a discharge destination other than home.

Human Subject Review

The study was conducted in accordance with the Institutional Review Board (IRB) protocol for research on human subjects at the university where the Principal Investigator (PI) is a doctoral student and the project site. The DNP student completed an online Collaborative Institutional Training Initiative (CITI) program in the Biomedical and Social and Behavioral Responsible Conduct of Research prior to study implementation. No direct patient contact was involved as the design utilized a retrospective case-controlled analysis approach. Therefore, this study was granted exempt review status by the project site IRB and university IRB. The study PI was responsible to ensure the ethical conduct of the study and study personnel.

Privacy and Confidentiality of Data

For this study, de-identified data was collected in a retrospective fashion; therefore, the IRB approved that consent be waived. All data were collected retrospectively by an honest broker. The honest broker is employed at the project site, within the CV service line, and has access to all the necessary data as part of her usual role. To comply with the IRB requirements,

this honest broker was not part of the project team. The process of de-identification, by which personal identifiers are removed from the health information, mitigated privacy risks to individuals. The Safe Harbor method of de-identification under the US Health Insurance Portability and Accountability Act of 1996 (HIPAA) Privacy Rule eliminated 18 patient identifiers in healthcare data (U.S. Department of Health and Human Services, 2015). For this scholarly project, personal information was de-identified according to the Safe Harbor method. A reference number was used to identify participants in lieu of patient name. All data results were reported in aggregate and all data was de-identified for reporting purposes. No identifiable organization information was used during dissemination of findings. The investigator used all data responsibly and only for the purposes of this study and dissemination of findings.

Data Collection Tools

This scholarly project used three tools to collect data: the (1) STS Adult Cardiac Surgery database, the (2) STS Risk Calculator, and the (3) Data Extraction Tool.

Society of Thoracic Surgeons Adult Cardiac Surgery Database

The first data collection tool was the STS Adult Cardiac Surgery Database. The STS database is the world's premier clinical outcomes registry for adult cardiac surgery. The STS database is a secure site used by healthcare institutions and is not accessible to the public. Routine quantitative data of CABG readmissions is routinely collected through this secondary data source. Insurance information, procedure specific details, post-operative complications, post-operative length of stay, and discharge destination are recorded for each patient. Specific data related to readmissions within a 30-day time frame are captured, such as problem etiology and interventions performed. Quarterly harvesting of data provides feedback of missing data percentages. The project site’s benchmark for completeness of data was 94%, which was

verified by the data manager and was subject to periodic audit by the STS. The data was manually imported into the database from each patient's office or hospital EHR and provided a succinct source for data retrieval. Since individual hospitals own their data, hospital-specific de-identified data may be used for clinical research (STS, 2017b).

Society of Thoracic Surgeons On-line Risk Calculator

The second data collection tool used in the project was the STS Online Risk Calculator. The STS On-line Risk Calculator is an internet-accessible tool which allows the user to calculate an individual patient's composite risk of mortality and other morbidities for CABG, valvular and combined procedures. The Risk Calculator incorporates the STS risk models that are designed to serve as statistical tools to account for the impact of patient risk factors on operative mortality and morbidity, such as stroke, infection, acute kidney injury, and prolonged intubation (STS, 2017b). Once the cardiovascular risk factors, echocardiogram findings, coronary anatomy, and status of surgery details were entered, a composite risk percentage score was generated for both morbidity and mortality. A higher score correlated to a greater risk of experiencing complications or death after the procedure. Each individual on-line risk calculator report was copied and placed in the patient's office EHR. This tool is not intended to predict readmission rate; however, assessment of individual co-morbid conditions was evaluated and used for baseline comparison between groups.

Data Extraction Tool

The third data collection measure was the Data Extraction Tool (Appendix), created by the PI for the purpose of this project. This tool provided guidance to the data extractor for collecting individual participant's information. This five section 42-item tool included typical demographics such as age, gender and race/ethnicity. The tool captured presence of known CV

comorbidities including hypertension, peripheral and cerebrovascular arterial disease, chronic kidney disease, or chronic lung disease. Pre-operative requirements for inotropic, intra-aortic balloon pump (IABP) support, or need for resuscitation prior to CABG procedure was documented. Post-operative length of stay and presence of postoperative complications of AF, acute kidney injury, or pleural effusion was ascertained. The outcome measures of 30-day mortality or unplanned readmissions/ER encounters were captured. Specific readmission for potentially preventable cardiac conditions from AF, HF, and pleural effusion was detailed. The number of days from hospital discharge to postoperative visits to the surgeon and cardiologist was obtained. Finally, any interventions implemented because of abnormal TH biometrics were documented. During data extraction, reliability of data collection and evaluation of data quality underwent periodic review.

Data Collection Procedures

No subjects were recruited for this retrospective chart review. The PI had no interaction with subjects. This was a retrospective case-controlled analysis involving data collection from the pre-TH and TH program intervention groups. After IRB approval was obtained from the project site and the doctoral student's university, data collection commenced for both cohorts. A list of patients meeting study eligibility criteria was supplied to the honest broker by the nurse navigator. Standard procedure for all CABG patients included importing pertinent electronic medical record data from the inpatient and office setting, including an individualized composite STS risk score for mortality and morbidity, into the STS Adult Cardiac Surgery database repository. This task was accomplished on every patient by the cardiac surgery data extractor.

All information, gleaned from our STS Adult Cardiac Surgery patient database, was de-identified by the cardiac surgery division data extractor, acting as an honest broker. The honest

broker entered data into the PI-created data extraction tool. Hard copies of the completed data extraction tool were kept in a locked cabinet in the cardiac surgery office and accessible only to the data extractor and PI.

A coded list of variables was used for data collection in the control (pre-TH) and intervention (TH) groups. Baseline demographic information, as well as occurrence of readmission and emergency room encounters was abstracted from the STS Adult Cardiac Surgery database and entered onto the Data Extraction Tool. For each group, mortality and morbidity risk scores, 30-day all-cause readmission, and specific readmissions for HF, AF, and pleural effusion were extracted. The frequency and reason for ER encounters during the 30-day post-discharge period were recorded. Presence of preoperative comorbid conditions as well as selected postoperative complications were examined for their impact on readmissions.

The eligible hospital discharge dates for study inclusion were 5/1/16 through 4/30/18. The cohort data was separated into pre-TH (5/1/16-4/30/17) and TH program intervention (5/1/17-4/30/18) groupings for analysis. Data extraction for the 30-day readmission component was completed 6/1/18. Data analysis commenced June 1, 2018.

Data Analysis Plan

Descriptive statistics were used to analyze the study groups' demographic data. This information included factors that describe the heterogeneity of the control and intervention groups, such as age, gender, and race/ethnicity. *A priori* power analysis was conducted using G*Power 3.1.9.2. A minimum of 51 patients was required in each group (pre-TH and TH intervention) for comparing mean 30-day readmission to achieve power of 80%. These analyses used an alpha of 0.05 as the criterion for detection of statistical significance.

Charts were separated according to participation in the TH program. This independent variable was set as a dichotomous value of 1=No or 2=Yes. Hospital readmission events within 30 days of discharge was the unit of analysis by which the primary aim of the TH program was evaluated. This dependent variable was set as a dichotomous value 1=Yes (readmission occurred) or 0=No (readmission did not occur). Use of a dichotomous variable suggested that chi square be used to predict the probability of being readmitted from TH program participation.

The second aim of this scholarly project was to evaluate the number of ER encounters and readmissions specifically for HF/volume overload, AF, and pleural effusions. The dependent variable was again set as a dichotomous value 1=Yes (ER visit occurred) or 2=No (ER visit did not occur). The reason for each ER encounter was captured as a nominal value: 1=AF; 2=pleural effusion; 3=HF; 4=other. Finally, the third aim was to assess adherence to follow-up cardiology and surgery appointments. This data point was captured by setting the dependent variable as an ordinal value: 1= No; 2=Yes (with number of days from hospital discharge to appointment date noted); 3=Unknown. Each category of interest was tabulated for the control group and TH program group. TH interventions were free text responses that were analyzed to assess frequency of any treatments rendered.

Conclusion

This chapter reviewed the retrospective cohort analysis research design and implementation plan for this quality improvement project. The convenience sample population was described using inclusion and exclusion criteria. Steps to protect human subjects and maintain confidentiality of data were delineated. Details of the project's outcome measures and data analysis plan to evaluate this study were supplied. Clinical significance of the project will be evident if the TH intervention is associated with decreased readmissions.

Chapter IV-Results

Patients undergoing isolated CABG may experience unplanned readmissions and emergency room encounters for a variety of reasons within the 30-day post-hospital discharge period. Data collection and analysis were conducted to evaluate the effectiveness of a TH intervention in preventing these events. The purpose of this chapter is to report the findings by utilizing statistical techniques to analyze data and study aims. A broad analysis allows for scholarly project interpretation and promotes recommendations for future study.

Analysis of Data

The sample consisted of 83 subject charts: 51 charts from the control group and 32 charts from the TH intervention group. The nurse navigator reported that all 32 patients completed the 30-day TH program, entering the requested data daily. Thus, no data were missing. Data analysis was conducted using IBM SPSS (version 25, Chicago, IL) computer software.

Descriptive statistics were utilized to depict the sample characteristics and to provide the demographic and clinical profile of the sample. The descriptive statistics were reported as frequency distributions for categorical variables, and means and standard deviations for continuous variables. Independent *t*-test or chi-square test was utilized appropriately to determine any statistical differences in the sample characteristics between the treatment and control groups pre-operatively and the primary outcomes of interest.

Baseline demographics of the treatment and control groups were mostly similar preoperatively (Table 1). The majority of patients were male (85.5%) and Caucasian (90.4%). Five patients self-identified as Black or African American (6%). The mean age was 73.3 years old (SD = 5.8). Composite STS mortality (M =1.7 in each group; t (81) = 0.022; p = 0.982) and

morbidity (M = 14.4 in each group; $t(81) = 0.012$; $p = 0.992$) risk scores were similar between cohorts. However, three pre-operative clinical characteristics had statistically significant differences between groups for cerebrovascular disease, peripheral arterial disease, ans cardiac surgery status.

Table 1

Pre-Operative Clinical Characteristics

	Total (N = 83)		Control (n = 51)		Treatment (n = 32)		
	n	*%*	*n*	*%*	*n*	*%*	p^a
Gender							.378
Male	71	85.5	45	88.2	26	81.3	
Female	12	14.5	6	11.8	6	18.8	
Race							.625
Caucasian	75	90.4	47	92.2	28	87.5	
Black or African American	5	6.0	2	3.9	3	9.4	
Asian	1	1.2	1	2.0	0	0.0	
Hispanic	2	2.4	1	2.0	1	3.1	
Heart Failure history	16	19.3	11	21.6	5	15.6	.504
Current dialysis	0	0.0	0	0.0	0	0.0	na
Cardiac Symptoms on Admission							.373
Stable Angina	52	62.7	33	64.7	19	59.4	
Unstable Angina	11	13.3	6	11.8	5	15.6	
Anginal Equivalent	1	1.2	1	2.0	0	0.0	
Non-STEMI	14	16.9	10	19.6	4	12.5	
STEMI	4	4.8	1	2.0	3	9.4	
Other	1	1.2	0	0.0	1	3.1	
Cardiac Symptoms at Surgery							.355
Stable Angina	63	75.9	37	72.5	26	81.3	
Unstable Angina	7	8.4	4	7.8	3	9.4	
Anginal Equivalent	1	1.2	1	2.0	0	0.0	
Non-STEMI	0	0.0	0	0.0	0	0.0	
STEMI	1	1.2	0	0.0	1	3.1	
Other	11	13.3	9	17.6	2	6.3	
History of MI	18	21.7	13	25.5	5	15.6	.288
Atrial Fibrillation	7	8.4	5	9.8	2	6.3	.571
Chronic Lung Disease							.216
None	79	95.2	49	96.1	30	93.8	
Mild	1	1.2	1	2.0	0	0.0	

	Total (N = 83)		Control (n = 51)		Treatment (n = 32)		
	n	*%*	*n*	*%*	*n*	*%*	p^a
Moderate	2	1.2	1	2.0	0	0.0	
Unknown	2	2.4	0	0.0	2	6.3	
CVD history	17	20.5	6	11.8	11	34.4	.013*
PAD history	10	12.0	9	17.6	1	3.1	.048*
Diabetes	36	43.4	20	39.2	16	50.0	.489
Hypertension	70	84.3	42	82.4	28	87.5	.530
Immunocompromised	4	4.8	4	7.8	0	0.0	.104
Cardiac Surgery Status							.021*
Elective	25	30.1	12	23.5	13	40.6	
Urgent	51	61.4	37	72.5	14	13.8	
Emergent	7	8.4	2	3.9	5	15.6	
Not resuscitated 1 hour prior to surgery	82	98.8	51	100.0	31	96.9	.204
Cardiogenic shock 24 hours prior to surgery	2	2.4	0	0.0	2	6.3	.071
Preoperative IABP	5	6.0	3	5.9	2	6.3	.945
Preoperative inotrope	1	1.2	0	0.0	1	3.1	.204
Prior PCI	21	25.3	14	27.5	7	21.9	.570
Incidence of Surgery							
First surgery	82	98.8	50	98.0	32	100.0	.425
Prior CABG surgery	1	1.2	1	2.0	0	0.0	.425

	M	*SD*	*M*	*SD*	*M*	*SD*	
Age	73.3	5.8	73.6	5.9	72.8	5.6	.531
STS morality score %	1.2	1.8	1.7	1.7	1.7	2.0	.992
STS morbidity score %	14.4	10.3	14.4	10.9	14.4	9.3	.436
Creatinine (ng/dl)	1.1	0.4	1.1	0.5	1.0	0.2	.163
Ejection Fraction (%)	51.4	12.0	49.8	12.9	54.0	10.0	.099

Significance level (*p* value) based on chi square for categorical variables and independent samples *t* test for continuous variables.

STEMI = ST segment elevated MI; MI = Myocardial infarction; CVD = Cerebrovascular disease; PAD = Peripheral arterial disease; IABP = intra-aortic balloon counter pulsation; PCI = Percutaneous intervention; CABG = Coronary artery bypass graft; STS = Society of Thoracic Surgeons; M = mean; SD = standard; * = $p<.05$

Overview of Total Sample Characteristics

Symptoms of ischemic heart disease were prevalent across both groups, with the majority of total participants experiencing stable angina as a presenting symptom upon hospital admission (62.7%). Non-STEMI was the second most frequent presenting symptom in 16.9% of the total sample, followed by unstable angina as the presenting symptom of 13.3% of total subjects. Total incidence of pre-op AF was 8.4% and patients presenting with HF within two weeks of admission was 19.3%.

The most common preoperative comorbid conditions were HTN (84.3%) and diabetes (43.4%). Ninety-five percent of the total population did not have chronic lung disease. The overwhelming majority (98.8%) of total participants underwent CABG as the first cardiovascular surgical procedure, with 25.3% of those having undergone prior percutaneous catheter intervention.

At the time of surgery, the majority of total participants (75.9%) had documented evidence of stable anginal symptoms. Patients with a history of prior MI accounted for 21.7% of the total sample population.

Group Differences on Sample Pre-operative Clinical Characteristics

Some preoperative characteristics demonstrated statistically significant differences between groups. The treatment group was significantly more likely to have had prior cerebrovascular disease (34.4%) than the control group (11.8%), $x^2(1) = 6.127$, $p = .013$, whereas the control group was more likely to have prior peripheral arterial disease (17.6%) than the treatment group (3.1%), $x^2 (1) = 9.913$, $p = .048$. The groups differed on surgery status with the control group more likely to have urgent surgery (72.5%) than treatment group (13.8%). The

treatment group was more likely to have elective surgery (40.6%) than control group (23.5%), x^2 (2) =7.755, p=.021

Primary Aim-All Cause Readmissions

The primary aim of this study was to evaluate the effect of the TH on all-cause 30-day readmissions. Readmission within the designated 30-day time frame occurred in 5.9% (n=3) of the control and 3.1% (n=1) of the treatment group, x^2 = (1) = 0.326, p =0.568. These findings do not demonstrate a statistically significant difference, although the small number of readmissions failed to meet the cell size assumption for a valid chi square test. The three readmissions in the control group were the result of symptomatic anemia requiring blood transfusion, development of an ascending aortic dissection requiring re-operation, and intravenous antibiotic treatment for epididymitis. The single readmission in the treatment group was for cardioversion of rapid AF.

There was no 30-day mortality in either group. There were no statistically significant differences in any postoperative outcomes between treatment and control groups (Table 2). There was no relationship identified between post-operative incidence of pneumonia, acute kidney injury, AF, pleural effusion and need for ER visit or readmission.

Secondary Aims

A second aim of this study was to evaluate the frequency and reasons for ER encounters within 30 days of hospital discharge. The outcomes of interest were specific to common preventable causes, such as AF, HF, and pleural effusion. Emergency room visits occurred in 7.8% of the control and 6.3% of the TH group, which was not statistically different $x^2(1) = 0.074$, p= 0.785. Four ER visits occurred in the control group: two cases of atypical chest pain, one for pleural effusion requiring thoracentesis, and one for symptomatic hypotension that resulted in

medication adjustment. Two patients from the TH group required ER visits: a pleural effusion requiring thoracentesis and one HTN crisis event, requiring medication adjustments.

Another aim of this study was to evaluate adherence to recommendations for cardiology and surgical follow-up visits. Scheduled follow-up with the patient's cardiologist was recommended within 14 days of hospital discharge. Surgical follow-up appointments were recommended to occur within two to four weeks post hospital discharge. The mean number of days to a cardiology visit was 19.8 for the control and 13.7 for the treatment group, not statistically significantly different (p =.062). However, this number improved by 6.1 days, with the treatment group meting the recommended duration of follow-up of 14 days. Two patients in the control group and one patient in the treatment group were lost to cardiology follow-up. Three patients in the control group and no patients in the treatment group had documented cardiology follow-up appointments occurring more than 30 days after hospital discharge. The mean number of days from hospital discharge to a postoperative surgical visit was identical (20.9 days) for both groups. In the control group, five surgical visits occurred more than 30 days post-discharge and there were four patients (7.8%) lost to surgical follow-up. In the treatment group, four surgical visits occurred more than 30 days post-discharge and no patients failed to show for surgical appointments.

Table 2

Post-Operative Outcomes by Treatment Group

	Total (N = 83)		Control (n = 51)		Treatment (n = 32)			
	n	*%*	*n*	*%*	*n*	*%*	x^2	*p*
Atrial fibrillation	30	36.1	18	35.3	12	37.5	0.041	.839
Pneumonia	2	2.4	2	3.9	0	0.0	1.286	.257
Pleural effusion	12	14.5	7	13.7	5	15.6	0.057	.811
Kidney injury	5	6.0	3	5.9	2	6.3	0.005	.945
Mortality ≤ 30 days	0	0.0	0	0.0	0	0.0	--	--
Readmission ≤ 30 days	4	4.8	3	5.9	1	3.1	0.326	.568
Emergency room ≤ 30 days	6	7.2	4	7.8	2	6.3	0.074	.785
Cardiology visit > 30 days	2	2.4	2	3.9	0	0.0	1.286	.257
Surgical visit > 30 days	4	4.8	4	7.8	0	0.0	2.637	.104

Telehealth Interventions

Fourteen of the 32 patients (43.7%) in the TH group required interventions based on abnormal biometrics, including medication adjustment, and referrals for cardioversion, and thoracenteses. Of those needing intervention, seven (50%) experienced symptoms of fluid overload and required a diuretic prescription. One patient underwent outpatient thoracentesis. Four patients experienced HTN or tachycardia requiring upward titration of medication. One patient experienced hypotension which necessitated a decrease in medication dosage. One patient was referred to the emergency room for shortness of breath and ultimately admitted for cardioversion of atrial fibrillation. These findings suggest tht the TH monitoring resulted in treatment, referrals, and interventions in the post-hospitalization period.

Summary of Findings

This chapter reviewed the results of the data analysis in accordance with appropriate statistical tests. The samples were homogenous in age, gender distribution, general comorbidities, and status. No statistically significant differences were noted in 30-day all-cause readmission, ER encounters or readmissions specifically related to atrial fibrillation, HF, or pleural effusion. The treatment group showed a trend toward quicker follow-up to cardiology post-hospitalization and less likelihood of being a no-show to surgical follow-up appointment. Those in the TH group who received interventions primarily received medication initiation and titration.

Chapter V-Discussion of Findings

The final chapter addresses the interpretation of the statistical analysis as it relates to the primary outcome of this study, the prevention of hospital readmissions. The outcome of hospital readmission is discussed in relation to the reviewed literature on the subject. This section also addresses the secondary aims of this scholarly project, which were to evaluate the number of ER encounters and readmissions specifically for HF/volume overload, AF, and pleural effusions, and measure adherence to follow-up appointments. Finally, implications for practice and policy change are discussed.

Outcomes

This retrospective case-control analysis sought to evaluate unplanned all-cause 30-day readmission between patients receiving standard discharge care compared to patients receiving TH in addition to standard discharge care. Secondary outcomes were to evaluate the number of emergency room encounters and readmissions specifically for HF/volume overload, AF, and pleural effusions, and measured adherence to follow-up appointments.

Readmissions

This scholarly project demonstrated a lower percentage of readmissions in the treatment compared to control group, though not statistically significant. The project site achieved overall reduction in isolated CABG readmissions from 14.1% (baseline measurement 2016) to 5.9% in the control group and 3.1% in the TH group. Readmissions in the control group were attributable to epididymitis, aortic dissection, and symptomatic anemia requiring blood transfusion. In the control group, these readmissions were unrelated to the specific interest of readmission for AF, HF, or pleural effusion. This overall reduction in CABG readmissions

aligns with the STS Adult Cardiac Surgery national readmission baseline measurement of 10.1% (STS, 2017a).

One patient in the TH group required readmission for cardioversion of AF. This episode occurred during a weekend. This readmission may have been prevented if the patient was classified as observation status and there were sufficient personnel available during weekend hours to perform the cardioversion procedure. Classification of inpatient versus outpatient status remains controversial because hospital reimbursement is less for those patients classified as observation status. Patients requiring a hospital stay to determine etiology of presenting symptoms may be classified as outpatients on observation status and charged for services that Medicare would have paid if they were admitted as inpatients (Department of Health and Human Services, 2014). The competing priorities of a hospital for admission reimbursement versus concern to avoid readmissions penalties remains challenging.

Variability in systematically reducing 30-day readmissions in this study is consistent with literature related to the use of TH-type interventions. Findings from four studies revealed lower readmission rates in HF patients who utilized RPM to reduce HF hospitalizations, Blum and Gottlieb (2014) who evaluated TH in an outpatient HF population, Maeng et al. (2014), who employed TH plus CM in a HF population, and Inglis et al. (2015) who examined 41 RCTs specific to TH use in the HF population. Conversely, results from other studies noted no statistically significant reduction in 30-day readmissions for HF patients (Chaudhry et al. 2010; Ong 2016). The study results are also congruent with findings from two studies that not demonstrate statistical difference in 30-day readmission for their respective cardiac surgery and CABG populations (Barnason et al. 2009; McElroy et al. (2016). All participants from this project site completed the TH program and did not experience attrition due to technology

difficulties as noted by Chaudhry et al. (2010) and McElroy et al. (2016). The lack of difference in readmission rates between cohorts may be attributed to increased provider awareness of impending financial penalties beginning October 1, 2016 and timely intervention of patients' concerning symptoms as demonstrated by the overall rate of readmissions.

Nonsignificant difference in readmissions between the groups may also suggest that a different CABG population should be the future target for intervention, such as the frail patients discharged to an inpatient rehabilitation facility. Daras and colleagues (2018) noted that the national observed hospital readmission rate by 30 days post-discharge from inpatient rehabilitation facilities was 13.1%. This statistic indicates further opportunity to improve transitions of care.

Post-Operative Complications

The incidence of postoperative AF (36.1%) was similar between groups and reflective of nationally reported incidence of AF (25.1%) following CABG surgery (STS, 2017a). Despite the common occurrence of in-hospital postoperative AF, there was not a preponderance of readmissions related to AF in study participants. Only one subject in the intervention group required readmission for cardioversion of AF. Perhaps this finding reflects adequate beta-blockade achieved in this sample prior to hospital discharge.

Provider Follow-Up

There was a definitive trend toward timely cardiology follow-up with the TH group (13.7 days) compared to control (19.8 days) although this finding did not reach statistical significance. However, a reduction in wait time for cardiology follow-up by 6.1 days may indicate clinical significance as timely provider follow-up in conjunction with the TH monitoring may reduce hospital and unplanned ER visits. Only one of the 14 patients in the TH program who required

intervention experienced a weekend readmission for cardioversion of AF. One TH program participant required a weekend ER visit for hypertensive crisis necessitating medication adjustment. Capture of the number of days from hospital discharge to ER visit or hospital readmission could have provided additional information to assess potential breakdowns of care delivery.

Unexpectedly, there was no change in days from hospital discharge to surgical follow-up for either group (20.9 days). The inability to improve timeliness to surgical follow-up appointments may have been affected by multi-site surgical coverage requirements implemented during the study period. Multi-site surgical coverage requirements impacted the ability to secure appointments with the surgeon of record within the recommended time frame. This delay in timely follow-up presents opportunity to establish initial postoperative appointments with the cardiac surgery NP, either in person or via audiovisual TH service, to assess recently discharged patients and address concerns in a more efficient manner. Extending NP clinic coverage on weekends and off hours provides another opportunity to mitigate readmissions.

Forty-three percent of TH participants required intervention, with 50% of those interventions consisting of medication adjustment. This finding is similar to Kleinpell and Avitall (2007), who reported six of ten interventions involved medication adjustment. This project demonstrated a higher trend (50%) of patients requiring intervention for medication adjustment compared to McElroy et al. (2016), who reported medication adjustments in 14% of the patients utilizing digital health kits. However, the interventions prescribed in this study did not translate into significant reduction in readmission. This finding paves the way for changing current practice regarding diuretic administration after discharge.

Limitations

Limitations of a study are defined as characteristics of the design or methodology that impact the interpretation of results. The first limitation noted in this study was that the TH group (n=32) did not meet the predetermined sample size (n=51) to achieve the desired statistical power. Therefore, inadequate power of the study may have affected the ability to find statistically significant differences. A trend noted during this study period was the frequent addition of left atrial appendage clipping procedure to the CABG surgery for patients with paroxysmal AF. This additional procedure disqualified the surgery from the isolated CABG category and made those patients ineligible for the study; thus, reducing overall sample size.

Second, merger and acquisition of other hospital entities during the study period established new cardiology referral patterns to cardiac surgery. These newly-referred patients originated from a wide geographic catchment area, thus limiting the project site home-care service ability to extend coverage beyond a certain geographic boundary. This critical factor also limited recruitment of additional TH subjects.

Third, this scholarly project was conducted in single project site with a fairly homogenous patient sample, precluding the ability to generalize beyond this sample CABG population. Although comparison is made to the STS national database, the sample size and sample characteristics are reflective of this patient cohort and may not be consistent with other individuals having undergone CABG surgery.

Implications for Practice and Policy Dissemination

Although readmission rates in this study were less than 6% overall, there are important implications for practice. One aspect of care coordination to reduce readmissions is the development of ER protocols to treat AF in the recently discharged CABG patient, especially

during non-business hours or weekends. Notification of the on-call cardiac surgeon to review ER occurrences of AF in CABG patients could streamline time to cardioversion and curb the need for readmission. Likewise, the ability to streamline insurance pre-approval processes and provide interventional radiology personnel to perform weekend outpatient thoracentesis procedures could also reduce the incidence of readmissions for pleural effusion.

A recommendation for policy change is the elimination of barriers needed to promote the adoption of TH services. CMS un-bundled current procedural terminology (CPT) code 99091 in January, 2018. This change provides separate reimbursement to providers for time (minimum 30 minutes/month) expended on collection and interpretation of patient health data that is generated remotely, digitally stored, and transmitted to a provider (Lacktman, 2018). However, comparable insurance parity for TH services is needed within each state to enable widespread adoption of this technology.

Recommendations for Nursing Practice and Further Study

Hospital readmissions remain an indirect marker for adequacy of care provided during the index hospital stay. Reducing readmissions is a prime focus of Medicare to avoid unnecessary healthcare expenditures. This project provided insight into the need to change transition of care practices. In the TH intervention group, 50% of the patients required diuretic therapy after discharge. One practice recommendation is to provide a diuretic prescription for every patient upon discharge, with instructions that are individualized for weight gain above a pre-established point. The need for additional diuretic after discharge suggests further study is warranted to determine effective individualized dosing for diuretic therapy after discharge.

The need to establish a new method for surgical follow-up was evident from the inability to schedule routine postoperative surgeon appointments within a two-week period. Establishing

the choice of an office or audiovisual TH with a nurse practitioner within one week of hospital discharge may alleviate the wait to see a surgeon and increase patient satisfaction.

Historically, the ACC/AHA CABG guidelines focused on procedural considerations, perioperative management, and prevention of CABG-associated morbidity and mortality. A novel recommendation is to evaluate best practices for discharge care post isolated CABG surgery for incorporation into future AHA/ACC guidelines.

In this project, adherence to TH is 100%, which is quite different than Chaudry et al. (2010) and Ong et al. (2016). This finding may be attributable to the fact that the monitoring was for a 30-day time period and the process was simplified to daily biometric transmission. A future study recommendation is to explore TH and RPM in a way that promotes the best adherence to the technology.

As TH is used more frequently in the discharge period, it will be necessary to evaluate the cost effectiveness of whether this modality is used as a substitute or supplement of care. Because 20% of patients are discharged to rehabilitation centers following isolated CABG, focus on strategies to prevent readmission in this subset population is also warranted.

Conclusion

The health policy goal of reducing hospital readmissions from poor inpatient care or poorly coordinated post-discharge care represents an opportunity to reduce cost and improve transitions of care from hospital to home. This scholarly project evaluated the effect of a TH program in addition to usual post-discharge care on 30-day readmissions. Outcome measures provide an opportunity to evaluate care delivery and adjust processes to continually improve patient experience and results. The project demonstrated clinical significance by the decreased number of 30-day readmissions and ER encounters in the TH group, and by timeliness to

cardiology follow-up and reduced number of failures to show for both cardiology and surgery follow-up appointments. The project provided insight into opportunities to improve transition of care practices such as communication among providers, initiating diuretic therapy on discharge, and expediting surgical follow-up.

Appendix-Data Extraction Tool

TH Data Extraction Tool Patient #_____

DEMOGRAPHICS
Age:
Gender: 1. Male 2. Female
Race/Ethnicity: 1. Caucasian 2. Black or African American 3. American Indian or Alaska Native 4. Asian 5. Native Hawaiian or Other Pacific Islander 6. Hispanic 7. Other_____
PRE-OP STATUS
STS **Mortality** Risk Score:
STS **Morbidity** Risk Score:
Pre-op Ejection Fraction (EF): _____%
Clinical evidence of Heart Failure within 2 weeks of surgery per documentation of dyspnea on light exertion, recurrent dyspnea occurring in the supine position, fluid retention; or the description of rales, jugular venous distension, pulmonary edema on physical exam, or pulmonary edema on chest x-ray: 1. Yes 2. No
Current dialysis treatment: 1. Yes 2. No
Most recent creatinine level prior to surgery: ____
Cardiac symptoms at time of admission: 1. Stable angina 2. Unstable angina 3. Anginal equivalent 4. Non-STEMI 5. STEMI 6. No symptoms
Cardiac symptoms at time of surgery: 1. Stable angina 2. Unstable angina 3. Anginal equivalent 4. Non-STEMI 5. STEMI 6. No symptoms

Prior MI: 1. Yes 2. No
Pre-op atrial fibrillation: 1. Yes 2. No
Chronic lung disease: 1. Mild (FEV1 60% to 75% of predicted, and/or chronic inhaled or oral bronchodilator therapy) 2. Moderate (FEV1 50% to 59% of predicted, and/or chronic steroid therapy aimed at lung disease) 3. Severe (FEV1 < 50 or Room Air pCO2 > 50) 4. Lung disease documented, severity unknown 5. Unknown
Prior cerebrovascular disease (CVA, TIA, non-invasive/invasive testing with =/>50% stenosis of major extra or intracranial vessels, or prior revascularization): 1. Yes 2. No 3. Unknown
Prior peripheral arterial disease (claudication, amputation, vascular reconstruction, AAA, or positive non-invasive test): 1. Yes 2. No 3. Unknown
Diabetes HbA1C >6.5%, random BS>200, fasting BS>126): 1. Yes 2. No 3. Unknown
Hypertension: 1. Yes 2. No 3. Unknown
Immunocompromise condition per documentation of immunosuppressive medication therapy within 30 days preceding the operative procedure, systemic steroid therapy, anti-rejection medications and chemotherapy 1. Yes 2. No 3. Unknown
Clinical status prior to surgery: 1. Elective (admitted from home) 2. Urgent (requires surgery within the same hospitalization) 3. Emergent (requires surgery within 24 hours) 4. Emergent salvage (resuscitation in progress)
Resuscitation 1 hour prior to surgery: 1. Yes 2. No

Cardiogenic shock within 24 hours prior to surgery (SBP<90mmHg +/or CI<2.2L/min +/or inotropic/vasopressor/mechanical support): 1. Yes 2. No
IABP prior to surgery: 1. Yes 2. No
Any IV inotropic medications within 48 hours preceding surgery: 1. Yes 2. No
Prior percutaneous intervention (PCI): 1. Yes 2. No
Incidence: 1. First cardiovascular surgery 2. First re-op 3. Second re-op 4. Third re-op 5. Fourth or more re-op
Prior CABG: 1. Yes 2. No
Prior open surgical valve: 1. Yes 2. No
POST-OP
Post-op length of stay (# days from date of surgery to hospital discharge):
Post-op atrial fibrillation: 1. Yes 2. No
Post-op pneumonia: 1. Yes 2. No
Post-op pleural effusion: 1. Yes 2. No
Post-op Acute Kidney Injury: 1. Yes 2. No
READMISSION
Mortality within 30 days of discharge: 1. Yes 2. No
Readmission within 30 days of hospital discharge: 1. Yes 2. No

Reason for readmission: 1. Atrial fibrillation 2. Pleural Effusion 3. Heart Failure 4. Other
Intervention(s):
Post-discharge Emergency Room encounter within 30 days: 1. Yes 2. No
Reason for ER visit: 1. Atrial fibrillation 2. Pleural Effusion 3. Heart Failure 4. Other
Intervention (s):
Cardiology visit post discharge: 1. No 2. Yes Discharge day #_____ 3. Unknown
Surgical visit post discharge: 1. No 2. Yes, Discharge day #_____ 3. Unknown
TELE-HEALTH FACTORS
Participation in TH program: 1. No 2. Yes
Type interventions based on abnormal biometrics (List):

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