Results of a Postoperative Telemedicine Trial after Cardiac Surgery and Incorporation into Practice

Maren Downing, MEng, Christina Bull, NP, Teena Chavis, NP, Michael Modrow, PA-C, Gina McConnell, RN, Charles Harr, MD, MBA, Judson Williams, MD, MHS

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Results of a Postoperative Telemedicine Trial after Cardiac Surgery and Incorporation into Practice

*We describe the implementation and results of a postoperative telemedicine program for adult cardiac surgery, including a clinical trial and an organic postoperative telemedicine program aimed at reducing readmission rates and barriers to care.*

- Two telemedicine visits at days 3 and 10 post discharge
- Home vitals collection
- Pre-visit health surveys

**Findings:** An APP-led post-discharge telemedicine program following cardiac surgery can reduce hospital readmission and barriers to care, and also improve patient satisfaction.

*APP: advanced practice provider*
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Maren Downing, MEng2,3, Christina Bull, NP1,2, Teena Chavis, NP1,2, Michael Modrow, PA-C1,2, Gina McConnell, RN1,2, Charles Harr, MD, MBA,1,2 Judson Williams, MD, MHS1,2

Author Affiliations
1. WakeMed Heart and Vascular, Department of Cardiovascular and Thoracic Surgery, Raleigh NC
2. WakeMed Health and Hospitals and WakeMed Clinical Research Institute, Raleigh NC
3. Campbell University School of Osteopathic Medicine, Lillington NC

Corresponding Author:
Maren Downing, MEng
Medical Student, Campbell University School of Osteopathic Medicine
Leon Levine Hall of Medical Sciences
4360 US-421 Lillington, NC 27546
Email: m_downing0106@email.campbell.edu
Phone: 803.587.9327
ORCID: 0000-0001-5121-4584

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CENTRAL MESSAGE

A postoperative telemedicine program following cardiac surgery can reduce hospital readmission, barriers to care, and improve patient satisfaction.

PERSPECTIVE STATEMENT

Telemedicine has been shown to provide benefits to both patients and health care systems while remaining clinically effective and has become a significant modality for patient care. A postoperative telemedicine program following cardiac surgery can reduce hospital readmission, barriers to care, and improve patient satisfaction.

Central Picture: The Tele Heart Care logo used at WakeMed Health and Hospitals

ABSTRACT

Objective: To describe the implementation and results of a postoperative telemedicine program for adult cardiac surgery, including a clinical study and an organic postoperative telemedicine program aimed at reducing readmission rates and barriers to care.

Methods: CABG patients consented to enrollment in our Perfect Care study funded by The Duke Endowment including APP-led post-discharge telemedicine services with data collection. There were two telemedicine visits at days 3 and 10 post discharge using a live face-to-face video platform. Patients were provided with home wearables for heart rate monitoring, blood pressure cuffs, and scales. The success of the Perfect Care study led to formation of our organic program, termed Tele Heart Care, which was adapted to include a larger patient population while remaining structurally similar.
**Results:** Fifty patients were enrolled prospectively between Jan and Oct 2021 in Perfect Care. 30-day readmission rates for those enrolled was 4% compared with a 16% readmission rate for non-enrolled patients during this period. Furthermore, 36% of enrolled patients received medication modifications to optimize blood pressure, heart rate and rhythm, fluid-volume status, or treat infectious symptoms. Tele Heart Care enrolled 203 patients and was associated with a fall of 30-day readmission rates in all cardiac surgery patients at our institution from 24% to 4% over a six month period.

**Conclusion:** An APP-led post-discharge telemedicine program following cardiac surgery can reduce hospital readmission, barriers to care, and improve patient satisfaction. With involvement of multiple stakeholders, a successful program can be launched despite the present state of national health system finances with limited human capital and constrained access to monitoring equipment.

**MINI ABSTRACT**

We describe the process design, implementation, and results of a postoperative telemedicine program following cardiac surgery. We found a decrease in 30-day readmission rate and high patient satisfaction. Program implementation was successful due to trial phase data and multiple stakeholder involvement in design.

**KEYWORDS**

Cardiac surgery, CABG, telemedicine, telehealth, readmission, barriers to care
GLOSSARY OF ABBREVIATIONS

advanced practice provider (APP)
blood pressure (BP)
electronic medical record (EMR)
enhanced recovery after surgery (ERAS)
The Health Insurance Portability and Accountability Act (HIPAA)
non-ST elevation myocardial infarction (NSTEMI)
pulmonary embolism (PE)
standard deviation (SD)
INTRODUCTION

Telemedicine has become a significant modality for patient care outside of the hospital environment and its implementation in surgical care has increased in recent years. Postoperative telemedicine is shown in selected settings to provide benefits to both patients and health care systems while remaining safe and effective. Postoperative follow-up after cardiac surgery is critical, and strategies for early detection and management of complications are needed. Diagnosis and treatment of postsurgical complications has been shown possible through telemedicine alone without compromising the patient’s perceptions of their quality of care.

Telehealth is a viable method for follow-up after discharge to expedite recovery. Hospital 30-day readmission rates after cardiac surgery range between 8-29% and may be higher in some places. Factors predictive of readmission are increasing age, female gender, renal failure, prior heart failure or myocardial infarction, and diabetes. Patient follow-up within one week after discharge for those at high risk of readmission has been shown to reduce the rate of readmission after open heart valve surgery. Additional benefits of postoperative telemedicine include saving time and expense for both patients and providers along with increasing access to care. Eliminating barriers to telemedicine can increase its use and therefore afford better access to care and more timely interventions for complications.

While recent medical literature supports the use of postoperative telemedicine to assess time-sensitive conditions so they may be addressed in a timely manner to prevent hospital readmission, cardiac surgery is a field often omitted when assessing telemedicine feasibility. The majority of postoperative telemedicine programs make use of telephone calls and automated surveys which carries limited utility for assessment. As such, we sought out a strategy to improve timely access to postoperative care of cardiac surgery patients. We describe herein the
trial implementation and results of a postoperative telemedicine program aimed at reducing readmission rates and barriers to care for the adult cardiac surgery population. We hypothesize that the implementation of a postoperative telemedicine program will reduce readmission rates and barriers to care for the adult cardiac surgery population at our institution.

METHODS

Our institution conducted a Perfect Care study supported by funding from the Duke Endowment. Patients undergoing CABG who had a discharge disposition of home without home health were considered for enrollment. Further inclusion criteria included access to a smartphone, connection to WiFi, device Bluetooth connectivity, and ability to navigate their smartphone device. This study was determined to be quality improvement by the Institutional Review Board (2/11/2019); individual consent was not required.

All patients were provided with home wearables for heart rate monitoring, blood pressure cuffs, and scales. These home wearables were configured for the patient before they left the hospital to ensure proper initial setup. They connected directly to a smartphone application that consistently monitored vitals throughout the day. This application communicated vitals with abnormal parameters directly to a clinician, and a clinician checked all parameters from the application at least once daily. If abnormal parameters were measured, they were sent directly to the APP who monitored them during business hours. Other parameters not automatically monitored through provided home wearables but available for input into the app were temperatures, blood sugars, and oxygen saturations.

Patients agreed to telemedicine visits at approximately days 3 and 10 following hospital discharge that were scheduled before the patient left the hospital. The platform for visits utilized
the existing hospital electronic medical record (EMR) framework, Epic (Epic, Verona, WI), via live face-to-face video. Before the visit, patients received a survey through the monitoring app asking targeted questions for infection, fluid overload, arrhythmias, pain, and malaise. The option to upload pictures of surgical incisions was also included. Visits were conducted as regular follow-up checks along with review of medications for adherence and any needs for adjustments based on vitals and survey results. After the visit, patients received surveys through the app to rate their satisfaction with their experience.

Following presentation of these study results to our health system administration, funding was granted for a full-time APP position to lead a post-discharge telemedicine program, termed Tele Heart Care. (Figure 1) With human resource funding in place, the following interdisciplinary stakeholders engaged in program development from trial phase to practice: social work, case management, outpatient clinical staff, physical therapy, quality analytics, nurse educators, patients, and physician champions.

Our cardiac surgery department implemented Tele Heart Care for all cardiac surgery patients, not just those who were felt to be sufficiently technologically savvy. Those without access to a smart device or internet were offered the opportunity to participate in a telephone visit. The only exclusion criteria was patients who were discharged to a skilled nursing facility. Remote monitoring was possible for all patients despite cost constraints after being afforded grant funding (WakeMed Foundation, wakemedfoundation.org) with wearables made available to patients who could not afford to buy them on their own. Patient educational materials were created to include a flyer encouraging patients to obtain their own devices as well as a daily log whereby data points and vital sign measurements were to be recorded and subsequently reviewed at telemedicine visits. (Figure 2) Collaboration with our institutional IT department allowed us to
create a specific EMR visit type with a patient questionnaire tailored to a pertinent review of systems, adapted from the Perfect Care study pre-visit survey. Patients were encouraged to upload pictures of their incisions to the EMR software portal. (Figure 3)

Data are reported as percentages with the purpose of presenting clinical results and methods for incorporation into practice. No statistical analyses were conducted for this data and no statistical significance determined.

RESULTS

Perfect Care

The Perfect Care study enrolled 50 patients over January to October 2021. (Table 1) 40 participants were male and 10 were female with a mean age of 61 years old (SD=11). 74% of those enrolled were Caucasian, 14% African American, 4% Asian, and 8% Other. The mean STS predicted risk of mortality was calculated for those in the Perfect Care cohort undergoing isolated CABG (n=39) and was calculated as 0.8%. The mean STS predicted risk of mortality for those not enrolled in Perfect Care during this time, however still eligible due to a home discharge status, that underwent isolated CABG (n=110) was 1.8%. Interventions done as a result of the telemedicine visits in decreasing order of prevalence include: medication adjustment, diuretic management, BP management, wound care, arrhythmia management, pain management, glucose control, arranging home services, chest x-ray, lab work, thoracentesis, and ultrasound. (Figure 4)

Many patients required more than one intervention. 36% of patients had medication modifications to optimize blood pressure, heart rate, or rhythm or to combat fluid-volume overload or treat minor infectious symptoms. 30-day readmission rates postoperatively for those enrolled was 4% (one due to an NSTEMI and one due to a PE) compared with 16% readmission
rate for our institution for non-enrolled patients with home discharge during this period. The
Perfect Care study cohort mortality rate was 0%. With regards to patient satisfaction, 36 patients
completed the post-visit survey. 97% of respondents reported having either a good, very good, or
excellent overall healthcare experience with 3% indicating a fair or poor experience. 89% of
respondents indicated their experience with the remote monitoring devices as good or excellent
and 11% rated it as fair or poor.

Tele Heart Care

Tele Heart Care went live June 2022 with 203 patients enrolled. (Table 1) Of the 83
patients who underwent cardiac surgery who were not enrolled, reasons for this included
discharge to a skilled nursing facility, not answering their phone to confirm or complete the visit,
or the patient opted not to participate. Of the 203 patients, 144 were male and 59 were female
with a mean age of 65 years old (SD=10). 76% were Caucasian, 17% African American, 3%
Asian, and 4% Other. Over the 6-month period between June 2022 to December 2022,
readmission rates of all cardiac surgery patients at our institution regardless of discharge
disposition fell from 24% in June to 4% in December, and fell from 15.73% in Q2 to 9.68% in
Q4. (Figure 5) With regards to post-discharge return to the emergency room, 12% of patients not
enrolled returned while only 7% of those enrolled returned.

DISCUSSION

The Perfect Care study implemented telemedicine visits at days 3 and 10 post cardiac
surgery discharge and was associated with a reduction in 30-day readmission rates for those
enrolled which encouraged the development of our Tele Heart Care program that supported this
reduction in 30-day readmission rates. We found that a telemedicine program for early
postoperative care of the cardiac surgery patient carries important utility for better patient care,
including improved outcomes and improved patient satisfaction scores, in contrast to prior
suggestions that the role of telemedicine is best placed in long-term follow-up settings. (Figure
6)

On the contrary, Telehealth in this study was used to augment care in the early period
between discharge and a patient’s usual in-person follow-up with their surgeon at approximately
postoperative week 4. The creation of a comprehensive post-discharge telemedicine program
inclusive of those who underwent adult cardiac surgical intervention necessitated the inclusion of
multiple stakeholders, a critical component of program success. Multidisciplinary care and
patient involvement in the management of their health are both augmented by telemedicine and
previously shown to sustain reduction in readmissions. By the continuous collection of vital
signs as opposed to only reviewing data points at postoperative visits, providers are able to detect
any alarming trends and intervene quicker. Images in medicine proved helpful as well not just for
patients but for the large number of team members involved in the care of cardiac surgery
patients. (Figures 1-3)

Developing an organic post-discharge telemedicine program without trial resources posed
a number of obstacles which were ultimately overcome. It proved difficult to secure funding to
outright provide monitoring devices universally to the population. Third-party payer
reimbursement was investigated but was not widely available on most plans to include Medicare.
As such, a process was created encouraging patients preoperatively to purchase or secure access
to their own personal scale, blood pressure cuff and pulse oximeter. Recognizing the
vulnerability of those without the resources to secure such devices, nonprofit grant funding was
secured to provide a limited supply of scales, blood pressure cuffs, and pulse oximeters to those patients unable to purchase for themselves. Importantly, we found that the large majority of patients were able and willing to secure their own medical monitoring devices. Affordability, without compromising clinical outcomes, is essential for a telemedicine care model to be a viable option for healthcare delivery.

The Perfect Care study patient population was largely male and Caucasian and as such may not be generalizable to the larger public, but the real-world results from our organic Tele Heart Care program with a diverse population indicates broad benefits. In addition, this study was limited to cardiac surgery but it is suggested that this same model would be effective for other specialties. However, barriers to telemedicine implementation and adoption still exist. A systematic review found that the highest frequency patient barrier is age, followed by level of education, and computer literacy. In efforts to combat this, we offered the opportunity for patients to conduct visits via telephone for those that are not able to access wifi or work smart technology. The same review found that the highest frequency organizational barrier is cost, followed by reimbursement, legal liability, and privacy confidentiality. For patients participating in Tele Heart Care that went home by themselves or with home care experienced a difference in average direct variable cost of $7,000 or lower for the period between June 2022 to March 2023. By using the electronic medical record for patient interactions and visits, we remained HIPAA compliant and protected patient health information. By allowing patients to conduct visits within their own home, patients may personalize their attendees to allow more participation from their support group such as family members or caretakers. A decrease in the number of scheduled clinic visits can make a significant impact on improving access to surgical services.
Other surgical specialties have conducted research on optimal positioning for mobile evaluation of surgical sites. Both patient and provider education is necessary for successful adoption. Patient satisfaction is essential for telemedicine to be a viable mode of healthcare delivery and should remain a focus for telemedicine programs in the future. Travel cost, absence from every-day activity, and dependence on others are all barriers to access to healthcare and the Tele Heart Care program we describe may improve access for underserved cohorts. The need remains for definition of and action towards provider reimbursement, insurance coverage, data management guidelines, and guidance on care across state lines.

A limitation in the interpretation of the data and processes presented includes potential concomitant benefit to patients from a robust infection prevention initiative as well in an existing ERAS Cardiac pathway. No a priori statistical assumptions were made for either study and as such statistical significance was not calculated. Additionally, the Perfect Care study participants were required to be smart technology-proficient and therefore may of inherently higher socioeconomic status, introducing bias. This bias was attempted to be mitigated by removing the requirement for smart technology-proficiency for participation in Tele Heart Care. The calculated STS predicted risk of mortality was lower for those enrolled in Perfect Care than those not enrolled, however this may be skewed since it was only for isolated CABG and scores were not calculated for the 22% of the enrolled population undergoing additional procedures. This study was conducted at a large community-based health system, and each institution’s organization structure varies which could play a significant role in the implementation of a telemedicine program. Ultimately, telemedicine may be implemented in whichever way fits an institution best. Finally, technical literacy is often associated with age and socioeconomic status, and we acknowledge the importance of research in overcoming this obstacle for patients.
CONCLUSIONS

In conclusion, an APP-led post-discharge telemedicine program following cardiac surgery can reduce hospital readmission, barriers to care, and improve patient satisfaction. With involvement of multiple stakeholders, a successful program can be launched despite the present state of national health system finances with limited human capital and constrained access to monitoring equipment. Increased follow-up intervals are made possible by telemedicine.

REFERENCES


**TABLES**

Table 1: Participants demographics comparison between the Perfect Care study and Tele Heart Care.

<table>
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<th>Category</th>
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<td><strong>Perfect Care</strong></td>
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<td>Female</td>
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<td>Mean Age</td>
<td>61 years (SD=11)</td>
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<tr>
<td></td>
<td>Caucasian</td>
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<td>-----------</td>
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<tr>
<td></td>
<td>African American</td>
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<tr>
<td></td>
<td>Asian</td>
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<td></td>
<td>Other</td>
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**Tele Heart Care**

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<thead>
<tr>
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<th>Total Participants</th>
<th>203</th>
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<tr>
<td>Male</td>
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<td>144</td>
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<tr>
<td>Female</td>
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**Mean Age**

65 years (SD=10)

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<th></th>
<th>Caucasian</th>
<th>76%</th>
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<tr>
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<td>African American</td>
<td>17%</td>
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<td></td>
<td>Asian</td>
<td>3%</td>
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<tr>
<td></td>
<td>Other</td>
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**Standard Deviation (SD)**

326

**FIGURES**

Figure 1: The Tele Heart Care logo used at WakeMed Health and Hospitals

Figure 2: An excerpt from the Tele Heart Care flyer aimed at encouraging patients to check their vital signs and record them on a log. A 3-day example of the log is also shown, which will be reviewed during the telemedicine visit.
Figure 3: Methods and process for both Perfect Care and Tele Heart Care from patient identification and enrollment preoperatively to completion of telemedicine visits postoperatively with included typical postoperative in-person follow up.

Figure 4: Interventions made as a result of telemedicine visits during the Perfect Care study categorized by type in decreasing order of prevalence by number of occurrences.

Figure 5: 30-day readmission rates in our cardiac surgery department shown by quarter showing a decrease from 15.73% in Q2 right before Tele Heart Care implementation to 9.68% in Q4 after Tele Heart Care implementation.

Figure 6: Graphical abstract providing an overview of the telemedicine process and important findings.
• **Weigh yourself every morning**
  Write down your weight on your log sheet. When weighing, wear the same amount of clothing each day and weigh yourself after using the bathroom, but before eating or drinking.

• **Check your blood pressure**
  Write down your blood pressure results. To get the best blood pressure reading, be seated and rest seated for 5 to 10 minutes. Check your pressure levels by placing your arm extended on a table top with your palm facing up. If using a wrist cuff, check in a “cross your heart” position keeping the cuff level with your heart.

• **Check your temperature, oxygen levels and heart rate**
  Use a pulse oximeter for your heart rate and oxygen levels. Write those results, and your temperature, on the log sheet.

• **Check your blood sugar levels**
  Only check your blood sugar levels and document if you are diabetic.

• **Virtual visits**
  On the days of a video visit, start your visit at the time of appointment check-in. Send pictures of your incisions (chest, chest tube sites, and leg) via message at least 3 hours prior to your appointment. If you are concerned about your incision at any time, please call the office. Also have your log sheets handy to share that information.

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</table>
**Preoperatively**

**Perfect Care**
- Identification:
  - CABG patients
  - Discharged home without home health
  - Smartphone availability
  - Wi-Fi connection
  - Bluetooth connectivity
- Enrollment:
  - Appointments made before discharge

**Tele Heart Care**
- Identification:
  - All cardiac surgery patients
  - Those not discharged to SNF
  - No technology requirements
- Enrollment:
  - Appointments made before discharge

**Postoperatively**

**Surgery**
- Setup of provided home wearables for heart rate monitoring, BP cuff, and scales
- Vital signs monitored through smartphone application
- Automatic notification if abnormal
- Pre-visit survey distributed
- Telemedicine visits at days 3 and 10 post discharge conducted live, face-to-face
- Typical post discharge day 14 in person visit

**Interventions made**
Intervention Breakdown by Type

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<th># of Occurrences</th>
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<td>Wound Care</td>
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<td>Arrhythmia</td>
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<td>Pain Management</td>
<td>9</td>
</tr>
<tr>
<td>Glucose Control</td>
<td>7</td>
</tr>
<tr>
<td>Arrange Home Health</td>
<td>5</td>
</tr>
<tr>
<td>Chest X-Ray</td>
<td>3</td>
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<td>Lab</td>
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<td>Thoracentesis</td>
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<td>Ultrasound</td>
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- Two telemedicine visits at days 3 and 10 post discharge
- Home vitals collection
- Pre-visit health surveys

Findings: An APP-led post-discharge telemedicine program following cardiac surgery can reduce hospital readmission and barriers to care, and also improve patient satisfaction.
30-day Readmission Rate

% of patients

Quarter

Q1 2022  Q2 2022  Q3 2022  Q4 2022

14.97%  15.73%  14.11%  9.68%