Published in final edited form as:

Cardiovasc Resusc Med. 2018 ; 19(1 Pt B): 106–111. doi:10.1016/j.carrev.2017.06.008.

The Impact of Care Management Information Technology Model On Quality Of Care After Coronary Artery Bypass Surgery: “Bridging the Divides”

William S. Weintraub, MD¹, Daniel Elliott, MD, MSCE¹, Zaher Fanari, MD², Jennifer Ostertag-Stretch¹, Ann Muther, Margaret Lynahan¹, Roger Kerzner, MD¹, Tabassum Salam, MD¹, Herbert Scherrer¹, Sharon Anderson¹, Carla A Russo, MS¹, Paul Kolm, PhD¹, and Terri H Steinberg, MD, MBA¹

¹Christiana Care Health System, Newark, DE

²Prairie Heart Institute, Springfield, IL

Abstract

Background—Reducing readmissions and improving metrics of care are a national priority. Supplementing traditional care with care management may improve outcomes. The Bridges program was an initial evaluation of a care management platform (CareLinkHub), supported by information technology (IT) developed to improve the quality and transition of care from hospital to home after Coronary Artery Bypass Surgery (CABG) and reduce readmissions.

Methods—CareLink is comprised of care managers, patient navigators, pharmacists and physicians. Information to guide care management is guided by a middleware layer to gather information, PLR (ColdLight Solutions, LLC) and presented to CareLink staff on a care management platform, AerialTM (Medecision). In addition there is an analytic engine to help evaluate and guide care, NeuronTM (Coldlight Solutions, LLC).

Results—The “Bridges” program enrolled a total of 716 CABG patients with 850 admissions from April 2013 through March 2015. The data of the program was compared with those of 1111 CABG patients with 1203 admissions in the 3 years prior to the program. No impact was seen with respect to readmissions, Blood Pressure or LDL control. There was no significant improvement in patients’ reported outcomes using either the CTM-3 or any of the SAQ-7 scores. Patient follow-up with physicians within 1 week of discharge improved during the Bridges years.

Conclusions—The CareLink hub platform was successfully implemented. Little or no impact on outcome metrics was seen in the short follow-up time.

Address for Correspondence: William S. Weintraub, MD, Division of Cardiology, Christiana Care Health System, Newark, DE 19317, Telephone: 302-733-1200; Fax: 302-733-4998, wwintraub@christianacare.org.

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Keywords

Information technology; Transition of care; Care management; Coronary Artery Bypass Surgery; Readmissions

The recognition that rising health care costs in the United States are unsustainable and also the appreciation that health outcomes in the United States lag behind other developed nations has led to efforts to improve outcomes.¹ In particular the goals are to improve health, improve health care and lower costs.² Health care costs are increasingly considered as important new target of quality improvement processes. A particular area of concern has been the problem of the transition from hospital to home in patients hospitalized for an acute event.³ The post-discharge period is a difficult one for patients and families, and the transition has not historically been as efficiently as it might be.⁴ A disease area of concern is ischemic heart disease. Patients hospitalized for revascularization are at risk of readmission and of recurrent ischemic events.⁵⁻⁷ There is solid evidence from randomized trials that secondary prevention, including both lifestyle modification and appropriate pharmacologic management, will reduce ischemic events.⁸ There is also evidence that readmissions can be reduced, but more data is needed on how to specifically target readmissions rate through quality improvement processes.^{9, 10}

Care management may be able to improve outcomes by making sure that patients get necessary services, and are better able to adhere to therapies.¹¹ Care management is dependent on adequate information in order to guide therapy. There are multiple data streams concerning patients to be integrated and then presented to the care managers. To successfully accomplish this in a health care system, specialized software is required to integrate in-patient and outpatient data and additional specialized software for the care managers to work with that will help guide their tasks. An additional principle of care management is that it is not possible to provide all services to all patients. Rather patients at highest risk or those where an intervention can reduce risk are those who should receive the most extensive care management support. Patients at lower risk need less intense services.

In the “Bridging the Divides” program we set out to develop an IT-enabled longitudinal care management program for patients following an acute myocardial infarction (MI) or percutaneous coronary intervention. The goals of this program were to decrease readmissions, improved patients reported outcomes, improve management of hypertension and hyperlipidemia. The purpose of the present report is to describe our initial experience with IT enabled care management for ischemic heart disease with an emphasis on readmissions and secondary prevention.

Methods

The protocol was approved by the Institutional Review Board of Christiana Care Health System.

Patient Population

The study population comprised patients undergoing revascularization by coronary artery bypass surgery (CABG). This program was considered part of standard medical care, and this was reflected in the consent process. Patients were offered the opportunity to opt out of the program. This process was carefully reviewed by the IRB and Christiana Care legal services and is consistent with the law in the state of Delaware.

The goal was to seek to enroll consecutive patients hospitalized in for CABG. The period of patient recruitment was from April 1, 2013 until March 31, 2015.

Care management

A team comprised of nurses, pharmacists, social workers and physicians (CareLink Services) provided care management to program participants. The CareLink team underwent web-based health coach training and continuous education about clinical issues and community resources. Detailed care plans and interaction schedules were developed for patients at each severity level. The care plans were integrated into our IT-enabled care management platform; utilizing the 'bundling' of tasks and auto-firing of future tasks based on planned interaction schedules.

An embedded Care Manager met with new enrollees in the hospital and coordinated immediate post-discharge care. This included the scheduling of first follow-up appointments with cardiologists and primary care providers, ensuring access to discharge medications, and arranging transportation. CareLink staff conducted most interactions with enrollees by telephone. During these calls, assessments were made on a series of clinical issues [e.g. chest pain, shortness of breath, fluid overload, medication adherence, symptoms or concerns related to co-morbidities] and non-clinical issues [e.g. difficulties in scheduling or attending follow-up visits, or barriers to obtaining medications]. CareLink staff engaged a network of resources including physicians, pharmacies or community organizations to resolve concerns. Enrollees were empowered to call CareLink directly for either clinical or non-clinical issues. CareLink staff also met with patients periodically at appointments in physician's offices, and engaged in videoconferences with enrollees receiving Home Health Care services.

CareLink leadership invested substantial effort in developing relationships with clinical providers in the hospital and in post-acute care medical practices. An embedded Care Manager joined rounds with the Cardiothoracic Surgery team in the hospital in order to prepare for patient discharge needs. A CareLink pharmacist developed close ties with our area pharmacies so as to be able to provide patients more options such as home delivery or pill-box filling. The CareLink team joined a home health care agency and area skilled nursing facilities by weekly teleconference for updates on enrollees. CareLink cultivated a method of direct contact with managers at high volume cardiology practices to streamline needs such as scheduling of urgent appointments.

In order to increase the adherence to statins, our pharmacist undertook detailed medication reconciliation with high-risk patients. In addition, if any member of the CareLink team recognized that a patient was not on an appropriate high-intensity statin, the pharmacist reviewed the medications and called prescribers to alert them to the possibility of this gap in

care. CareLink provided home blood pressure monitors to patients in need of them, and reviewed blood pressure readings at each telephone call. Education about the need for medication adherence and diet and lifestyle modification was regularly given. CareLink routinely identified enrollees who were active smokers and counseled them repeatedly about options for smoking cessation and referred them to community programs. CareLink encouraged enrollment in cardiac rehabilitation and facilitated scheduling.

CareLink placed heavy emphasis on directing patients to appropriate sites for regular follow-up or urgent care, and pro-actively identified issues that could lead to the need for emergency care. The CareLink Medical Director undertook a detailed analysis of each high-risk patient, attempting to detect all potential factors that could lead to readmission. A risk Prediction model to predict patients at high risk for readmissions was developed by studying the pre-Bridges patient population and was used to further help in identifying high-risk patients early at admission.¹² In addition, the entire CareLink team participated in a weekly review of all high-risk patients, working collaboratively to brainstorm solutions for patients' needs. A regular review of readmissions or complications in patients' progress was undertaken by the whole team in an attempt to learn lessons that were then applied to the care of future patients. Patients were followed up to one year after admission.

Information Technology Methods

The design goal for the health information technology infrastructure was to eliminate both: (1) the data divide between existing data sources that have been developed but that currently operate in isolation and, (2) the clinical divide that exists between clinical care settings and providers. The design of the HIT platform is based on the following guiding principles:

- The platform would be tested with a single disease state, but would support any disease state, population, care management, or utilization program.
- The CareLink “hub” would utilize software analytics to identify program participants and patients who need particular levels of service. This would be done through the use of data analytics and real-time algorithms that would react to individual data points. The goal was to eliminate a one-size-fits-all care plan; care management was to be patient specific, based on acuteness and severity of illness.
- Care management software was implemented in a manner that had not previously been used by care provider organizations.
- A real-time “learning” data environment was established to continuously inform the program managers of best practices and innovative learnings.

Recognizing that patients don't receive all their care within one closed healthcare system, the data platform was designed to integrate clinical data that is generated across multiple delivery sites and health systems using various technology solutions. A cross-organization data platform was designed to consume information from disparate systems, both within Christiana Care and elsewhere in Delaware, on which predictive analytics are used to identify cohorts of patient who will receive required care management. This data platform is used for three purposes: (1) to analyze clinical data from disparate systems and multiple

business entities, (2) to use evidence-based algorithms to generate operational tasks for the CareLink Hub staff, and (3) to observe correlations and other findings that relate to clinical care. The technical platform is described in detail in the online appendix.

Outcomes

We identified inpatient, non-elective readmissions to Christiana Care within 30 days of discharge from the index procedure. We identified readmissions at our own system and we used QualityNet Data from CMS to identify readmissions at other hospitals. Patients reported outcomes were assessed at 30 days and it included: 1- The CTM-3 (Three-Item Care Transition Measure) a three-question scale to assess preparation for discharge, with higher numbers being better. 2. The Seattle Angina Questionnaire-7 (SAQ-7) scores for the domains of physical limitation, angina frequency and quality of life (or disease perception). Patients were studied for achievement of LDL cholesterol and blood pressure goals (<100 mg/dL for LDL-C and <140/90 for blood pressure) at 1 year. Follow-up timing after discharge was assessed as well.

Statistical analysis of outcome measures

We compared outcomes for all CABG patients admitted three years prior to and two years of the bridges program (table 1). Continuous variables are reported as means and standard deviations, categorical variables as percentages. Differences in demographic and clinical variables between Bridges years were analyzed by linear regression for continuous variables or logistic regression for dichotomous variables. Trends (over the Bridges study period) in 30-day, non-elective readmission rates and blood pressure and LDL-C control at 6 months post-discharge were assessed by hierarchical logistic regression (some patients had more than one hospitalization). Trends were based on Bridges years or a quarterly time frame. Care Management contact with patients was categorized as 1–7, 8–14, 15–30 and greater than 30 days after discharge. These data were analyzed by ordinal logistic regression. Graphical displays of trends over the Bridges study period included fractional polynomial (FP) smoothing of the trends.¹³ Both unadjusted and adjusted analyses were performed for 30-day readmission. The covariates for adjusted analyses included: age, sex, race (black and other race with white as reference), previous number of hospitalizations within 6 months, previous AMI, previous PCI, previous CABG, total Elixhauser comorbidity count, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), diabetes, renal failure, hospital length of stay and discharge disposition (home with services, skilled nursing facility (SNF) and other facility with discharge to home as reference.

Results

The “Bridges” program enrolled a total of 716 CABG patients from April 2013 through March 2015. The data of the program was compared with those of 1111 CABG patients in the 3 years prior to the program.

Table-1 shows the baseline characteristics for CABG patients enrolled during and before the Bridges program. Most patients were discharged with home health services. Readmission rates are presented in table 2. There was no change over time. The time course of

readmission after CABG is shown in Figure 1 left panel (unadjusted) and Figure 1 right panel (adjusted for baseline variables). There was no significant change over time for inpatient readmission, the composite of inpatient and observation stay and the composite of inpatient; observation and emergency department visits (table 2).

Patient reported outcomes are in table 2 and Figure 2. From year one to year two of Bridges there was no significant improvement in the CTM-3 score in the CABG patients (Figure 2). Similarly there was no significant improvement in any of SAQ-7 scores for the domains of physical limitation, angina frequency and quality of life (Figure 2). The scores were generally high, suggesting at most mild residual angina.

Blood pressure and LDL cholesterol data are presented in table 2. The majority of patients were at goal, with little clear opportunity for improvement (table 2). Time to care management contact with the Bridges patients is shown in Table 2 and Figure 3. The majority of patients were contacted within the first seven days.

Discussion

We have developed and implemented an innovative approach to care management for population health with novel use of information technology. The information technology solution included 1) data integration, 2) care management support and 3) data analytics. This overall program bridges care from hospital to home, incorporating both in-patient and out-patient care and crosses between health system and multiple independent care facilities. It integrated the use of the regional health information exchange to provide data from outside of Christiana Care to inform care management. This program successfully enrolled 716 CABG patients between April 2013 and March 2015. We have been able to successfully provide care and measure outcomes in these patients. The program has yet to impact measures of outcome.

Health care systems have traditionally provided acute care and variable levels of continuing care. Even when out-patient care following an acute episode is provided within the health care system, there is often poor coordination between in-patient and out-patient care.⁴ Care providers in their offices will generally be poorly informed concerning details of patients' care provided outside their offices. They will generally not have ready access to information, and even if available, it will not be provided in an organized comprehensive manner. In addition there will be sociological and economic concerns of their patients that most care providers will not be able to impact. The CareLink program offers at least a potential solution to this patient management problem.

There has been a general recognition that society is not well served by hospitals providing acute care and leaving out-patient care to the community with little coordination between them.¹⁴ In particular, patients are at risk when they transition from hospital to home after an acute care episode.^{3, 4} Patients at such times will often have considerable changes in their medications and ability to care for themselves, placing stress on patients and families. Thus, patients who cannot cope with the care transition may be at high risk for readmission and recurrent events. Ischemic heart disease offers a striking example of the limitations of the

traditional pattern of care. Ischemic heart disease is common and in-patient episodes are expensive.¹⁵ There are also compelling clinical trial data that appropriate medical care will prevent additional cardiovascular events.⁸ In addition, there are compelling data that many patients do not adhere to evidence based medical therapies.¹⁶ The goal of care management must be to assist patients in overcoming the obstacles to continuing optimal medical therapy.

The Information technology (IT) enabled care management program provides an approach to integrate inpatient and outpatient care. However, there have been limitations to this program. It is expensive and difficult to implement. There are presently no off-the-self software programs expressly designed for this purpose. The software that exists is generally not interoperable, and thus normalization of the data is a big undertaking. The skill sets in the care management hub are extensive, including care managers, patients' navigators, pharmacists and physicians. Creating such an entity is difficult and time consuming. Getting the software to the point where it will really serve the care management hub is likely to be a several year undertaking. The difficulties of implementing a program such as this may limit its generalizability. However, once developed this approach may offer a system-wide platform for delivering population health.

Although some earlier data suggested that care management might offer an effective strategy for reducing readmissions and associated costs especially if it was directed towards those who are at higher risk for readmission, this was not shown in our study.¹⁷ It has been suggested that case management intervention needs to start during the hospitalization so that the care quality and patient education can be maximized during the hospital stay.¹⁸ In our approach, we involved all patients early on and coordinated the inpatient and outpatient care. We even developed a locally-driven specific prediction model with ability to predict those and high risk early during admission and directed additional resources towards those at higher risk.¹² Despite the complex program and resources we could not reduce readmission or achieved a significant improvement in other goal of care.

There are a number of limitations to this study. This was a single institution, observational study, using a time-series approach to assessing the effect of the care management intervention. A randomized trial of the care management intervention was not felt to be practical. There may also not have been enough time for the intervention to affect metrics of readmission or other measure of outcome. We also did not adjust for the potential impact of CABG care improvement over the pre-Bridges and Bridges years on reported outcomes. Efforts to reduce readmission and improve overall care have been on-going for some years, so at least some of the ability to improve outcomes may have been limited by generally good outcomes at baseline.

Conclusion

In conclusion, we have developed and successfully implemented an approach to information technology enabled care management with the intent of improving health care for patients with ischemic heart disease. While we have not been able to reduce readmissions or costs to date, the Bridges grant has facilitated the development of our institutional infrastructure for health care delivery and transition of patients care to the community.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

Supported by Grant Number 1C1CMS331027 from the Department of Health and Human Services, Centers for Medicare & Medicaid Services. Drs. Weintraub and Kolm are supported by and Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health under grant number U54-GM104941 (PI: Binder-Macleod).

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Figure 1.
30 Days Non Elective Readmissions With Functional Polynomial Smoothing

Figure 2. CABG Patient's Reported Outcomes

30 Days CABG patients' reported outcomes. (Abbreviations: PCI: percutaneous coronary intervention, CTM: care transition measure, SAQ: Seattle Angina Questionnaire, PL: Physical Limitation, AF: Angina Frequency, QL: Quality of Life.)

Figure 3.
CABG patients' Care Management contact following discharge.

Table 1

CABG demographic and clinical characteristics by Bridges year.

Variable	Pre-Bridges Year 3	Pre-Bridges Year 2	Pre-Bridges Year 1	Bridges Year 1	Bridges Year 2	P value
Dates of Enrollment	4/1/2010 – 3/31/2011	4/1/2011 – 3/31/2012	4/1/2012 – 3/31/2013	4/1/2013 – 3/31/2014	4/1/2014 – 3/31/2015	N/A
Patients #	423	374	314	352	364	N/A
Hospitalization #	456	402	345	422	428	N/A
Age (years)	67.5 ± 11.1	67.1 ± 11.2	67.1 ± 10.9	66.1 ± 11.1	67.2 ± 10.7	0.410
Male (%)	73.0	73.0	75.5	72.4	75.5	0.524
Race (%)						
White	88.6	85.0	86.9	81.0	83.0	0.018
Black	8.3	12.6	8.6	11.9	12.6	
Other	3.1	2.4	4.5	7.1	4.4	
Previous AMI	7.9	5.7	5.5	4.5	6.8	0.348
Previous PCI	27.8	19.9	18.0	21.3	20.3	0.029
Previous CABG	2.2	0.7	2.0	1.9	0.9	0.426
Previous hospitalization within 6 months (%)						
0	53.9	50.2	52.7	55.0	52.8	0.168
1	34.6	36.6	31.6	32.2	31.5	
>1	11.4	13.2	15.6	12.8	15.6	
Insurance (%)						
Medicare	63.2	61.7	60.9	60.9	57.5	<0.001
Medicaid	3.7	5.0	7.2	7.6	5.8	
Private	29.6	30.6	27.5	26.8	32.2	
Self pay	2.6	2.2	1.2	1.4	0.7	
Other	0.9	0.5	3.2	3.3	3.7	
Elective (%)	49.6	50.2	46.7	39.3	37.6	<0.001
Transfer (%)	4.4	8.0	5.8	5.9	7.7	0.183
Elixhauser comorbidities						
Total count	4.3 ± 3.0	4.7 ± 2.8	5.0 ± 2.8	5.3 ± 3.0	5.2 ± 2.9	<0.001
CHF (%)	30.3	34.1	35.4	37.0	34.8	0.115

Variable	Pre-Bridges Year 3	Pre-Bridges Year 2	Pre-Bridges Year 1	Bridges Year 1	Bridges Year 2	P value
COPD (%)	27.6	28.6	29.6	33.4	28.7	0.357
Diabetes (%)	41.4	45.0	47.5	50.7	47.4	0.026
Renal failure (%)	22.6	21.4	21.2	22.0	18.2	0.198
Hypertension (%)	85.3	90.8	90.4	89.8	94.6	0.001
Depression (%)	11.8	13.4	15.1	15.9	19.9	0.001
Admission BMI	29.8 ± 6.1	30.5 ± 7.3	29.8 ± 6.0	30.6 ± 6.8	31.0 ± 6.7	0.018
Length of stay (days)	9.0 ± 7.6	9.3 ± 7.9	8.5 ± 5.7	9.3 ± 10.8	8.7 ± 7.0	0.646
Discharge disposition (%)						
Home	9.6	9.0	8.4	6.9	6.1	0.020
Home with services	71.5	67.7	69.3	68.3	67.5	
SNF	12.3	17.4	15.1	16.1	20.1	
Other facility	2.4	4.0	3.5	6.2	2.6	
Died in hospital	4.2	2.0	3.8	2.6	3.7	

Continuous variables are mean ± 1 standard deviation. Abbreviations: AMI: acute myocardial infarction, PCI: percutaneous coronary intervention, CABG: coronary artery bypass grafting, CHF: congestive heart failure, COPD: chronic obstructive pulmonary disease, BMI: body mass index, SNF: skilled nursing facility.

Table 2

CABG Patients Outcomes after enrollment in Bridges the Divide Program

Outcome	Pre-Bridges Year 3	Pre-Bridges Year 2	Pre-Bridges Year 1	Bridges Year 1	Bridges Year 2	p value
A- 30 Days Non-elective readmission rates (%)						
I	8.0	9.2	7.0	9.3	7.5	0.409
IO	12.3	12.8	10.5	12.5	12.0	0.396
IOE	16.1	17.0	15.0	16.6	16.1	0.503
B- BP and LDL-C control at 6 months post-discharge.						
BP	70.7 (75)	72.7 (161)	65.7 (146)	71.2 (208)	68.6 (220)	0.645
LDL	78.1 (64)	82.9 (70)	80.4 (56)	77.6 (76)	86.7 (75)	0.422
C- 30 Days Patient Reported Outcomes of CABG Bridges Patients.						
CTM-3	N/A	N/A	N/A	84.0 ± 17.7	82.9 ± 16.7	0.674
SAQ-7 PL	N/A	N/A	N/A	94.6 ± 16.7	95.7 ± 9.6	0.689
SAQ-7 AF	N/A	N/A	N/A	95.4 ± 12.4	95.0 ± 15.2	0.886
SAQ-7 QL	N/A	N/A	N/A	90.8 ± 15.6	82.0 ± 27.8	0.101
D- Care Management Contact With CABG Bridges Patients (%).						
Day 1-7	N/A	N/A	N/A	74.8	75.8	0.737
Day 8-14	N/A	N/A	N/A	4.1	5.8	
Day 15-30	N/A	N/A	N/A	7.8	7.1	
Day > 30	N/A	N/A	N/A	13.3	11.3	

Abbreviations: CABG: coronary artery bypass grafting, I: inpatients, IO: inpatient or observation, IOE: inpatient, observation or Emergency Department, BP: blood pressure, LDL-C: low density lipoprotein cholesterol. CTM: care transition measure, SAQ: Seattle Angina Questionnaire, PL: Physical Limitation, AF: Atrial Fibrillation, QL: Quality of Life.